# 3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.1 Introduction

This chapter of the Generic Environmental Impact Statement (GEIS) provides a description of the environmental conditions and resources in four regions of Wyoming, South Dakota, Nebraska, and New Mexico where previous and existing *in-situ* leach (ISL) uranium recovery operations have been licensed by NRC and where new ISL facilities may be proposed for U.S. Nuclear Regulatory Commission (NRC) review. These uranium milling regions are defined in Section 3.1.1 and provide the basis for the structure of Chapter 3, which describes the affected environments for each region. Section 3.1.2 includes general information that applies to each of the four regions.

### 3.1.1 Geographic Scope—Defining Uranium Milling Regions

For the purpose of analysis in this GEIS, NRC assumptions about potential future ISL facility locations were based on

- The locations of past and existing uranium milling operations in states where NRC has the regulatory authority over uranium recovery

- The locations where uranium milling companies have expressed interest in future uranium recovery using the ISL process

- The locations of historical uranium ore deposits in Wyoming, South Dakota, Nebraska, and New Mexico

In the United States, uranium ore deposits have been studied and developed in a number of western states: Arizona, Colorado, Montana, Nebraska, New Mexico, South Dakota, Utah, Washington, Wyoming, and Texas (see Figure 1.1-2). Regional ore deposits found in those states can encompass portions of several contiguous states.

The affected environment described in this chapter is further limited to states where NRC has authority to license ISL facilities. NRC does not have regulatory authority in all states, because at the state's request, NRC may relinquish its regulatory authority to the state. Therefore, in certain states, known as Agreement States, NRC has relinquished its regulatory authority to license uranium milling facilities. Colorado, Utah, and Texas are Agreement States with state, not NRC, regulation of uranium milling. NRC has retained its regulatory authority over uranium milling activities in non-Agreement States. Western non-Agreement States where NRC regulates uranium milling activities include Wyoming, South Dakota, Nebraska, and New Mexico. Montana, Arizona, and Nevada are also non-Agreement States with respect to uranium milling. No companies have indicated to NRC its plans at present to submit license applications to construct and operate ISL facilities in Montana, Arizona, or Nevada over the next several years (NRC, 2009).

Locations within Wyoming, South Dakota, Nebraska, and New Mexico that include ore deposits and where past, existing, or future uranium milling activities or interest has been identified are shown in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4.

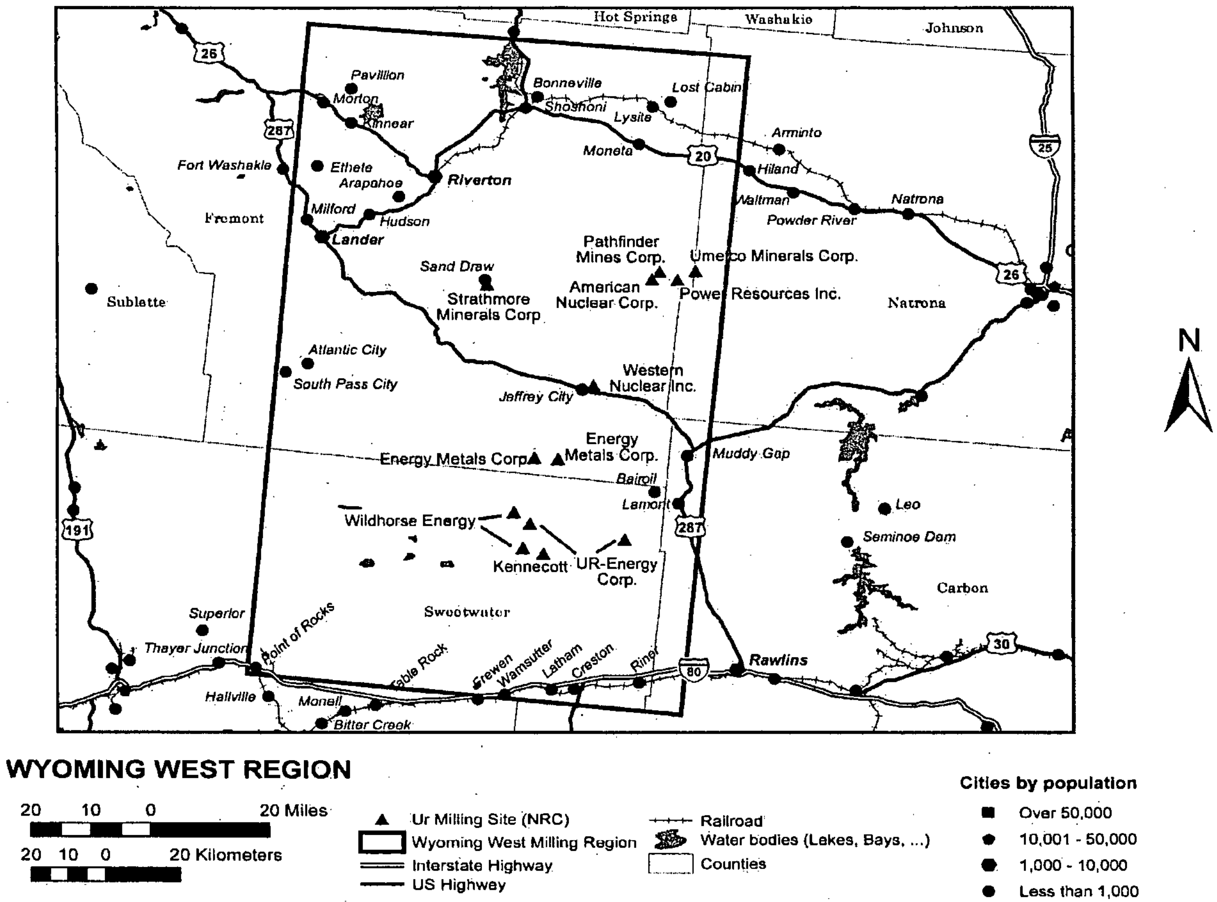


**Figure 3.1-1. Wyoming West Uranium Milling Region With Current and Potential ISL Milling Sites**

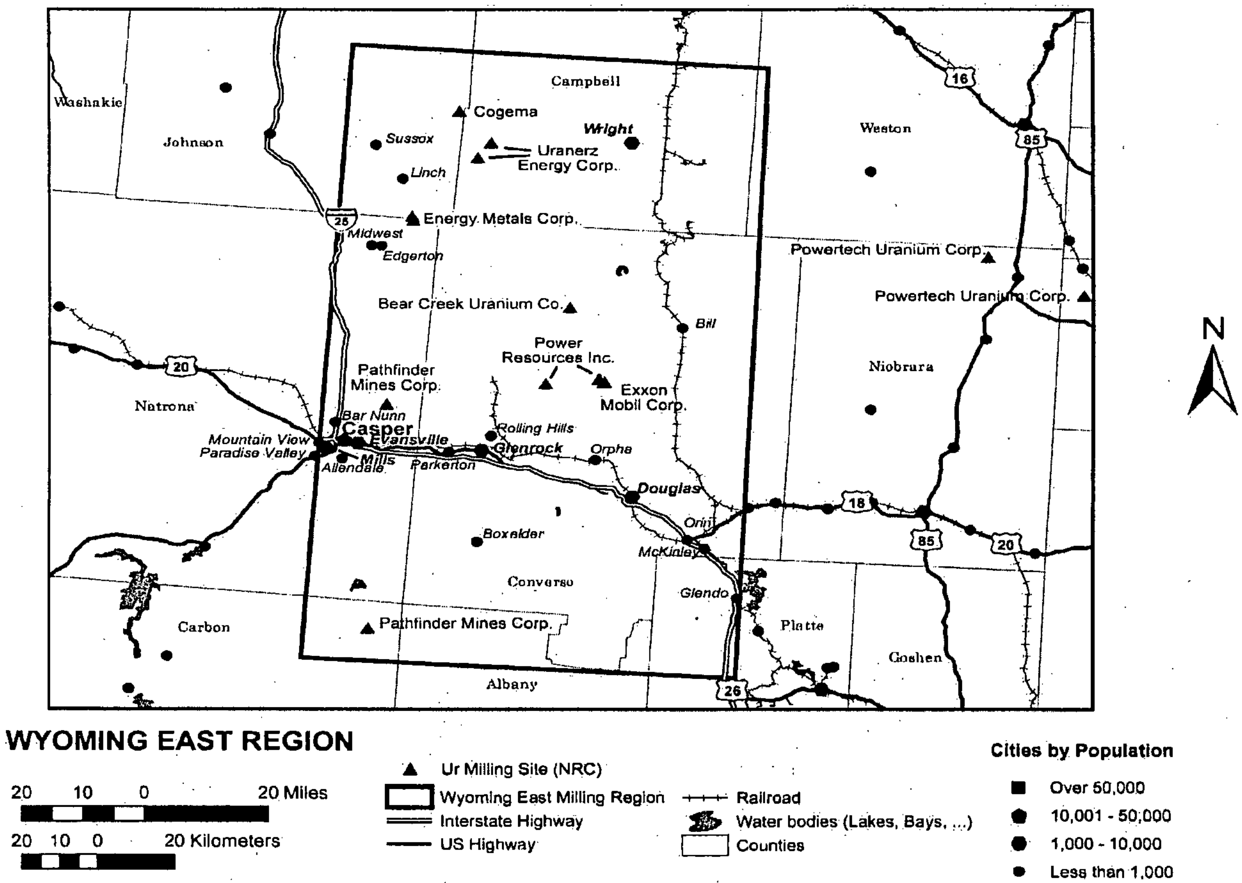


**Figure 3.1-2. Wyoming East Uranium Milling Region With Current and Potential ISL Milling Sites**

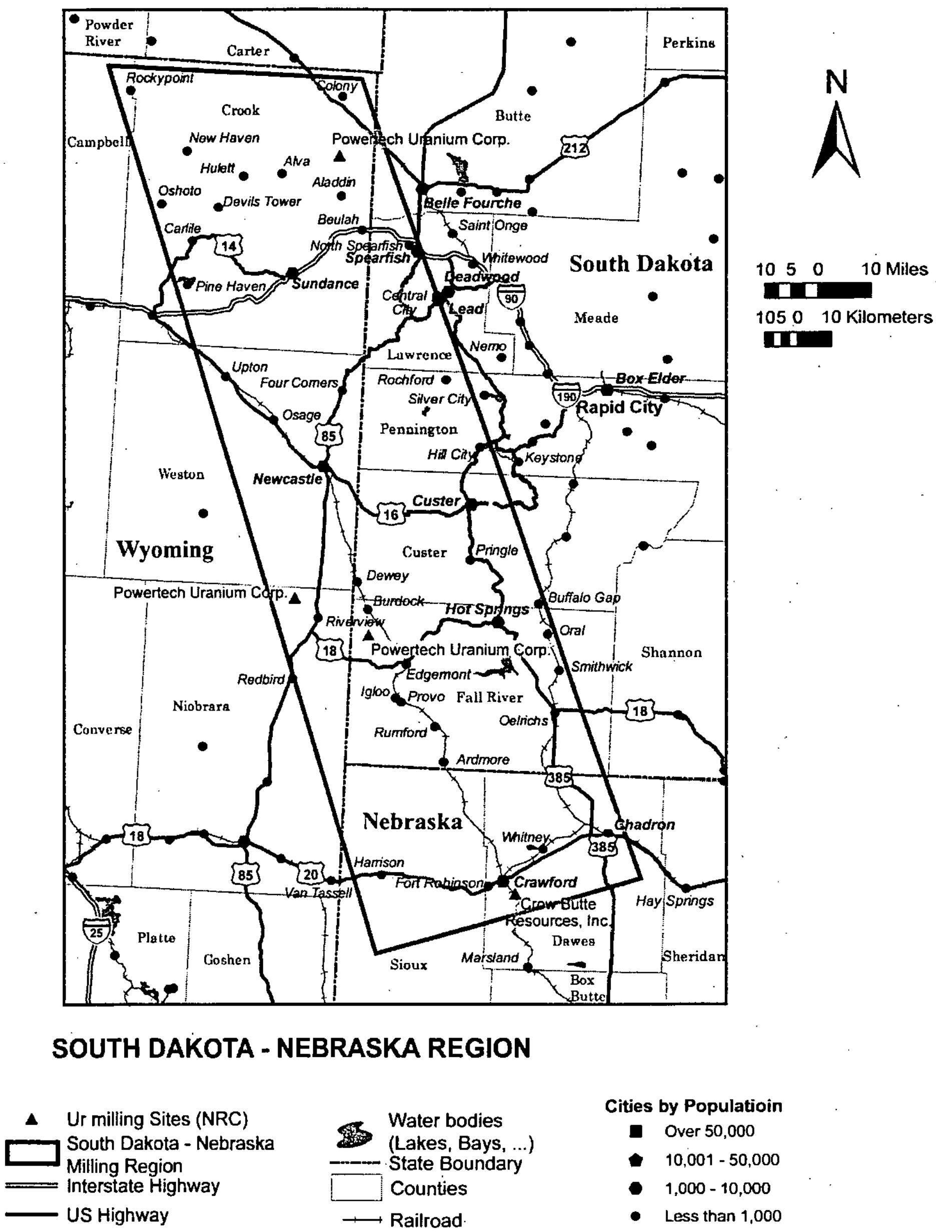


**Figure 3.1-3. Nebraska-South Dakota-Wyoming Uranium Milling Region With Current and Potential ISL Milling Sites**

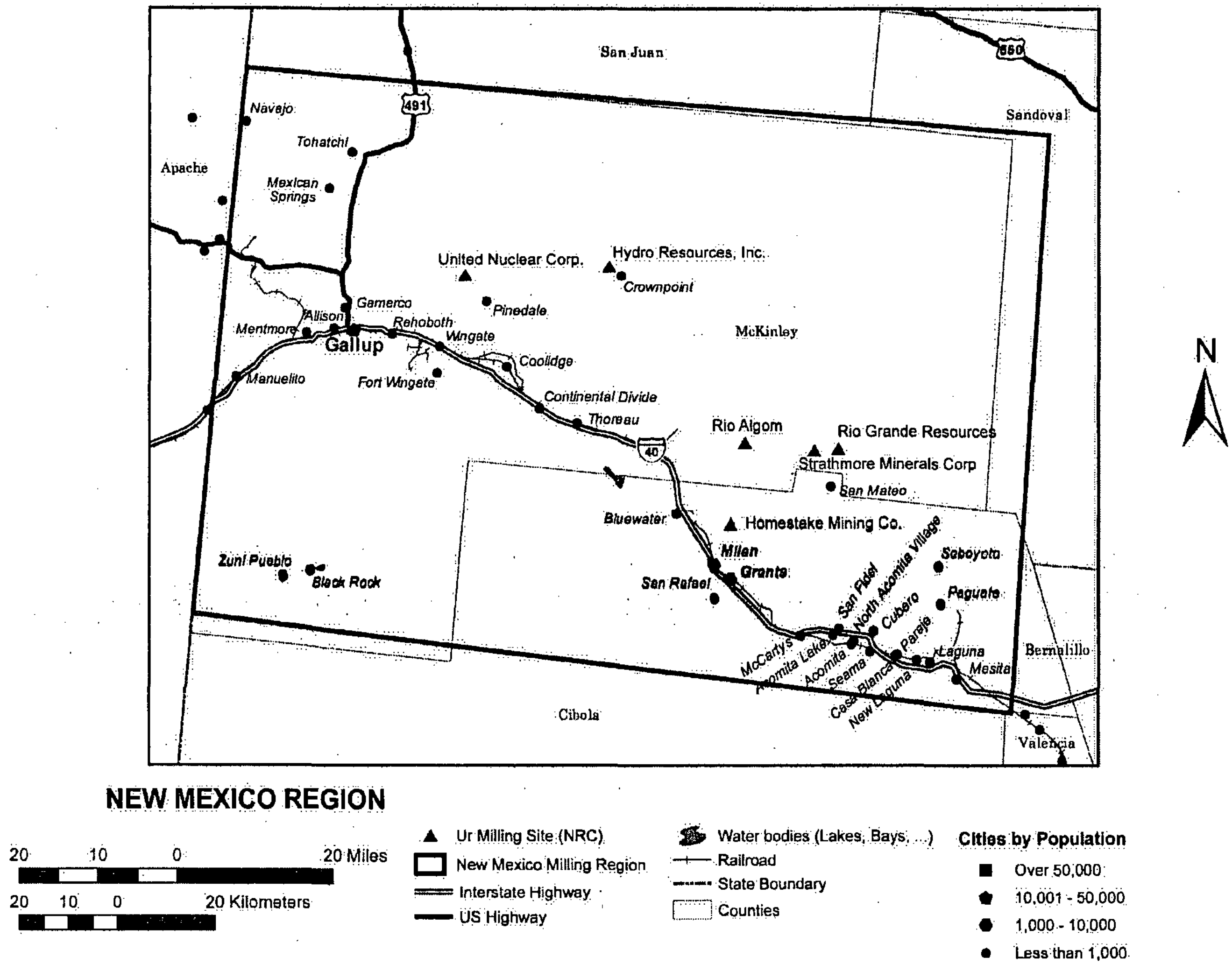


**Figure 3.1-4. Northwestern New Mexico Uranium Milling Region With Current and Potential ISL Milling Sites**

As shown in the figures, NRC has delineated separate uranium milling regions where the boundaries of each milling region encompass past, existing, and potential future ISL milling sites. In defining these regions, NRC also considered aspects of the affected environment (e.g., regional groundwater characteristics, regional demographics) such that potential future ISL milling sites within each region would more likely share those aspects for the purpose of evaluating potential environmental impacts. Therefore, NRC considers that these regions reasonably bound the geographic scope of the GEIS for describing the affected environment and for assessing potential environmental impacts within each region.

For the purposes of the GEIS, the regions have been named (see Section 1.4)

- Wyoming West Uranium Milling Region (Section 3.2)
- Wyoming East Uranium Milling Region (Section 3.3)
- Nebraska-South Dakota-Wyoming Uranium Milling Region (Section 3.4)
- Northwestern New Mexico Uranium Milling Region (Section 3.5)

Using this regional approach, the assessments of impacts in the GEIS may or may not be applicable or informative to reviews of ISL facilities proposed outside of the designated uranium milling regions. In such cases, the applicability of the GEIS would depend on the similarities of the proposed site and regional conditions with those described in the GEIS.

Identifying regions based on the locations of past, existing, and potential future uranium recovery operations as is done in the GEIS does not mean NRC prefers these locations or would prevent uranium recovery in other areas. It is the applicant or licensee that proposes the location of an ISL facility in the license application submitted to NRC, and NRC reviews such applications to fulfill its regulatory responsibilities.

### 3.1.2 General Information for All Uranium Milling Regions

To limit redundancies in discussing general information applicable to all four uranium milling regions addressed by the GEIS, that information is provided in this section.

#### 3.1.2.1 Formation and Characteristics of Sandstone-Hosted Uranium Ore Deposits

Sandstone-hosted uranium deposits account for the vast majority of the uranium ore produced in Wyoming, South Dakota, Nebraska, and New Mexico (Chenoweth, 1988, 1991; Collings and Knode, 1984; McLemore and Chenoweth, 1989, 2003). Uranium mineralization in these sandstone deposits occurs primarily in what have been termed stratabound or roll-front deposits (Rackley, 1972; Renfro, 1969; Collings and Knode, 1984; McLemore, 2007). A conceptual model of a roll-front uranium deposit is illustrated in Figure 3.1-5. Roll fronts occur where water infiltrates from the surface and flows through an aquifer with slight amounts of uranium. Near the surface, oxidizing conditions cause the minerals and volcanic ash to weather (or dissolve) and release minute quantities of uranium into the groundwater. As groundwater continues to flow, it can encounter reducing conditions where the uranium is no longer stable in solution. In an aquifer, a reducing environment is characterized by the presence of hydrogen sulfide ($H_2S$), iron sulfides, or organic material. As a result, uranium precipitates from the groundwater and forms mineral coatings on the sediment grains in the formation. The principal ore minerals found in the roll-front deposits are uraninite ($UO_2$) and coffinite ($USiO_4$) with associated pyrite, marcasite ($FeS_2$), hematite ($Fe_2O_3$), ferroselite ($FeSe_2$), native selenium, jordisite ($MoS_2$), and calcite ($CaCO_3$). The zoning and alteration associated with the formation of a typical sandstone

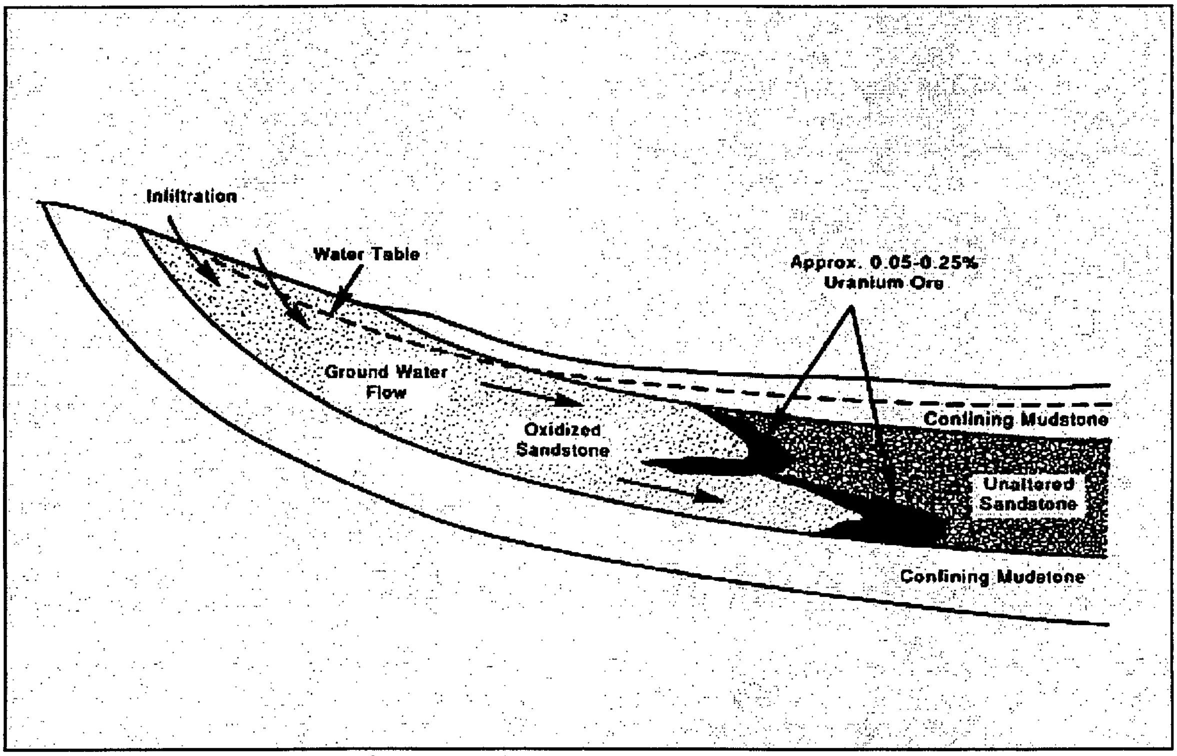


**Figure 3.1-5. Simplified Cross Section of Sandstone Uranium Roll-Front Deposits Formed by Regional Groundwater Migration (NRC, 1997)**

roll-front deposit are diagrammed in Figure 3.1-5. In addition to uranium, elements such as selenium, arsenic, molybdenum, and vanadium, which are generally mobile in oxidized conditions, are also precipitated in the vicinity of roll-front deposits because of the low solubility of their reduced forms. Harshman (1974) investigated the concentration and distribution of the ore and associated trace elements and minerals around the redox fronts of Wyoming ore deposits. Selenium, occurring as native selenium or ferroselite, was found at concentrations of several hundred ppm (parts per million) in zones at the edges of the altered sandstone or in reduced mineralized sandstone close to the redox interface. Molybdenum, occurring as jordisite, was found in highly variable concentrations, usually concentrated in the altered sandstone near the redox boundary. Vanadium, occurring as vanadium oxide ($V_2O_4$), was found at concentrations of several hundred ppm, deposited in the convex (reducing) side of the interface.

Roll-front deposits are ideally crescent- or C-shaped when viewed in cross section, with thin mineralization forming the tips of the crescents. Thick mineralization occurs in the center of the concave C-shaped ore body in the direction of groundwater flow. Individual mineralization fronts are typically from 0.6 m [2 ft] to more than 7.5 m [25 ft] thick and may be several hundred meters [feet] long. Fronts may coalesce to form ore bodies kilometers [miles] in length. Thin mineralized trails and more finely disseminated minerals branch off the main front and are located between fronts. High grade uranium roll-front deposits average about 0.2 percent $U_3O_8$. Lower grade ore (0.05–0.10 percent $U_3O_8$) is commonly present on the unaltered side of the higher grade roll front.

Several features are common to most major sandstone roll-front uranium deposits and their host rocks in Wyoming, South Dakota, Nebraska, and New Mexico (Rackley, 1972; McLemore, 2007). These features are: (1) sandstones of fluvial origin (i.e., produced by the action of a stream or river); (2) common association with arkosic (i.e., sediments with a considerable amount of the mineral feldspar) or micaceous sediment; (3) siltstones and mudstones interbedded with sandstones; (4) association with organic materials; (5) presence of pyrite in unweathered deposits; (6) gray color of the sandstones and light-gray or green color of the mudstones in unweathered deposits; (7) association with volcanic debris in the host formation or in overlying formations; (8) the discordant roll front features or solution fronts; and (9) the sharp contact between mineralized zones and adjacent carbonaceous-free or oxidized zones. The first seven features are related directly to the source rock, sedimentation, and the sedimentary environment; the last two features are related to the mineralizing process.

### 3.1.2.2 Complex Land Ownership Rights, Responsibilities, and Opportunities

The federal government, through the U.S. Bureau of Land Management (BLM) manages $2.8 \times 10^8$ ha [700 million acres] of subsurface mineral estate nationwide, including approximately $2.3 \times 10^7$ [58 million acres] where the surface is privately owned (BLM, 2007). In many cases, the surface rights and mineral rights were severed under the terms of the nation's homesteading laws. Applicable laws include the Coal Lands Act of 1909 and 1910; the Agricultural Entry Act of 1914; the Stock Raiding Homesteading Act of 1916; and the Mineral Leasing Act of 1920, as amended. These and other federal laws, regulations, and BLM policy directives provide the authority and direction for administering the development of federal mineral resources beneath privately owned surfaces.

The leasing and development of federal mineral resources occur in four phases including planning and leasing, permitting, drilling and production, and surface reclamation. In each phase, the BLM, the lessee/operator, and the private surface owner have rights, responsibilities, and opportunities.

Parcels of land or mineral estate that are open for leasing under the terms of a BLM land use plan may be nominated for leasing by companies or members of the public. BLM reviews every nomination to ensure that leasing the parcel would conform to the terms of the land use plan, which has been developed previously with broad public input.

The initial term for a federal mineral resource lease is 10 years, but lessees can apply to extend the lease at the end of the 10-year period. Successful bidding on and acquiring the lease gives the lessee or designated operator the right to enter and occupy as much of the surface as is reasonably required to explore, drill, and produce the mineral resources on the leasehold, subject to applicable federal laws, regulations, lease stipulations, and permit requirements. BLM works to encourage coordination and cooperation among all parties that have rights and responsibilities in these split estate situations.

Because federal mineral resources include uranium ore deposits, there is a potential for split estate situations to occur when there is interest in exploration or operations related to uranium milling in an ore deposit that is located on land where federal surface mineral resources are open for leasing under the terms of a BLM land use plan. BLM has programs and practices in place including planning, permitting and bonding that facilitate public involvement and encourage resolution of potential conflicts between surface owners and lessee/operators. Details of these programs including rights and responsibilities are discussed on the BLM website (www.blm.gov). BLM also must fulfill the requirements of the National Environmental Policy Act (NEPA), the National Historic Preservation Act (NHPA), the Endangered Species Act, the Clean Water Act, and other applicable laws regarding surface resources. NRC also has similar obligations with regard to licensing ISL facilities once an application for a license to operate has been submitted to NRC for review. NRC is currently working with BLM to develop working arrangements that will facilitate cooperation in efficiently meeting both agencies' obligations with respect to review of ISL facility proposals while limiting unnecessary duplication of effort. Results of these interactions (e.g., official agreements or memoranda of understanding) will be made available to the public once they have been developed.

### 3.1.3 References

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## 3.2 Wyoming West Uranium Milling Region

### 3.2.1 Land Use

Approximately 53.3 percent of the land in the state of Wyoming is public land (47 percent federal ownership and 6.3 percent state ownership). Most of these federal lands are located in the western and northwestern parts of Wyoming, and the vast majority of private lands is located in the eastern half of the state. BLM administers the largest amount of public land in the state (28 percent). BLM lands are mixed with private and state lands. Forty-eight percent of Wyoming privately owned surface land has a split-estate status (BLM, 2008a) (Section 3.1.2.2).

Private lands, including Native American lands, which are administered by the Bureau of Indian Affairs, represent 45.9 percent of Wyoming land. In terms of general landscape, Wyoming big sagebrush (30.8 percent) and mixed grass (20.2 percent) occupy about half of the land in Wyoming, while irrigated agriculture occupies only 4.2 percent of the land (Wyoming Geographic Information Science Center, 2008).

For the purpose of this GEIS, the Wyoming West Uranium Milling Region encompasses parts of Carbon, Fremont, Natrona, and Sweetwater Counties (Figure 3.2-1). This region, which is a part of the Rocky Mountain System, straddles the Wyoming Basin to the east and the Middle Rocky Mountains to the west (U.S. Geological Survey, 2004). Based on known past, current, and planned uranium milling operations, Figure 3.2-2 shows that these operations are concentrated in two major uranium districts known as the Crooks Gap area in the Great Divide Basin straddling northeastern Sweetwater County and southeastern Fremont County and the Gas Hills area in the Wind River Basin located in eastern Fremont County (see details in the Geology and Soils Section 3.2.3).

> **BLM Grazing Permit/ License/Lease**
> BLM grants official written permission to private permitees or lessees to allow a certain number, type, and class of their livestock to graze on public lands for a specified time period and on a defined rangeland.

The land ownership and use statistics for the Wyoming West Uranium Milling Region shown in Table 3.2-1 were calculated using the Geographic Information System used to prepare the map shown in Figure 3.2-1. The majority of the land of the four counties of this region is composed of federal land (66 percent) and Native American land (9 percent) (Table 3.2-1). Private lands, intermixed with BLM land, occupy approximately 25 percent of the region. The eastern tips of the Shoshone and Bridger National Forests form a very small part on the western edge of this region (1 percent). A portion of the Wind River Indian Reservation and land administered by the U.S. Bureau of Reclamation represent approximately 13 percent of the land at the northwestern corner of the Wyoming West Uranium Milling Region. Riverton, located in this corner, is the largest town of the region with almost 10,000 inhabitants (Figure 3.2-1). Riverton is located more than 80 km [50 mi] from the Crooks Gap area and the Gas Hills area. Towns in the vicinity of these two uranium districts include Jeffrey City, Sand Draw, and Bairoil, each of which has a population of a few hundred or less (Figure 3.2-2).

As shown on Figure 3.2-1, BLM manages the vast majority of the land in the Crooks Gap and the Gas Hills areas. The land is mostly used as rangeland for cattle and sheep grazing under the BLM permit system. Other land uses under BLM management include oil and gas development, wildlife habitat, and public recreation.

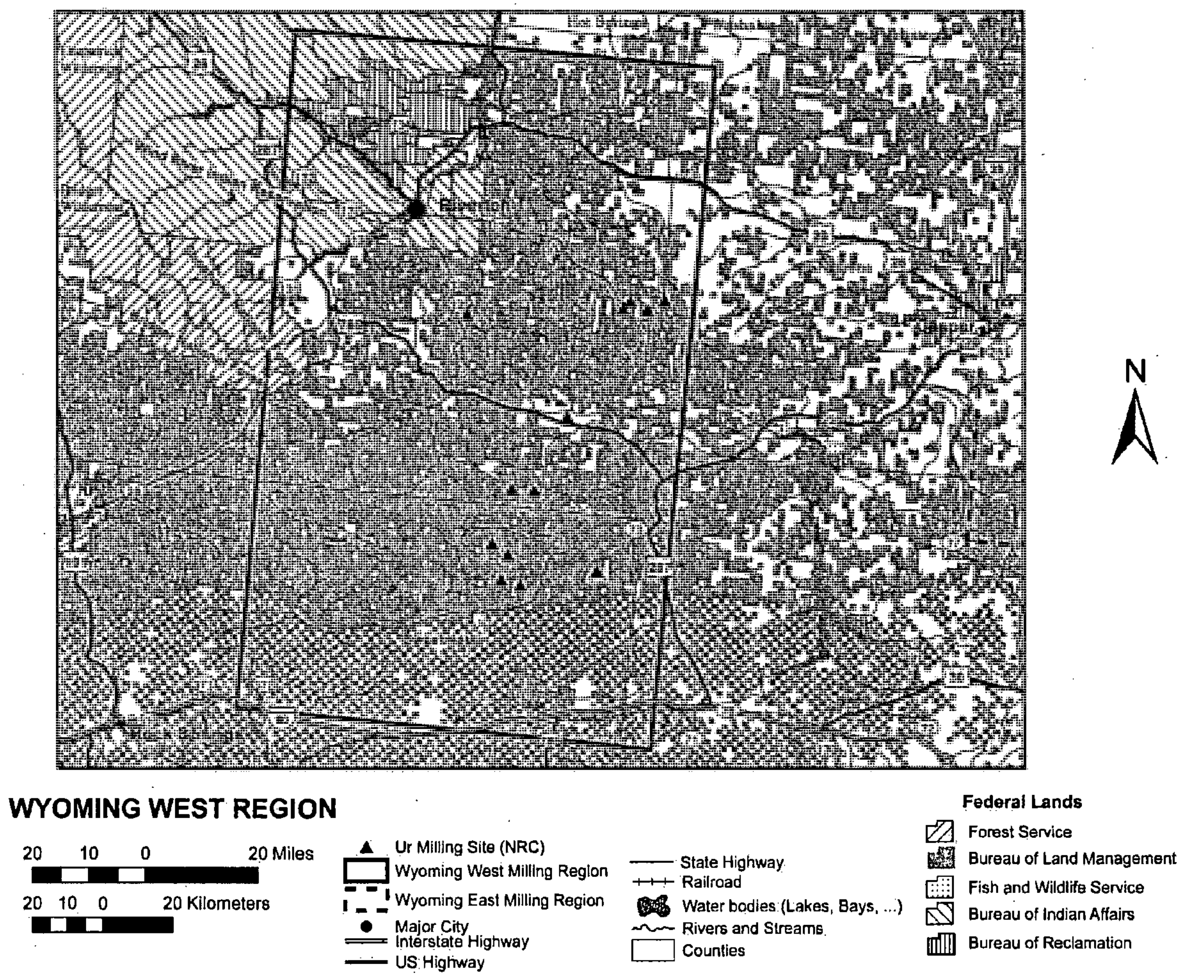



**Figure 3.2-1. Wyoming West Uranium Milling Region General Map With Current and Future Uranium Milling Site Locations**

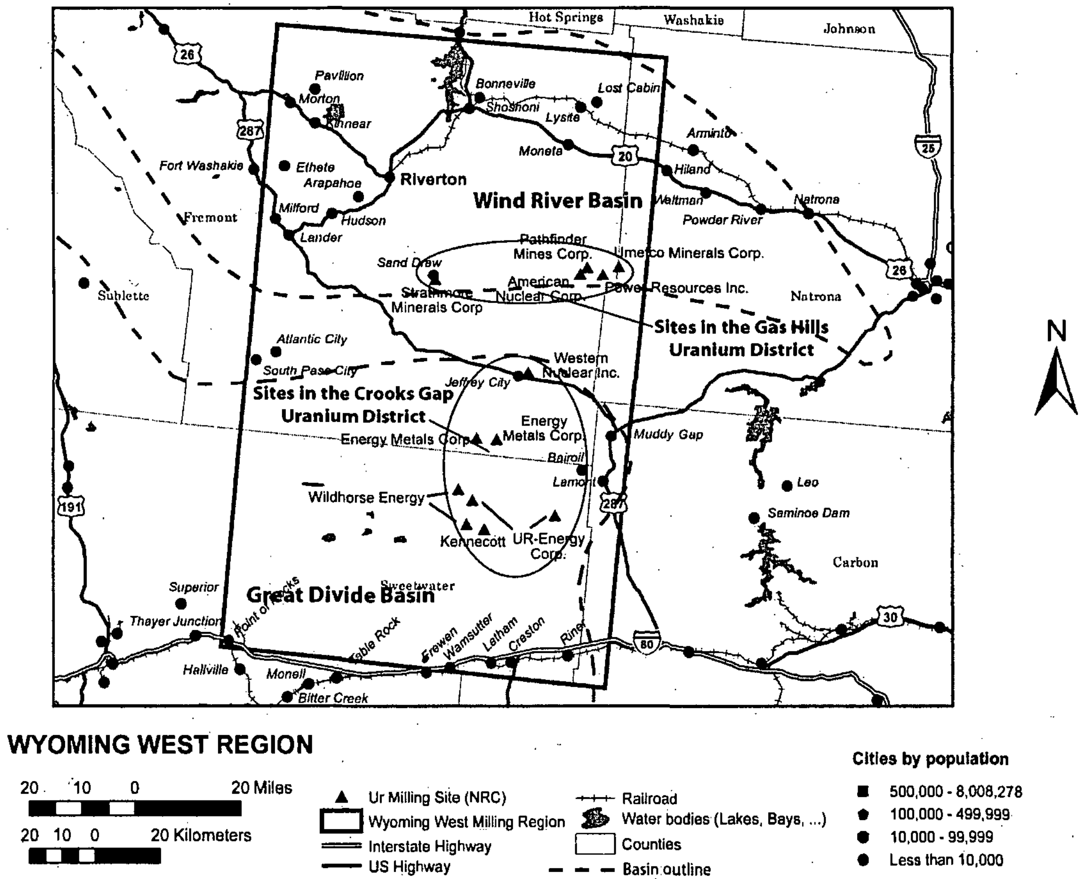



**Figure 3.2-2. Map Showing Outline of the Wyoming West Uranium Milling Region and Locations of the Crooks Gap Uranium District in the Great Divide Basin and the Gas Hills Uranium District in the Wind River Basin**

**Table 3.2-1. Land Surface Ownership and General Use in the Wyoming West Uranium Milling Region**

| Land Surface Ownership and General Use | Area ($mi^2$) | Area ($km^2$) | Percent |
|---|---|---|---|
| U.S. Bureau of Land Management, Public Domain Land | 5,476 | 14,184 | 61.4 |
| Private Lands | 2,191 | 5,675 | 24.6 |
| Bureau of Indian Affairs, Indian Reservations | 809 | 2,095 | 9.1 |
| Bureau of Reclamation | 352 | 911 | 3.9 |
| U.S. Forest Service, National Forest | 87 | 226 | 1 |
| **Totals** | 8,915 | 23,090 | 100.0 |

Most of the private land in the eastern and southern part of the region is intermixed with BLM grazing land and is used to produce hay for feeding cattle in winter. Other scattered land uses in this region include wildlife habitat, wilderness areas, hunting, dispersed recreation and off-road vehicle use, oil and gas recovery, gas and carbon dioxide pipelines and transmission lines, and cultural and historical sites, such as the Oregon/Mormon Pioneer National Historic Trail (BLM, 1987, 2007e). The presence and extent of these land uses will have to be addressed on a site-specific basis at, and in the vicinity of, any new potential uranium milling facility.

### 3.2.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of goods and personnel (Section 2.8). As shown on Figure 3.2-3, the Wyoming West Uranium Milling Region is accessible by Interstate 80, which borders the south of the region between Rock Springs and Rawlins. The Wyoming West Uranium Milling Region is also accessed from the west by State Highway 28, from the northwest by U.S. Highway 26, from the north by U.S. Highway 20, and from the east by U.S. Highway 20 and State Route 220. Rail lines traverse the northern and southern portions of the region.

Areas of past, present, or future interest in uranium milling in the region are also shown in Figure 3.2-3. These areas are located in four main subregions when considering site access by local roads. Areas of milling interest that are located in the northeastern part of the region near the Natrona and Fremont County borders are accessible by State Route 136 from Riverton or by a local access road that travels south from Waltman until intersection with State Route 136. Another area of milling interest is in the central portion of the milling region adjacent to State Route 135, which is accessed from the north from Riverton or from the south from U.S. Highway 789. Traveling east from that point on U.S. Highway 789 to Jeffrey City is another area of milling interest. Other sites of interest in the southeastern portion of the Wyoming West Uranium Milling Region (Great Divide Basin Area in Sweetwater County) are accessible by unpaved local access roads that extend west from U.S. Highway 287 at Bairoil and a location farther south between Bairoil and Rawlins. These west-trending roads intersect a north and south-trending unpaved road that connects Wamsutter on the southern border of the region at Interstate 80 to Jeffrey City and Moneta to the north. U.S. Highway 287 continues south to Interstate 80.

Table 3.2-2 provides available traffic count data for roads that support areas of past or future milling interest in the Wyoming West Uranium Milling Region. Counts are variable with the

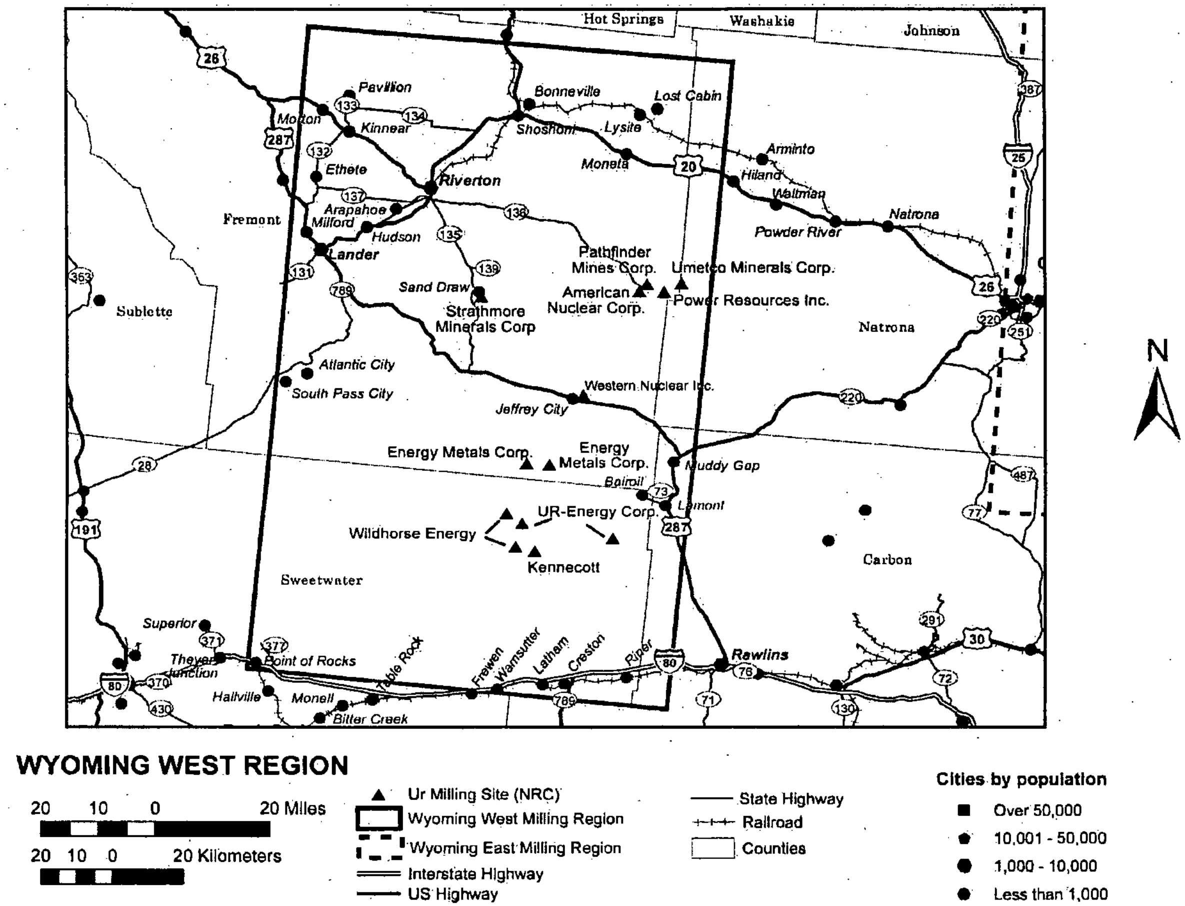



**Figure 3.2-3. Wyoming West Uranium Milling Region Transportation Corridor**

| Table 3.2-2. Average Annual Daily Traffic Counts for Roads in the Wyoming West Uranium Milling Region* | | | | | |
|---|---|---|---|---|---|
| Road Segment | Distance (mi) | Trucks | | All Vehicles | |
| | | 2005 | 2006 | 2005 | 2006 |
| State Route 136 to Riverton | 44 | 10–20 | 20–30 | 130–260 | 200–270 |
| State Route 135 from State Route 136 to State Route 789 | 1.04 | 170 | 210 | 840 | 1,090 |
| State Route 789 from State Route 135 to U.S. Highway 26 | 1 | 570–650 | 570–650 | 11,500–17000 | 11,650–17,100 |
| U.S. Highway 20/26 from Riverton to Shoshoni | 22 | 520–650 | 520–650 | 3,340–19,580 | 5,100–19,620 |
| U.S. Highway 20/26 from Shoshoni to Waltman | 51 | 270–580 | 470–550 | 2,350–3,090 | 2,190–3,060 |
| U.S. Highway 20/26 from Waltman to Casper | 49 | 470–670 | 480–650 | 2,480–13,740 | 2,450–13,580 |
| Interstate 25 from Casper to State Route 95 | 21 | 570–1,030 | 610–1,030 | 2,610–10,220 | 2,710–10,220 |
| U.S. Highway 287 (State Route 789) at Lander South | - | 390 | 400 | 5,080 | 4,550 |
| U.S. Highway 287 (State Route 789) at Jeffrey City | - | 140 | 140 | 850 | 890 |
| U.S. Highway 287 at Muddy Gap | - | 140 | 140 | 910 | 910 |
| State Route 220 at Muddy Gap North | - | 620 | 620 | 1910 | 1910 |
| State Route 73 from Bairoil to Lamont | 4.64 | 30 | 30 | 230 | 230 |
| U.S. Highway 287 from Lamont to Muddy Gap | 11 | 700 | 690 | 2,400 | 2,400 |

*Wyoming Department of Transportation. "Wyoming Department of Transportation Vehicle Miles." Data for Calendar Year 2005 and 2006 Provided on Request. Casper, Wyoming: Wyoming Department of Transportation, District 2 Office. April 18, 2008.

minimum all-vehicle count at 130 vehicles per day on State Route 136 to Riverton and the maximum on U.S. Highway 20 from Riverton to Shoshoni at 19,620 vehicles per day. Most all-vehicle counts in the Wyoming West Uranium Milling Region are above 800 vehicles per day. Yellowcake product shipments are expected to go from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189.

Table 3.2-3 describes representative routes and distances for shipments of yellowcake from locations of uranium milling interest in the Wyoming West Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment

**Table 3.2-3. Representative Transportation Routes for Yellowcake Shipments From the Wyoming West Uranium Milling Region***

| Origin | Destination | Major Links | Distance (mi) |
|---|---|---|---|
| South of Moneta, Wyoming | Metropolis, Illinois | Local access road to Waltman, Wyoming<br>U.S. Highway 20 east to Casper, Wyoming<br>Interstate 25 south to Denver, Colorado<br>Interstate 70 east to St. Louis, Missouri<br>Interstate 64 east to Interstate 57<br>Interstate 57 south to Interstate 24<br>Interstate 24 south to U.S. Highway 45<br>U.S. Highway 45 west to Metropolis, Illinois | 1,390 |
| Sand Draw, Wyoming | Metropolis, Illinois | Local access roads to State Route 135<br>State Route 135 south to U.S. Highway 287<br>U.S. Highway 287 south to Interstate 80<br>Interstate 80 east to Cheyenne, Wyoming<br>Interstate 25 south to Metropolis, Illinois (as above) | 1,400 |
| Jeffrey City, Wyoming | Metropolis, Illinois | Local access roads to U.S. Highway 287<br>U.S. Highway 287 to Interstate 80<br>Interstate 80 east to Cheyenne, Wyoming<br>Interstate 25 south to Metropolis, Illinois (as above) | 1,360 |
| Great Divide Basin Area, Wyoming | Metropolis, Illinois | Local access road south to Wamsutter<br>Interstate 80 east to Cheyenne, Wyoming<br>Interstate 25 south to Metropolis, Illinois (as above) | 1,360 |

*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.

distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

### 3.2.3 Geology and Soils

Wyoming contains the largest known reserves of uranium in the United States and has been the nation's leading producer of uranium ore since 1995 (Wyoming State Geological Survey, 2005). Sandstone-hosted uranium deposits account for the vast majority of the ore produced in Wyoming (Chenoweth, 1991). In the Wyoming West Uranium Milling Region, uranium mineralization is found in fluvial sandstones in two major uranium districts: the Crooks Gap area of the Great Divide Basin and the Gas Hills area of the Wind River Basin (Figure 3.2-2). The uranium mineralization in the sandstone-hosted deposits in the Crooks Gap and Gas Hills areas is amenable to recovery by ISL milling. Since 1991, all uranium produced from sandstones in these two districts has been by the ISL method (Wyoming State Geological Survey, 2005).

The Crooks Gap area is located in Fremont and Sweetwater Counties and encompasses approximately 9,100 $km^2$ [3,500 $mi^2$] in south-central Wyoming (Bailey, 1969; Rackley, 1972; Boberg, 1981). In 1954, ore-grade mineralization was found at Crooks Gap, and by late 1957, 3,800 metric tons [4,200 tons] of ore had been mined, mostly from shallow workings (Bailey, 1969). Production plus minable reserves at Crooks Gap are estimated to be between 5,000 and 5,400 metric tons [5,500 and 6,000 tons] $U_3O_8$.

The Gas Hills Uranium District is located along the southeastern margin of the Wind River Basin in central Wyoming (Anderson, 1969; Rackley, 1972; Boberg, 1981). Uranium in the Gas Hills district was discovered in 1953, and ore production began in 1955 (Anderson, 1969). The mineralized ground encompasses an area of about 160 $km^2$ [100 $mi^2$]. Prior to 1968, the Gas Hills uranium district produced approximately 26 million metric tons [29 million tons] of $U_3O_8$, which accounted for about 12 percent of total uranium production in the United States (Chenoweth, 1991).

The dominant source of sediment in the Great Divide and the Wind River Basins was Precambrian (greater than 540-million-year-old) granitic rock of the Sweetwater Arch (Rackley, 1972) (Figure 3.2-4). The Sweetwater Arch is also referred to as the Granite Mountains (Bailey, 1969; Anderson, 1969; Lageson and Spearing,1988). The Sweetwater Arch is a large mass of granitic rock 140 km [87 mi] long, with a maximum width of 50 km [31 mi]. Uplift of the Sweetwater Arch began to affect sedimentation in the adjacent Great Divide Basin and Wind River Basin in Late Cretaceous time (65 to 99 million years ago). Rapidly subsiding portions of these basins received thick clastic wedges (i.e., wedges made up of fragments of other rock) of predominantly arkosic sediments (i.e., sediments containing a significant fraction of feldspar), while larger, more slowly subsiding portions of the basins received a greater proportion of paludal (marsh) and lacustrine (lake) sediments.

Sediment transported southward into the Great Divide Basin was deposited on an apron of alluvial fans (Rackley, 1972). One of the major fans is centered near the Crooks Gap Uranium District, and another is northwest of the Lost Soldier anticline. Sedimentation in the Gas Hills area of the Wind River Basin was on an alluvial (i.e., deposited by running water) fan in which ridges of older resistant rock protruded through the fan and controlled the movement of the streams and their pattern of deposition. Beginning in the middle Eocene (41 to 49 million years ago) and increasing in the Oligocene (23.8 to 33.7 million years ago), regional volcanic activity contributed a significant amount of tuffaceous materials (i.e., materials made from volcanic rock and mineral fragments in a volcanic ash matrix) to local sediments. Deposition within the basins probably continued through the Miocene (5.3 to 23.8 million years ago), but post-Miocene erosion has completely removed Oligocene and Miocene units.

A generalized stratigraphic section of Tertiary (1.8- to 65-million-year-old) formations in the Wyoming West Uranium Milling Region is shown in Figure 3.2-5. Stratigraphic descriptions presented here are limited to formations that may be involved in potential milling operations or formations that may have environmental significance, such as important aquifers and confining units above and below potential milling zones.

Formations hosting major sandstone-type uranium deposits in the Wyoming West Uranium Milling Region are the Wind River Formation in the Wind River Basin and the Bottle Springs Formation in the Great Divide Basin. Both the Wind River and Bottle Springs are lower Eocene (49 to 54.8 million years old) in age (Houston, 1969) and consist of interbedded, arkosic sandstone; conglomerate; siltstone; mudstone; and carbonaceous shale—all compacted but poorly cemented (Harshman, 1968). The source beds for uranium deposits are sandstones

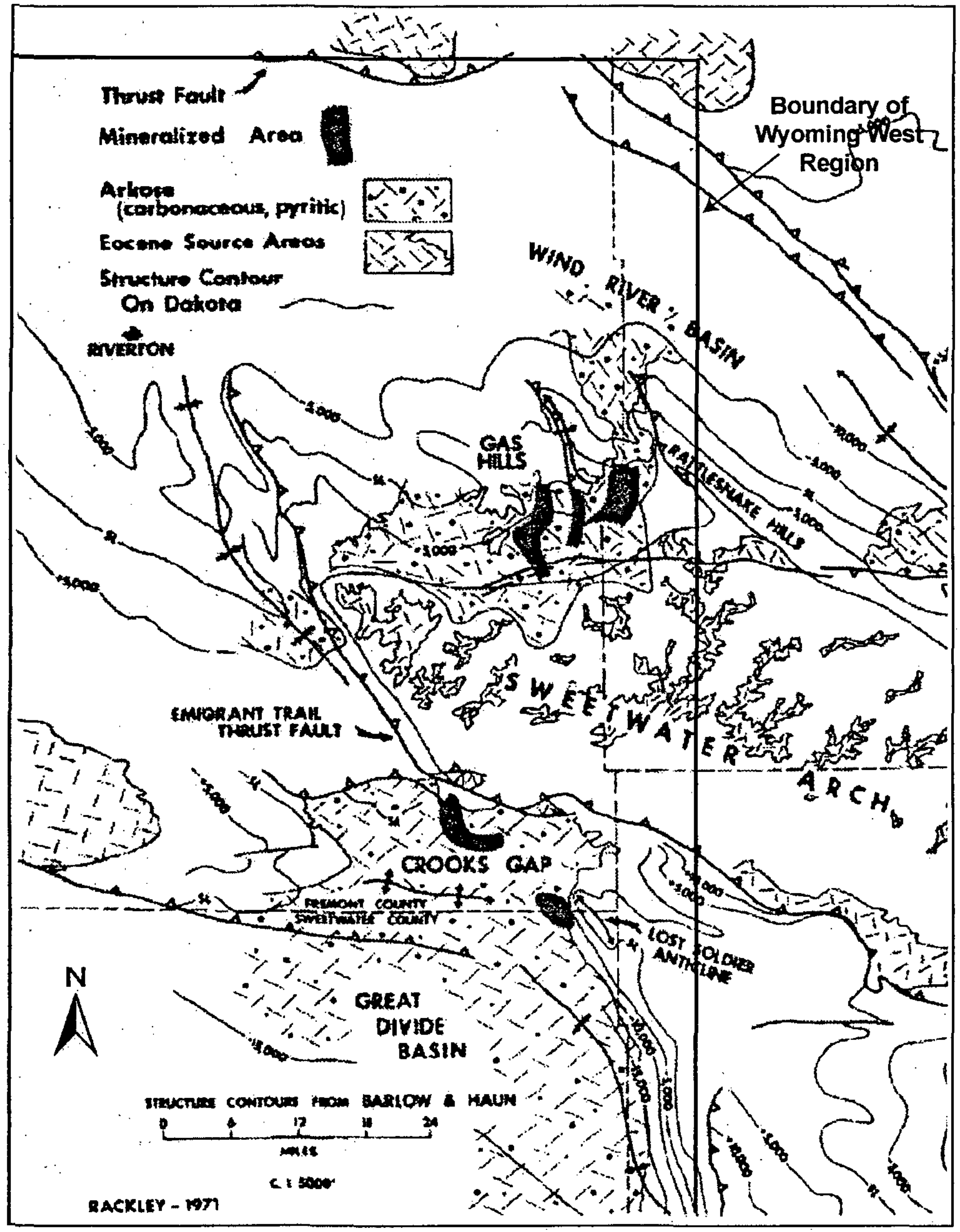



**Figure 3.2-4. Index and Structure Map of Central Wyoming Showing Relation of Sweetwater Arch to the Great Divide Basin and the Wind River Basin. The Distribution of Arkosic, Carbonaceous Sediments, and Mineralized Areas in the Crooks Gap and Gas Hills Uranium Districts Are Also Shown (Modified From Rackley, 1972).**

| Central Wyoming | | | | |
|---|---|---|---|---|
| System | Series | | Formation | |
| Tertiary | Pliocene | | Moonstone Formation | |
| | Miocene | | Browns Park Formation | Split Rock Formation |
| | Oligocene | | White River Formation | |
| | Eocene | Upper | Wagon Bed Formation | |
| | | Middle | | |
| | | Lower | Battle Springs Formation | Wind River Formation |
| | Paleocene | | Fort Union Formation | |
| Cretaceous | Upper | | Lance Formation | |

**Figure 3.2-5. Stratigraphic Section of Tertiary Age Formations in the Great Divide Basin and Wind River Basin of Central Wyoming. Major Sandstone-Type Uranium Deposits Are Hosted in the Battle Springs Formation in the Great Divide Basin and the Wind River Formation in the Wind River Basin (Modified From Harshman, 1968).**

interstratified with lensing mudstones and shales (Anderson, 1969). The mineralized zone in the Battle Springs Formation at Crooks Gap occurs in a stratigraphic range of as much as 460 m [1,500 ft] {i.e., occurs in a zone up to 460 m [1,500 ft] thick} (Stephens, 1964). In the Gas Hills Uranium District, mineralization in the Wind River Formation occurs in a stratigraphic range of perhaps 150 m [500 ft] (Bailey, 1969).

The Wagon Bed Formation conformably overlies the Wind River and Bottle Springs Formations. The Wagon Bed is composed of a series of interbedded arkosic sandstones and silicified claystones. Regionally, the Wagon Bed Formation may not be present in the central parts of the basins, having been removed by erosion. The White River Formation unconformably overlies the Wagon Bed Formation or the Wind River and Bottle Springs formations where the Wagon Bed has been removed by erosion. The White River consists of tuffaceous siltstone, claystone, and conglomerate with subordinate amounts of tuff. The White River overlaps older Tertiary formations and wedges out against pre-Tertiary rocks on the flanks of the basins. The White River Formation is overlain by the Browns Park Formation in the Great Divide Basin and the Split Rock Formation in the Wind River Basin. The Browns Park and Split Rock consist of tuffaceous siltstone and sandstone beds that sometimes cap prominent ridges (Harshman, 1968).

The Fort Union Formation underlies the Wind River and Bottle Springs Formations and, to a limited extent, is also a host of sandstone-type uranium deposits (Davis, 1969; Langden, 1973).

The Fort Union is a fluvial deposit consisting of alternating and discontinuous mudstones, siltstones, carbonaceous shales, and coarser arkosic sandstone. The Fort Union is unconformably underlain by sediments of the Lance Formation, which is in turn underlain by a thick sequence of older sandstones, mudstones, and shales.

The uranium deposits in the Wyoming West Uranium Milling Region are genetically related to geochemical interfaces or roll fronts (see Section 3.1.1). Principal ore minerals at Crooks Gap are meta-autunite, uraninite, and coffinite. The uranium minerals occur as earthy brown to black coatings on and interstitial fillings between quartz sand grains. In the Gas Hills district, roll fronts can be followed for long distances and individual ore bodies are found along them that may reach hundreds of meters [thousands of feet] in length.

The source of uranium in sandstone roll-front deposits in central Wyoming is a topic of conjecture. Four theories on the source of uranium in these occurrences have been suggested: (1) leached uranium from overlying ash-fall tuffs; (2) leached uranium from igneous and metamorphic rocks in the highlands surrounding the basins; (3) leached uranium from the host sandstones themselves; and (4) hydrothermal uranium from a magma source at depth (Harris and King, 1993). Combinations of these theories have been proposed as well (Boberg, 1981). The most popular theories are the (1) tuff leach and (2) highland leach. The tuff leach theory is supported by extensive geochemical studies on uranium removal from tuff (Zielinski, 1983, 1984; Trentham and Orajaka, 1986). Further, it was the tuff leach theory that led to the discovery of most of the large uranium deposits in Wyoming (Love, 1952). On the other hand, many sandstone-hosted uranium deposits in Wyoming are found adjacent to crystalline rocks, especially the uraniferous granites of the northern Laramie and Granite Mountains (Harris and King, 1993). Oxidized uranium leached from these crystalline terrains could have been transported to the sites of present mineralization.

Soils within the Wyoming West Uranium Milling Region are diverse and can vary substantially over relatively short distances. The distribution and occurrence of soils in central Wyoming can vary both on a regional basis (mountains, foothills, basins) and locally with changes in slope, geology, vegetation, climate, and time. The Great Divide Basin and the Wind River Basin present a mixture of old, tilted sedimentary rocks that often occur in bands along the basin margins and younger sediments showing varying degrees of incision by erosion in basin centers.

The topographic position and texture of typical soils in the Great Divide Basin and Wind River Basin areas of central Wyoming were obtained from Munn and Arneson (1998). This map was designed primarily for statewide study of groundwater vulnerability to contamination and would not be expected to be used for site-specific soil interpretations at proposed ISL milling facilities. For site-specific evaluations, detailed soils information would be expected to be obtained from published county soil surveys or the U.S. Department of Agriculture Natural Resource Conservation Service.

In the Great Divide and Wind River Basins areas, loamy-skeletal soils (rocky soils) with little or no subsoil development occur along bedrock outcrops that form ridges along the flanks of the basins. On gently sloping to moderately steep slopes associated with ridge flanks, alluvial fans, and alluvial terraces, fine to fine-loamy soils with well-developed horizons of clay accumulation are found. These soils are generally light colored and depleted in moisture. Moderately deep fine loamy over sandy and coarse loamy soils with well-developed soil horizons occur on terraces along major streams. Soils found on floodplains and drainageways include clay loams and fine-sand loams. Dark-colored, base-rich soils formed under grass are generally associated with floodplains along streams with permanent high-water tables. These soils are generally very deep and have well-developed soil horizons.

### 3.2.4 Water Resources

Water resources of the Wyoming West Uranium Milling Region are described in terms of surface waters, wetlands and "Waters of the United States," and groundwater.

Areas regulated under Section 404 are collectively referred to as "Waters of the United States." Included are parts of the surface water tributary system down to the smallest streams; lakes, ponds, or other water bodies on those streams; and adjacent wetlands.

#### 3.2.4.1 Surface Waters

The Wyoming West Uranium Milling Region (Figure 3.2.-1) includes major portions of Fremont and Sweetwater Counties and small portions of Carbon and Natrona Counties. Surface runoff to streams, in terms of average annual flow per unit area of a watershed, in the Wyoming West Uranium Milling Region varies from more than 13 cm/yr [5 in/yr] in the mountains to less than 1.3 cm/yr [0.5 in/yr] in the intermontane plains and valleys (Gebert, et al., 1987). The potential uranium milling sites are located in the intermontane areas. The watersheds within the Wyoming West Uranium Milling Region are listed in Table 3.2-4 along with the range of designated uses of surface water bodies assigned by the State of Wyoming (WDEQ, 2001). Because surface water uses are designated for specific water bodies, such as stream segments and lakes, within a watershed and the specific locations of future uranium milling activities are not known at this time, the range of designated uses is provided rather than a listing of designated uses for each water body within a watershed. Not all water bodies within a watershed may have all of the designated uses listed in Table 3.2-4. For example, a watershed may contain perennial streams, intermittent streams that flow only during portions of the year, and ephemeral streams that flow only because of surface runoff from local precipitation events. The perennial streams, and possibly portions of intermittent streams, may be designated as "fisheries," whereas ephemeral streams are unlikely to be designated as fisheries. The descriptions of the water bodies and their classifications in this section focus on perennial streams that generally have higher designated uses than the intermittent and ephemeral streams. For information regarding specific water bodies, refer to the Wyoming Department of Environmental Quality Surface Water Standards webpage (deq.state.wy.us/wqd/watershed/ surfacestandards).

**Attainment Status**

The attainment status of a water body refers to whether or not its water quality meets the standards for its designated use. The designated use of a water body is assigned by the state, such as swimming, drinking, and protection and propagation of aquatic life. If the chemical pollutants or other water quality parameters, such as temperature or turbidity, exceed the standards for its designed use, the attainment status of the water body is described as impaired.

The historical uranium milling districts included in the Wyoming West Uranium Milling Region are Gas Hills in the east-central portion of the Wyoming West Uranium Milling Region and Crooks Gap near the Fremont-Sweetwater County line (Figure 3.2-2). Watersheds in the Wyoming West Uranium Milling Region are Great Divide Closed Basin, Sweetwater River, Muskrat Creek, Little Wind River, Popo Agie River, Lower Wind River, Badwater Creek, and their associated tributaries. Historical or potential uranium milling sites are present in the Great

**Table 3.2-4. Primary Watersheds in the Wyoming West Uranium Milling Region Range of Designated Uses of Water Bodies Within Each Watershed**

| Watershed | Range of State Classification of Designated Uses* |
|---|---|
| Great Divide Closed Basin | 2AB to 4C |
| Main Stem Sweetwater River | 1 (above Alkali Creek) |
| Sweetwater River and Tributaries | Generally 2AB (below Alkali Creek) with some tributaries 3B and 4B |
| Muskrat Creek | Generally 2AB with some tributaries 3B and 4B |
| Little Wind River | Generally 2AB with some tributaries 3B and 4B |
| Popo Agie River | Generally 2AB with some tributaries 3B and 4B |
| Lower Wind River | Generally 2AB with some tributaries 3B and 4B |
| Badwater Creek | Generally 2AB with some tributaries 3B and 4B |

*Class 1 waters are described as "outstanding waters" and have designated uses including Drinking Water, Game Fish, Nongame Fish, Fish Consumption, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2AB waters have designated uses including Drinking Water, Game Fish, Non-Game Fish, Fish Consumption, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2A waters have designated uses including Drinking Water, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2B waters exclude Drinking Water from the Class 2AB uses. Class 2C waters exclude Drinking Water and Game Fish from the Class 2AB uses.
Classes 3A, 3B and 3C waters have designated uses including Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Classes 4A, 4B and 4C waters have designated uses including Recreation, Wildlife Agriculture, Industry, Scenic Value.
Official definitions of surface water classes and uses are in Wyoming Department of Environmental Quality Water Quality Rules and Regulations (http://soswy.state.wy.us/Rules/RULES/6547.pdf).

Divide, Sweetwater River, Muskrat Creek, Littlewind River, and Lower Wind River Watersheds (Figure 3.2-6).

The Great Divide Closed Basin is located in northeastern Sweetwater County and western Carbon County in an area with internal drainage and no outlet to either the Atlantic or Pacific Oceans (Figure 3.2-6). Surface water flows from the upland areas on the perimeter of the basin toward playa lakes near the center of the basin. The State of Wyoming has assigned surface classifications to streams in this watershed ranging from 2AB to 4C (WDEQ, 2001). Most of the streams are classified as 3A or 3B. The attainment status of these streams has not been assessed. The Crooks Gap Uranium District is partly located within the Great Divide Closed Basin.

The Sweetwater River Watershed is located north of the Great Divide Closed Basin Watershed in Sweetwater County. The Sweetwater River is a Class 1 water above Alkali Creek and Class 2AB water below Alkali Creek (Table 3.2-4). Crooks Creek is reported to be impaired due to oil and grease from oil and natural gas production (WDEQ, 2008). The average flow in the Sweetwater River near Alcova, Wyoming, for water years 1939 through 1973 (the period of continuous record) was 3.2 $m^3/s$ [110 $ft^3/s$] (U.S. Geological Survey, 2008). The Crooks Gap Uranium District is partially within the Sweetwater River Watershed and is drained primarily by Crooks Creek and its tributaries. Topographic maps of the area show a number of unnamed springs and small impoundments on the ephemeral streams within the district.

The Muskrat Creek Watershed is located north of the Sweetwater River Watershed in Fremont County. Classifications of water bodies in the Muskrat Creek Watershed range from 2AB to 2C (Table 3.2-4). No data are available on average flow in Muskrat Creek. The Gas Hills uranium district is within the Muskrat Creek Watershed, which drains to the Wind River and ultimately to the Powder River (Figure 3.2-5). Muskrat Creek is ephemeral within the Gas Hills uranium

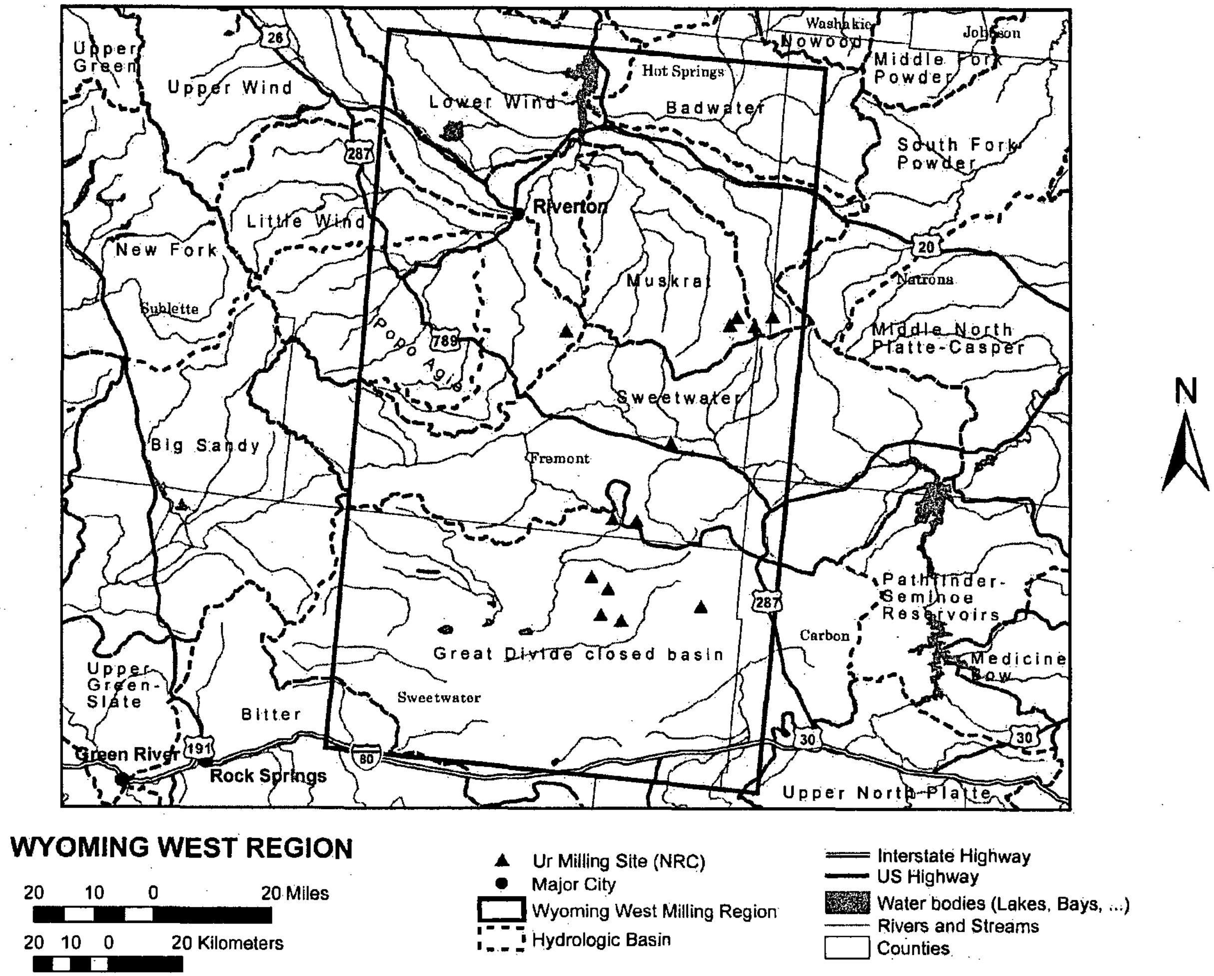



**Figure 3.2-6. Watersheds in the Wyoming West Uranium Milling Region**

district. The Gas Hills district is also drained by a number of other ephemeral stream channels with small surface water impoundments. Mapped springs in the district are Puddle Spring and Willow Spring.

The Little Wind River Watershed is located west of the Muskrat Creek Watershed and roughly centered on Riverton, Wyoming. The Little Wind River is classified as 2AB (Table 3.2-4). The average flow of the Little Wind River at Riverton for water years 1942 through 2008 was 16 $m^3/s$ [556 $ft^3/s$] (U.S. Geological Survey, 2008).

The Popo Agie River Watershed is located west of the Little Wind River Watershed on the eastern flank of the Wind River Mountains in Fremont County. The Popo Agie River is classified as 2AB (Table 3.2-4). The average flow of the Popo Agie River between 1947 and 1971 was 2.3 $m^3/s$ [80 $ft^3/s$] (U.S. Geological Survey, 2008). No historical uranium mining or milling has occurred within the Popo Agie Watershed.

The Lower Wind River Watershed is located north and downstream of the Little Wind River Watershed. Water bodies in the Lower Wind River Watershed are generally classified as 2AB with some tributaries classified as 3B; the difference is that 3B waters are not designated and protected for drinking water, fisheries, or fish consumption (Table 3.2-4). Lower Muddy Creek and Lower Poison Creek are described as impaired due to fecal coliform (WDEQ, 2008). The average flow of the Wind River below Boysen Reservoir is 29.5 $m^3/s$ [1,040 $ft^3/s$] (U.S. Geological Survey, 2008).

The Badwater Creek Watershed is located on the northern edge of the Wyoming West Uranium Milling Region northeast of the Muskrat Creek Watershed. Water bodies in the Badwater Creek Watershed are generally classified as 2AB with some tributaries classified as 3B and 4B. The difference between 3B and 4B waters is that 4B waters do not have "other aquatic life" as a designated use (Table 3.2-4). No data are available on average flow in Badwater Creek.

#### 3.2.4.2 Wetlands and Waters of the United States

The regulatory program of the U.S. Army Corps of Engineers (USACE) plays a critical role in the protection of the aquatic ecosystem and navigation. Under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899, the USACE performs the following services:

- Conducts jurisdictional determinations for wetlands and other Waters of the United States and navigable waters of the United States
- Authorizes activities in these jurisdictional areas through individual and general permits
- Ensures compliance of issued permits
- Enforces requirements of the law for unpermitted activities

Under Section 404 of the Clean Water Act, the Secretary of the Army is responsible for administering a regulatory program that requires permits to discharge dredged or fill material into waters of the United States, including wetlands.

Isolated waters such as playa lakes, prairie potholes, old river scars, cutoff sloughs, and abandoned construction and milling pits may also be waters of the United States if they meet certain criteria. Wetlands are found in many different forms including bottomland hardwood forests, wooded swamps, marshes, wet meadows, bogs, and playa lakes. Wetlands are of particular concern because they are valuable to restoring and maintaining the quality of the waters of the United States. Their functions include sediment trapping, nutrient removal, chemical detoxification, shoreline stabilization, aquatic food chain support, fish and wildlife habitat, floodwater storage, and groundwater recharge.

According to USACE (1987), wetlands are defined as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." A minimum of one positive indicator from each parameter (vegetation, hydrology, and soils) must be found to make a positive wetland determination.

- Vegetation—Under normal circumstances, an area is considered to have hydrophytic vegetation when more than 50 percent of dominant species, from all plant strata, are classified as Obligate (OBL), Facultative wet (FACW), or Facultative (FAC). Plants listed as Facultative Upland (FACUP), Not Listed (NL), or No Indicator (NI) are considered nonwetland plants for the purposes of wetland delineations.

- Hydrology—USACE (1987) requires that wetland soils must be continually saturated for a prolonged period (at least 5 percent) during the growing season.

- Soils—Hydric soils are those that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in their upper parts. Typical field indicators of hydric soils are the presence of thick organic layers, or in the case of predominantly mineral soils, a low chroma matrix (gray color) and/or bright mottling.

Man-made ponds and other surface features not immediately adjacent to traditional navigable waters do not fall under the jurisdiction of USACE. The landward regulatory limit for waters (in the absence of adjacent wetlands) is the ordinary high-water mark. The ordinary high-water mark is the line on the shores established by the fluctuations of water and indicated by physical characteristics such as

- A clear natural line impressed on the bank

- Shelving

**According to the U.S. Fish and Wildlife Wetland Mapper (2007), numerous types of wetlands and waters are located within the region:**

- **Perennial Streams**—A perennial stream has flowing water year round during a typical year. The water table is located above the streambed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow (USACE, 2000).

- **Intermittent Streams**—An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow (USACE, 2000).

- **Ephemeral Streams/Arroyos** (term used in arid regions)—An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral streambeds are located above the water table year round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow (USACE, 2000).

- Changes in the character of the soil
- Destruction of terrestrial vegetation
- The presence of litter and debris
- Other appropriate means that consider the characteristics of the surrounding areas

Waters of the United States and special aquatic sites that include wetlands would need to be identified and the impact delineated upon individual site selection for a potential ISL facility. Based on impacts and consultation with each area, an appropriate permit would need to be obtained from the local USACE district. Under Section 401 of the Clean Water Act, state water quality certification is required for work in waters of the United States. Within this region, the State of Wyoming regulates isolated wetlands and waters. Cumulative total project impacts greater than 0.04 ha [1 acre] require a general permit for wetlands mitigation by the Wyoming Department of Environmental Quality (WDEQ).

The majority of wetland areas located within the region consists of fresh water, ponds, emergent, or ponds with floating or submerged aquatic vegetation. These wetland areas are typically temporarily flooded on a seasonal basis. Numerous intermittent streams that are temporarily flooded are also found in the Wyoming West Uranium Milling Region.

### 3.2.4.3 Groundwater

Groundwater resources in the Wyoming West Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of Wyoming. Uranium-bearing aquifers exist within these regional aquifer systems in the Wyoming West Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in the Wyoming West Uranium Milling Region, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

#### 3.2.4.3.1 Regional Aquifer Systems

The location of the Wyoming West Uranium Milling Region is shown in Figures 3.2-1 and 3.2-2. The Upper Colorado River Basin aquifer system is the major regional aquifer system (large-scale underground layer of water-bearing permeable rock or unconsolidated materials) in the southwest Wyoming West Uranium Milling Region. The Upper Colorado River Basin aquifer system extends over 51,800 km$^2$ [20,000 mi$^2$] in the Green River, the Great Divide, and the Washakie structural basins in the southwestern parts of Wyoming (Whitehead, 1996).

Groundwater in the Upper Colorado River Basin aquifer system flows from aquifer recharge areas toward the centers of the structural basins. Discharge from the aquifers is by upward leakage to shallower aquifers and to major streams. Groundwater is less than 61 m [200 ft] below the land surface in most parts of the aquifer system and is nearest the land surface near the major streams. In and near mountainous areas, depth to groundwater ranges from 152 to 305 m [500 to 1,000 ft].

The Upper Colorado River Basin aquifer system in southwestern Wyoming consists of layered sedimentary formations. Whitehead (1996) grouped the sedimentary formations into five principal aquifers. From shallowest to deepest, they are the Laney aquifer, the Wasatch-Fort Union aquifer, the Mesaverde aquifer, a series of sandstone aquifers from the Dakota Sandstone through the Nugget Sandstone aquifers, and the Paleozoic aquifers.

The uppermost aquifer in the Wyoming part of the Upper Colorado River Basin aquifer system is the Laney aquifer. It is the highest permeability member of the Green River Formation. This aquifer consists of fractured sandstone beds and yields sufficient water for domestic and livestock watering supplies. Water in the Laney aquifer is fresh to slightly saline.

The Wasatch-Fort Union aquifer (that includes the Wasatch Formation and the Fort Union Formation) is composed of the major water-yielding sandstones interbedded with shale, mudstone, and some coal beds. The thickness of the Wasatch-Fort Union aquifer is notable and reported to be about 3,350 m [11,000 ft] thick in Sublette County and about 2,135 m [7,000 ft] thick near the center of the Great Divide Basin in south-central Wyoming. The regional groundwater flow direction in the eastern part of the aquifer is from recharge areas at basin margins toward the Great Divide Basin and southward into Colorado toward the center of the Washakie Basin. In the western part of the aquifer, water flows from recharge areas toward the Green River and its tributaries and toward the Flaming Gorge Reservoir in South Wyoming. Most of the fresh water in the Upper Colorado River Basin aquifer system is in the Wasatch-Fort Union aquifer, but the aquifer locally, where it is deeply buried, contains saline water. The Green River Formation overlies the Wasatch-Fort Union aquifer and forms an effective confining unit in most places.

The Mesaverde aquifer is composed of sandstone beds. In most places, the Mesaverde aquifer and the Wasatch-Fort Union aquifer are hydraulically connected. However, the Lewis Shale locally overlies the Mesavarde aquifer in the Great Divide and the Washakie Basins. The Mesaverde aquifer crops out at the land surface surrounding the Rock Springs Uplift. The groundwater flow direction in the Mesaverde aquifer is from recharge areas at the Rock Springs Uplift and near the eastern limit of the aquifer system toward the centers of structural basins. The aquifer contains fresh water locally at outcrop (recharge) areas, but it contains saline or brine water where the aquifer is deeply buried (e.g., in the Washakie Basin in southwestern Wyoming). The Mesaverde aquifer is hydraulically separated from deeper aquifers in Mesozoic rocks through thick confining layers that consist primarily of shale.

The Dakota and the Nugget aquifers consist of several sandstone formations separated by confining units. These aquifers crop out only locally in southwestern Wyoming and contain very saline water or brine in most places. A thick confining unit of Triassic- and Permian-aged rocks hydraulically separates them from the deeper Paleozoic aquifers.

The Tensleep Sandstone and the Madison Limestone are the principal aquifers in Paleozoic rocks. Groundwater in these aquifers flows toward the centers of the structural basins from adjacent topographically high areas. Groundwater discharges from the Tensleep Sandstone to the shallower aquifers occur by upward leakage. Much of the discharge from the Madison Limestone occurs by lateral movement of the groundwater into adjacent structural basins to the southeast and northeast. Because the Paleozoic aquifers are mostly deeply buried and contain saline water, they are not extensively used for water supply in southwestern Wyoming.

Recharge to the aquifers in most of the area is likely small, due to low annual precipitation and high evaporation rates (AATA International Inc., 2005). The mean annual precipitation in the Wyoming West Uranium Milling Region is typically in the range of 15–28 cm/yr [6–11 in/yr], but at high elevations, it locally exceeds 50 cm/yr [20 in/yr] based on precipitation data from

1971 to 2000 (AATA International Inc., 2005). The evaporation rate was estimated to be 105.9±7.1 cm/yr [41.7±2.8 in/yr] using the Kohler-Nordenson-Fox equation at the station in Lander, Wyoming (Curtis and Grimes, 2004).

In the central and northern portions of the Wyoming West Uranium Milling Region (near the Gas Hills region), the Wind River Formation contains the aquifers of primary importance. It consists of water-bearing sands and conglomerate units. The Wind River aquifer is underlain by a thick sequence of aquifers and aquitards. The primary aquifers in this sequence are the Cloverly Formation, the Nugget Formation, and the Pennsylvanian Tensleep Formation. Aquitards, which underlie the Wind River aquifer, are the Frontier, Mowry, Thermopolis, Morrison, Sundance, Chugwater, Dinwoody, and the Amsden Formations. The Chugwater and Sundance Formations comprise the primary aquitards underlying the Wind River Formation. The Wind River aquifer is overlain by the Wagon Bed, White River, and Split Rock Formation. Of these formations, the primary aquifer is the Split Rock Formation (NRC, 2004).

3.2.4.3.2 Aquifer Systems in the Vicinity of Uranium Milling Sites

An underlying hydrogeological system in past and current areas of uranium milling interest in the Wyoming West Uranium Milling Region consists of a thick sequence of primarily sandstone aquifers and shale aquitards. Uranium-bearing sandstone aquifers in the Wind River Formation (equivalent to the Battle Springs Formation at the proposed Lost Creek site and to the Green River Formation at the regional scale) are important sources for water supplies in the milling region.

Areas of uranium milling interest in the southern parts of the Wyoming West Uranium Milling Region near the Great Divide Basin (Crooks Gap) are underlain, from shallowest to deepest, by sedimentary deposits and sandstone layers (Quaternary aged), the Green River Formation, the Wasatch/Battle Springs Formation, the Fort Union Formation, and the Lance/Fox Hills Formation. This hydrogeological sequence is separated from the underlying Mesaverde Formation by the regionally continuous and impermeable Lewis Shale aquitard (AATA International Inc., 2005; Lost Creek ISR, LLC, 2007). All these formations host sandstone aquifers.

Areas of uranium milling interest in the northern parts of the Wyoming West Uranium Milling Region near the Gas Hills are underlain by the Late Tertiary-aged formation and deposits including the Split Rock, White River, and Wagon Bed Formations. Among these formations, the Split Rock Formation is the primary aquifer. This system is underlain by the Wind River Formation, the Fort Union Formation, and the Lance Formation. This sequence is underlain by a thick sequence of confined aquifers and aquitards. The most important underlying water supply aquifers involve the Cloverly aquifer, the Nugget Sandstone, and the Tensleep Sandstone (NRC, 2004).

3.2.4.3.3 Uranium-Bearing Aquifers

Uranium mineralization at locations of milling interest is typically hosted by the Early Tertiary-age confined sandstone aquifers in the Wyoming West Uranium Milling Region.

Confined sandstone beds in the Battle Springs Formation are the uranium-bearing aquifers in the Great Divide Basin (south-central Wyoming) within the southern portion of the Wyoming West Uranium Milling Region (AATA International Inc., 2005). Similarly, the Wind River Formation in the northern parts of the Wyoming West Uranium Milling Region near the Gas Hills is the uranium-bearing aquifer. Uranium mineralization in the Gas Hills has been identified in six different sandstone layers in the Wind River Formation, which are named 30, 40, 60, 70, and 80 Sands. In some areas, these sand layers are hydraulically separated by confining units including siltstone, clay, and shale beds, while in other areas they are hydraulically and stratigraphically connected (NRC, 2004).

For ISL operations to begin, portions of the uranium-bearing sandstone aquifers in the Battle Springs Formation and in the Wind River Formation in the Wyoming West Uranium Milling Region would need to be exempted by the Underground Injection Control (UIC) Program administered by WDEQ (Section 1.7.2.1) for the purposes of uranium recovery (NRC, 2004).

**Hydrogeological characteristics:** In the Wyoming West Uranium Milling Region, the production aquifer system typically consists of confined sandstone aquifers. Aquifer properties (e.g., transmissivity, thickness, storage coefficient) vary spatially in the region. Based on field test data at the Gas Hills and in the Great Divide Basin, transmissivity of the ore-bearing aquifers ranges from 0.01–90 $m^2$/day [0.1–1,000 $ft^2$/day] in the region. For ISL operations to be practical, the hydraulic conductivity of the production aquifer must be large enough to allow reasonable water flow from injection to production wells. Hence, portions of the production aquifers with low hydraulic conductivities may not be amenable to uranium recovery using ISL techniques. The average storage coefficient of the ore-bearing aquifer is on the order of $10^{-4}$, indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from $10^{-5}$–$10^{-3}$ (Driscoll, 1986, p. 68).

<u>Hydrologic Terminology</u>

**Transmissivity:** It is used to define the flow rate through the vertical section of an aquifer unit considering width and extending the full saturated height of an aquifer under unit hydraulic gradient. Transmissivity is a function of the aquifer's saturated thickness and hydraulic conductivity.

**Storage Coefficient:** It is used to characterize the capacity of an aquifer to release groundwater from storage in response to a decline in hydraulic head.

**Hydraulic Conductitvity:** It is a measure of the capacity of a porous medium to transmit water. It is used to define the flow rate per unit cross sectional area of an aquifer under unit hydraulic gradient.

Sandstone aquifers in the Battle Springs Formation are typically confined at the Lost Soldier and Lost Creek areas. However, the Battle Springs Formation locally crops out in the region, and hence the formation becomes locally unconfined. The transmissivity of the aquifer ranges from 8,690 to 24,800 L/day/m [700 to 2,000 gal/day/ft] {9–25 $m^2$/day [95 $ft^2$/day–270 $ft^2$/day]}, and the aquifer storage coefficient ranges from $3.0 \times 10^{-4}$ to $8.0 \times 10^{-4}$ (AATA International Inc., 2005; Lost Creek ISR, LLC, 2007). Lateral hydraulic gradients range from 0.05 at the Lost Soldier area to 0.0125 at the Lost Creek area, and range from 0.002 to 0.006 between these two sites (AATA International Inc., 2005). Hence, the lateral hydraulic gradients are an order of magnitude larger within the Lost Creek area and the Lost Soldier area than between these two sites. Collentine, et al. (1981, pp. 52–53) reported that wells in the Battle Spring aquifer typically yield 110–150 L/min [30–40 gal/min], but they are capable of yielding at least 570 L/min [150 gal/min].

Groundwater levels in the shallow, intermediate, and deep monitoring wells in the uranium-bearing aquifer were 55, 58, and 64 m [180, 190, and 210 ft] below the ground surface (AATA International Inc., 2005). These measurements indicate potential upward vertical flow within the Battle Springs Formation.

In the northern parts of the Wyoming West Uranium Milling Region, the uranium-bearing sandstone aquifers are typically confined as in the southern parts of the Wyoming West Uranium Milling Region. Transmissivity values in the uranium-bearing aquifers vary from 0.07 to 90 $m^2$/day [0.7 to 965 $ft^2$/day]. Aquifer storage coefficients vary in the range of $8.5 \times 10^{-5}$ to $8.0 \times 10^{-3}$, with an average storage coefficient of $3.0 \times 10^{-4}$ (NRC, 2004).

**Level of confinement:** The production aquifer is typically confined in the Wyoming West Uranium Milling Region; however, local unconfined conditions exist. The thickness of the confinement varies spatially.

At the regional scale, the thickness of the upper confinement of the Battle Springs Formation spatially varies. At the Lost Soldier and Lost Creek areas, the Battle Springs Formation is confined above by a 3- to 6-m [10- to 20-ft]-thick claystone unit (AATA International Inc., 2005). But, as noted previously, the Battle Springs Formation crops out over the northeastern portion of the Great Divide Basin, and hence locally unconfined conditions exist (Lost Creek ISR, LLC, 2007). The Battle Springs Formation is confined below by the continuous Lewis Shale at the local and regional scales. At the Lost Creek area, the Lewis Shale is up to 820 m [2,700 ft] thick (Lost Creek ISR, LLC, 2007). Thus, the sandstone aquifers in the Battle Springs Formation are confined at the Lost Soldier and Lost Creek areas. Aquitard vertical conductivity ranges from $1.2 \times 10^{-3}$ to $2.2 \times 10^{-3}$ m/day [$4.0 \times 10^{-3}$ to $7.3 \times 10^{-3}$ ft/day] (AATA International Inc., 2005).

At the Gas Hills site, the production aquifers are typically confined. Five potential ISL sites are identified, and the thickness of the confinement spatially varies with the location of the potential ISL sites. For example, at Mine Unit 1, the uranium-bearing 70 Sand is confined above and below by relatively thick, continuous, low permeability units of the Wind River Formation. At Mine Unit 2, the 30, 50, 60, 70, and 80 Sands are typically separated by up to 6-m [20-ft]-thick confining layers. At Mine Unit 3, the 30, 40, and 50 Sands are separated by relatively thin {1.5- to 9-m [5- to 30-ft]-thick} confining layers. At Mine Unit 4, a 3- to 12-m [10- to 40-ft]-thick confining layer, overlies the 80 Sand locally in some parts of the region, while the 70 and 80 Sands are unconfined in other parts. The 60 Sand is locally confined above by a 3- to 6-m [10- to 20-ft]-thick confining layer and the 50 Sand is typically underlain by a 1.5- to 9-m [5- to 30-ft]-thick confining layer in the region. The 50 Sand at Mine 5 is confined above by a 4.5- to 12-m [15- to 40-ft]-thick confining unit and confined below by a 6- to 12-m [20-to 40-ft]-thick confining layer (NRC, 2004).

**Groundwater quality:** In some parts of the Wyoming West Uranium Milling Region, the total dissolved solids (TDS) levels in the uranium-bearing aquifers exceed the U.S. Environmental Protection Agency's (EPA's) drinking water standards. The uranium and radium-226 concentrations in the uranium-bearing aquifers typically exceed their respective EPA Maximum Contaminant Levels.

Groundwater of the Battle Springs Formation is of bicarbonate-sulfate-calcium type or bicarbonate-calcium type. The TDS level ranges from 200 to 400 mg/L [200 to 400 ppm], which is below the EPA's Secondary Drinking Water Standard of 500 mg/L [500 ppm]. In general, groundwater quality in the Battle Spring aquifer has the best overall quality in the county. The only notable exceptions were from high concentration of radionuclides (radium-226 and radium-228) in several samples (Mason and Miller, 2004). The quality of groundwater near the town of Bairoil meets drinking water quality standards for all chemical constituents except for the elevated uranium and radium-226 concentrations associated with the roll-front uranium deposits

(AATA International Inc., 2005). Uranium and radium-226 concentrations typically exceed their respective EPA Maximum Contaminant Levels of 0.03 mg/L [0.03 ppm] and 5 pCi/L.

Groundwater from the Wind River Formation in the Gas Hills area is of calcium-sulfate and calcium-sodium-bicarbonate-sulfate type. The TDS level in the Wind River Formation is commonly higher {623 to 1,887 mg/L [623 to 1,887 ppm]} than in the Battle Springs Formation and exceeds the EPA's Secondary Drinking Water Standard. Similar to the Battle Springs Formation, both the uranium {0.04 mg/L [0.04 ppm on the average]} and radium-226 (5–50 pCi/L away from the ore zone) exceed respective EPA Maximum Contaminant Levels (NRC, 2004).

**Current groundwater uses:** Groundwater withdrawn from the Battle Springs Formation is primarily used for public water supply and agricultural purposes of the town of Bairoil (AATA International Inc., 2005). Groundwater use in the Gas Hills area is typically limited to livestock, wildlife watering, and to a lesser extent, industrial uses. In vicinity of the Gas Hills area, groundwater is not used for domestic and irrigation supplies (NRC, 2004). At the regional scale, the Laney aquifer also yields sufficient water for domestic and livestock watering (Whitehead, 1996).

3.2.4.3.4 Other Important Surrounding Aquifers for Water Supply

At the regional scale, the Laney aquifer, the Wasatch-Fort Union aquifer, the Mesaverde aquifer, the Dakota and the Nugget aquifers, and the Paleozoic aquifers are the important aquifers for water supply in the region (Whitehead, 1996). Among these aquifers, the Paleozoic aquifers are used less extensively, because they are mostly deeply buried and contain saline water. The Laney and the Wasatch-Fort Union aquifers are locally hydraulically connected. The Mesaverde aquifer is also locally hydraulically connected to the overlying Wasatch-Fort Union aquifer. However, in most places, these two aquifers are separated by the Lewis Shale at the regional scale.

At the Great Divide, the Battle Springs Formation interfingers with sandstone aquifers in the Wasatch Formation and the Green River Formation, and it is underlain by sandstone aquifers in the Fort Union Formation and Lance/Fox Hills Formation. The Fox Hill Formation is considered to be a minor aquifer, but the others are usually considered to be relatively important aquifers in the region (AATA International Inc., 2005). The Fort Union aquifer is largely undeveloped in the Lost Creek area, and the reported transmissivity values are typically less than 30 $m^2$/day [325 $ft^2$/day] (Collentine, et al., 1981). The TDS levels in the Wasatch Formation in the west and south parts of the Great Divide Basin are typically higher than the EPA drinking water standards of 500 mg/L [500 ppm]. However, the TDS levels in the Battle Springs/Wasatch aquifers are generally less than 500 mg/L [500 ppm] along the northern side of the region (Lost Creek ISR, LLC, 2007).

In most parts of the Gas Hills area, the Wind River Formation is underlain by an aquitard that consists of the Chugwater (between the Nugget Sandstone and the Tensleep Sandstone) and Sundance Formations (between the Clovery Formation and the Tensleep Sandstone). The other important aquifers, including the Clovery Formation (equivalent to the Dakota Sandstone), Nugget Sandstone, and Pennsylvanian Tensleep Sandstone, are separated from the Wind River Formation by a series of thick aquitards.

### 3.2.5 Ecology

#### 3.2.5.1 Terrestrial

A generalized overview and description of the habitat types and terrestrial species that may be found in areas used for milling operation are discussed in this section. These areas are broad and contain many subregions. For specific future locations of new milling sites, potential license applicants and the NRC review would be expected to address site-specific habitat types and terrestrial species.

**Wyoming West Uranium Milling Region Flora**

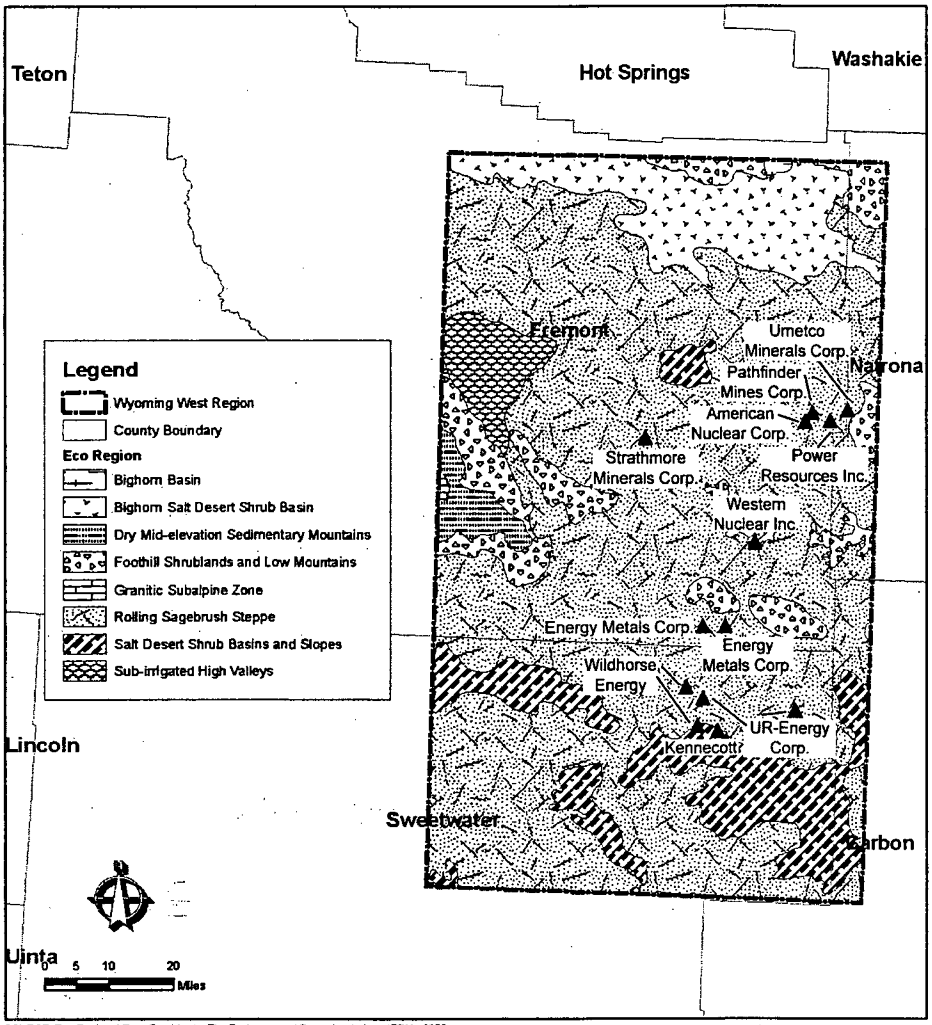
According to the EPA, the identified ecoregions in the Wyoming West Uranium Milling Region primarily consist of the Wyoming Basin and the Middle Rockies ecoregions (Chapman, et al., 2004). Figure 3.2-7 depicts the various ecoregions found within the Wyoming West Uranium Milling Region. Uranium milling districts within the uranium districts in the region are located within the Rolling Sagebrush Steppe and the Salt Desert Shrub Basin ecoregions of the Wyoming Basin.

The Wyoming Basin ecoregion is a broad, arid, intermontane basin interrupted by hills and low mountains and dominated by grasslands and shrublands. Nearly surrounded by forest-covered mountains, the region is drier than the Northwestern Great Plains to the northeast and does not have the extensive cover of pinyon-juniper woodland found in the Colorado Plateaus to the south. Much of the region is used for livestock grazing, although many areas lack sufficient forage to support this activity (Chapman, et al., 2004). Within the Wyoming Basin, the Wyoming West Uranium Milling Region contains several subecoregions that are described next, based on the descriptions of Chapman, et al. (2004).

The Rolling Sagebrush Steppe area of the Wyoming Basin is composed of rolling plains with hills, mesas, and terraces. Areas near the mountains may contain footslopes, ridges, alluvial fans, and outwash fans (Chapman, et al., 2004). The most abundant shrub vegetation in the region is Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), with silver sagebrush (*Artemisia cana*) and black sagebrush (*Artemisia nova*) occurring in the lowlands and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) in the higher elevations. Grass species include western wheatgrass (*Pascopyrum smithii*), needle-and-thread grass (*Stipa comata*), blue grama (*Bouteloua gracilis*), Sandberg bluegrass (*Poa secunda*), prairie junegrass (*Koeleria macrantha*), rabbitbrush (*Chrysothamnus nauseosus*), and fringed sage (*Artemisia frigida*) (Chapman, et al., 2004).

The Bighorn Basin is primarily an arid region influenced by the rainshadow effect of the Beartooth Mountains, Absaroka Range, and Pryor Mountains. This higher portion of the greater Bighorn Basin forms a transition from arid desert shrubland to semiarid shrubland. Sagebrush steppe vegetation dominates this region and is composed of species such as Wyoming big sagebrush, western wheat grass, blue wheatgrass (*Elymus magellanicus*), needle-and thread grass, blue grama, Sandberg bluegrass, junegrass (*Koeleria,* sp.), rabbitbrush, and fringed sage (Chapman, et al., 2004).

The Foothill Shrublands ecoregion serves as a transitional zone between the forested Dry Mid-Elevation Sedimentary Mountains ecoregion to the arid grassland and sagebrush regions in the Wyoming Basin and the High Plains (Chapman, et al., 2004). Vegetation found within this



SOURCE: Eco Regional Data Provided by The Environmental Protection Agency (EPA) - 2005

**Figure 3.2-7. Ecoregions of the Wyoming West Uranium Milling Region (Based on Chapman, et al., 2004)**

region include Sagebrush steppe communities, mountain mahogany woodlands that are often interspersed with mountain big sagebrush, blue grama, prairie junegrass, western wheatgrass, and ponderosa pine (*Pimas ponderosa*) savanna in the Laramie foothills (Chapman, et al., 2004).

The Subirrigated High Valleys are wet meadow systems located in areas of high drainage density beneath surrounding mountain ranges. Soil in this region remains moist due to the presence of a high water table. This region is abundant with floodplains, low terraces, riparian wetlands, and alluvial fans. As a result, the riparian areas and wet meadows are dominated by willows, alders, cottonwoods and wetland plants, such as horsetail (*Equisetum* sp.), spikerush (*Eleocharis* sp.), sedges (*Cyperaceae* sp.), and tufted hairgrass (*Deschampsia cespitosa*) found in low drainage areas. Shrubland areas may include Wyoming big sagebrush, western wheatgrass, needle-and-thread grass, blue grama, Sandberg blue grass, prairie junegrass, rabbitbrush, and fringed sage (Chapman, et al., 2004).

The Salt Desert Shrub Basins ecoregion is an arid environment that includes isolated playa lakes and sand dunes scattered throughout the Wyoming Basin. Vegetation in this area consists of arid land alkaline tolerant shrubs such as shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), and Gardner saltbush (*Atriplex gardneri*) low in abundance. Plant life is more diverse on sand dunes, which provide greater moisture, higher permeability, and lower alkalinity than the basin floor. Vegetation found on stable sand dune areas includes alkali cordgrass (*Spartina gracilis*), Indian grass (*Sorghastrum nutans*), blowout grass (*Redfieldia flexuosa*), alkali wildrye (*Leymus simplex)*, and needle-and-thread grass (Chapman, et al., 2004).

The Bighorn Salt Desert Shrub Basins are composed of two large, arid, alkaline depressions surrounded by mountains. This region is geographically isolated from the other salt desert shrub basins in southern Wyoming. This region has a greater human influence due to the proximity to major rivers (Bighorn, Shoshone, and Greybull Rivers), which provide water for irrigation. This region receives approximately 15 cm [6 in] of precipitation per year and supports desert shrubs and grasses. Vegetation found in this region may consist of greasewood, Gardner saltbush, shadscale, alkali sacaton (*Sporobolus airoides*), and saltgrass (*Distichlis spicata*) (Chapman, et al., 2004). The vegetation around major rivers consists of open woodland of plains cottonwood (*Populus deltoides*), narrowleaf cottonwood (*Populus angustifolia*), peachleaf willow (*Salix amygdaloides*), and wild plum (*Prunus americana*).
The Middle Rockies ecoregion is composed of steep-crested, high mountains that are largely covered by coniferous forests.

The Bighorn and Beartooth Mountains and the Wind River and Teton Ranges comprise the Granitic Subalpine Zone. Snowmelt moisture, absorbed and released throughout the spring and summer, provides water for humans and wildlife living at lower elevations in the droughty, sedimentary fringes of these mountains. Subalpine forests are dominated by lodgepole pine (*Pinus contorta*) at the lower elevations, with subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) found in the higher elevations. The diversity of the understory is low and consists mostly of grouse whortleberry (*Vaccinium scoparium*), Oregon grape (*Mahonia aquifolium*), and birchleaf spirea (*Spiraea betulifolia*). The subalpine spruce-fir zone is not as heavily grazed by livestock as mid-elevation areas; it serves as summer range for mule deer (*Odocoileus hemious*) and elk (*Cervus Canadensis*) (Chapman, et al., 2004).

The Dry Mid-Elevation Sedimentary Mountains ecoregion includes the mid-elevation Bighorn Mountains and the drier northeastern portion of the Wind River Range that are underlain by sedimentary rocks. The lack of moisture in the soil is enhanced by the rainshadow effects of the two mountain ranges. Upland forest cover is open and patchy due to arid conditions. Forests of the Wind River Range are dominated by Douglas firs (*Pseudotsugai* ssp.) with an understory of grasses, forbs, and shrubs. Forest cover is more extensive on the east slopes of the Bighorns where there is more summer precipitation. A ponderosa pine/juniper/mountain mahogany association exists here similar to one in the Black Hills region to the east, but it is of limited extent. The forest of the eastern Bighorn Mountains lacks enough precipitation to support the eastern deciduous species and boreal vegetation present in the Black Hills. Some quaking aspen groves occur in this region, particularly in the Wind River Range (Chapman, et al., 2004).

A comprehensive listing of habitat types and species found in the aforementioned ecoregions has been compiled as part of the Wyoming Gap Analysis project (Wyoming Geographic Information Science Center, 2007a,b).

The Wyoming Gap Analysis project is part of the National Gap Analysis Program. It began in 1991 and was officially completed in November 1996. The program's main goal was to analyze the status of biodiversity within Wyoming, focusing on two biodiversity elements: land cover types and terrestrial vertebrate species. Land ownership and management for the state of Wyoming was combined with the data on land cover and species distributions in a geographic overlay. A Geographical Information System was used to determine which biodiversity elements were inadequately protected within the current system of areas managed for conservation (Wyoming Geographic Information Science Center, 2007a,b).

**Wyoming West Uranium Milling Region Fauna**

According to the official state list of birds, mammals, amphibians, and reptiles in Wyoming compiled by the Wyoming Game and Fish Department, approximately 246 bird, 127 mammal, 12 amphibian, and 27 reptile species are found in Wyoming. The official state list of the common and scientific names of the birds, mammals, amphibians, and reptiles in Wyoming can be obtained from the Wyoming Game and Fish Department (2007a).

According to the World Wildlife Fund's species database (World Wildlife Fund, 2007a,b), approximately 285 different species are found within the Wyoming Basin. Common animals found in this region include large game mammals such as moose (*Alces alce*), pronghorn (*Antilocapra americana*), elk, mule deer, white tailed deer (*Odocoileus virginianus*), bighorn sheep (*Ovis Canadensis*), and American black bear (*Ursus americanus*). Numerous rodents such as chipmunks (*Tamias* spp.), squirrels (*Speermophilus* spp.), shrews (*Sorex* spp.), and rabbits (*Sylvilagus* spp.) and numerous myotic bat species are found within this region. Reptiles and amphibians found in the region include species such as the western rattlesnake (*Crotalus viridis*), gopher snake (*Pituophis caterifer*), garter snake (*Thamnophis elegans*), tiger salamander (*Ambystoma tigrium*), Woodhouse's toad (*Bufo woodhouii*), and spadefoot toad (*Scaphiopus* spp.). A diverse number of birds also inhabit this region, including hawks like the Cooper's hawk (*Accipter cooperii*), goshawk (*Accipiter gentilis*), and red-tailed hawk (*Buteo jamaicensis*) and the golden eagle (Aquila chrysaetos). Common birds in the region include finches (*Leucosticte* spp.), sparrows, owls (*Otus* spp.), swallows (*Tachycinets* spp.), and vireos (*Vireo* spp.) in addition to other songbirds. A noted species within this region is the white-tailed prairie dog (*Cynomys leucurus*). The white-tailed prairie dog towns in this region provide food for predators such as the coyote (*Canis latrans*), the swift fox (*Vulpes velox*), and the black-footed ferret (*Mustela nigripes*)—a federally recognized endangered species (World Wildlife Fund, 2007a,b).

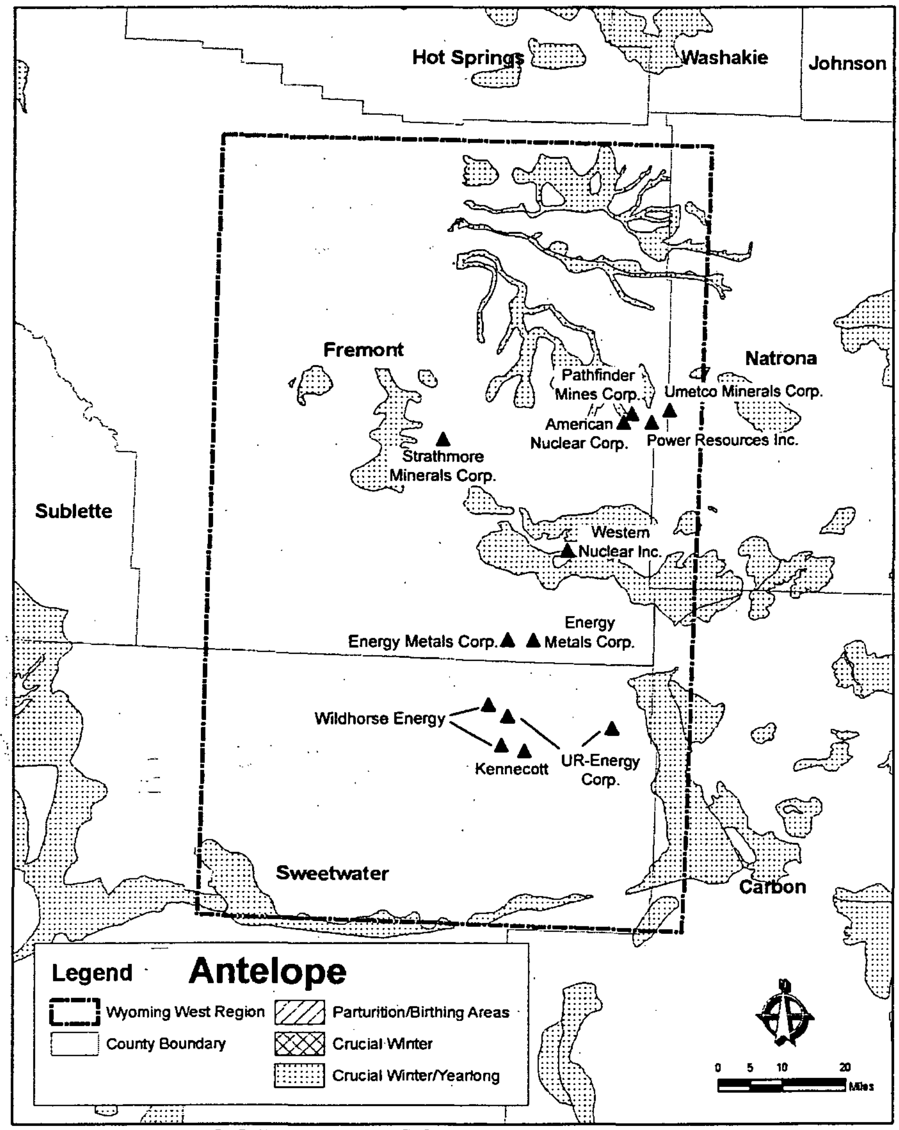
The Foothill Shrublands ecoregion is a transition region between the Dry Mid-Elevation Sedimentary Mountains ecoregion, Wyoming Basin Shrublands, the Northwest Great Plains, and the South Central Rockies Forest. Species found in this region will overlap all regions. Again, large mammal species such as bighorn sheep, cougar (*Puma concolor*), American bison (*Bison bison*), pronghorn, moose, elk, and coyotes can be found in this region. Shrews, voles (*Microtus* spp.), rabbits, squirrels, and prairie dogs common to the other ecoregions can also be found in this transition area. Raptors such as Cooper's hawk, goshawk, red-tailed hawk, golden eagles, and numerous owl species are bird predators in this area. Common bird species in the region include finches, sparrows, swallows, vireos, warblers, and kingbirds (*Tyrannus* spp.) in addition to other songbirds (World Wildlife Fund, 2007a–e).

The Middle Rockies ecoregion contains over 300 different species. This region features large, important herds of elk and mule deer, which are the main game species in this region. Large predators such as cougar and black bear are also abundant. Other mammals found in this region include the wolverine (*Gulo gulo*), lynx (*Lynx canadensis*), pronghorn, beaver (*Castor canadensis*), coyote (*Canis latrans*), Gunnison's prairie dog (*Cynomys gunnisoni*), black-tailed prairie dog (*Cynomys ludovicianus*), porcupine (*Eremophila dorsatum*), bat, and American marten (*Martes americana*). Numerous rodents such as squirrels, voles, rabbits, rats, and mice occur in this region. Common birds in the region include many of the species found throughout Wyoming like bluebirds (*Sialia* ssp.), sparrows, ducks, woodpeckers, owls, hawks, and eagles. Reptile and amphibian species include the soft-shelled turtle (*Apalone* spp.), plateau striped whiptail (*Cnemidophorus velox*), western rattlesnake, many-lined skink (*Eumeces multivirgatus*), fence lizard (*Sceloporus* spp.), tiger salamander, western toad (*Bufo boreas*), and the Baird's spotted toad (*Bufo punctatus*) (World Wildlife Fund, 2007a–e).

According to the Wyoming Game and Fish Department, crucial wintering habitats are found within this region for large game mammals and nesting leks for the greater sage grouse (*Centrocercus urophasianus*) (Wyoming Game and Fish Department, 2007b). Figures 3.2-8 through 3.2-14 depict the crucial winter and yearlong ranges for large mammals and game birds found in this region. Crucial wintering areas for some species were not identified in the region. However, maps of the region were included for completeness whether species were identified or not. Most of the crucial areas for big game animals in the Wyoming West Uranium Milling Region are located in the Rattlesnake Hills and Granite Mountains in the central and northwestern parts of the region, or along the Sweetwater River and its tributaries. Sites identified within Crook's Gap and Gas Hills Uranium Districts are located in or near crucial winter/yearlong habitat for antelope, moose, and mule deer. Numerous sage-grouse leks and nesting areas are located near sites in both uranium districts, particularly in the southeastern portion of the study region (i.e., Crook's Gap Uranium District).

### 3.2.5.2 Aquatic

Within the Wyoming West Uranium Milling Region, several watersheds have been listed as aquatic habitat areas. These areas include the Lower Wind River/Boysen Reservoir Watershed, Upper Sweetwater River Watershed, lower Sweetwater Watershed, Middle Fork Popo Agie, Middle North Platte River Corridor, and the South Fork Powder River Watersheds. These watersheds are part of the larger Lower Wind River, Sweetwater, South Fork Powder River, and Middle North Platte-Casper Watersheds previously discussed in Section 3.2.4.1 (Wyoming Game and Fish Department, 2007b). The two uranium districts within the Wyoming West




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.2-8. Antelope Wintering Areas for the Wyoming West Uranium Milling Region**

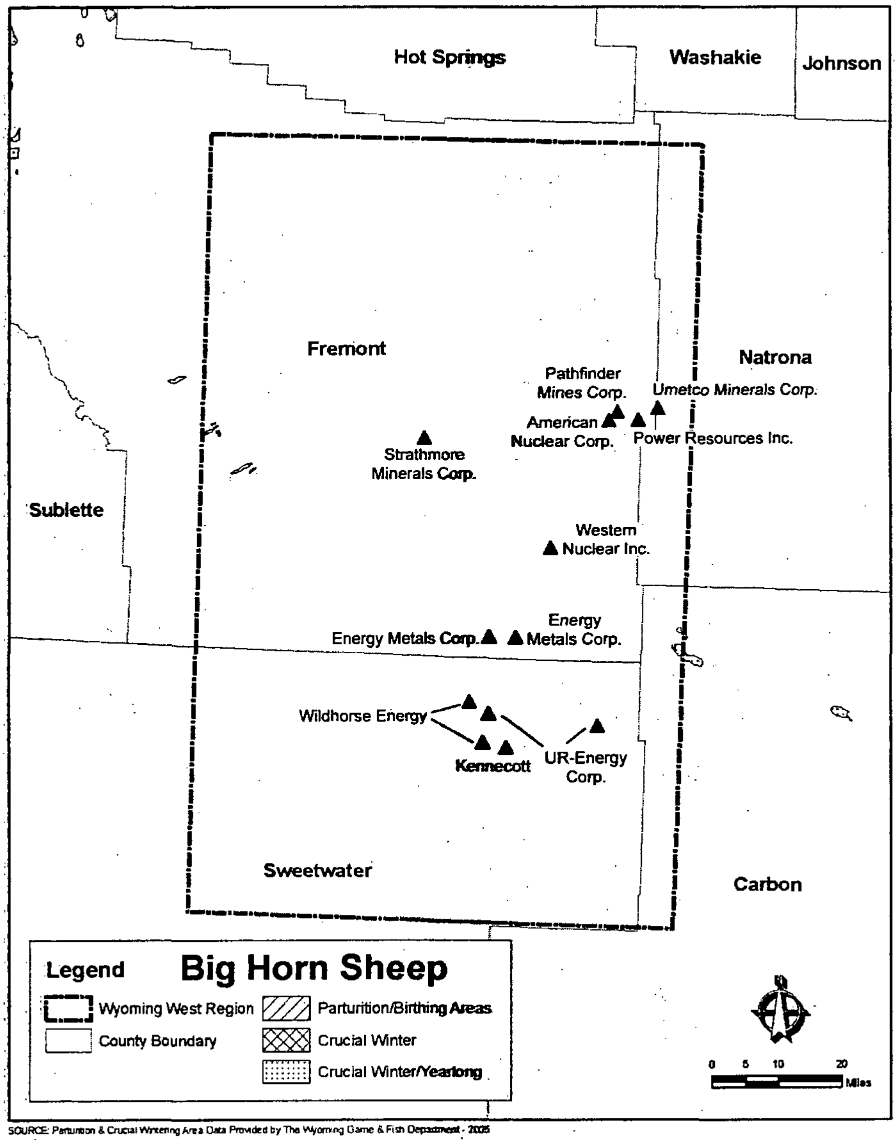



Figure 3.2-9. Big Horn Wintering Areas for the Wyoming West Uranium Milling Region

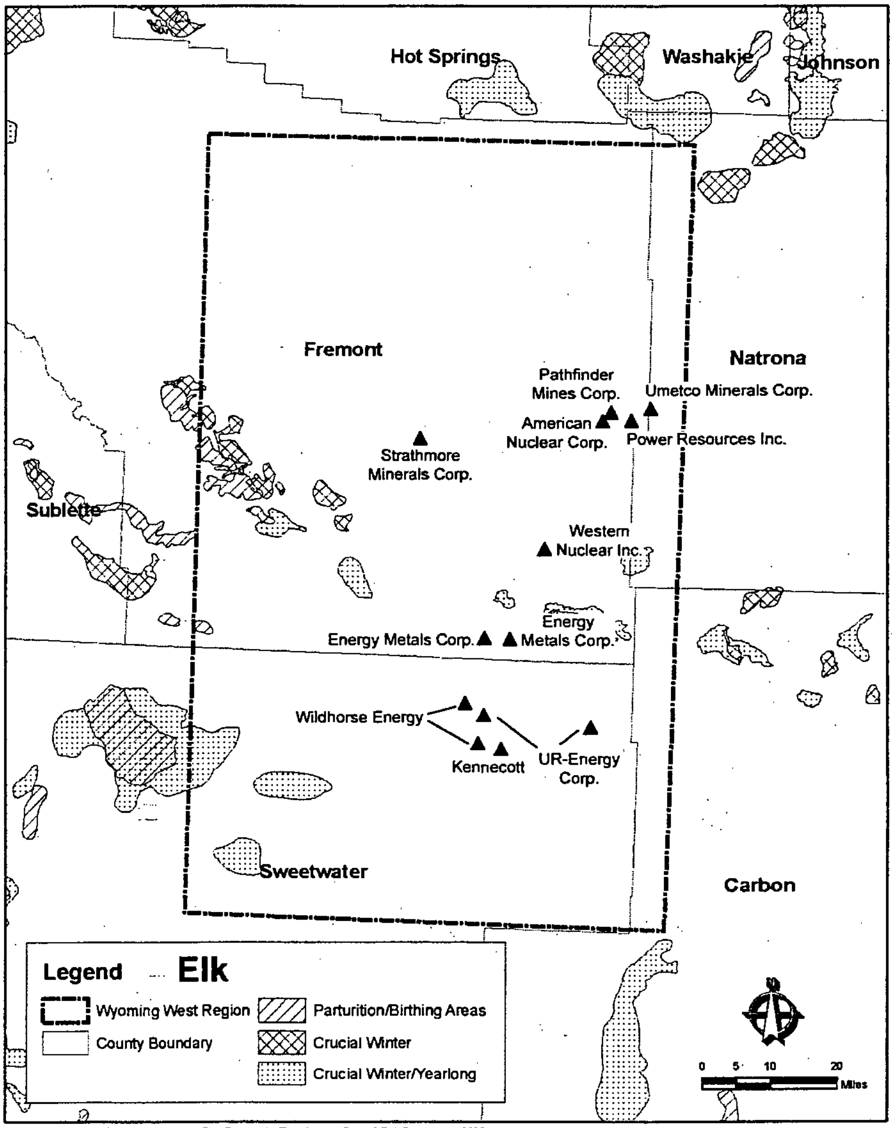
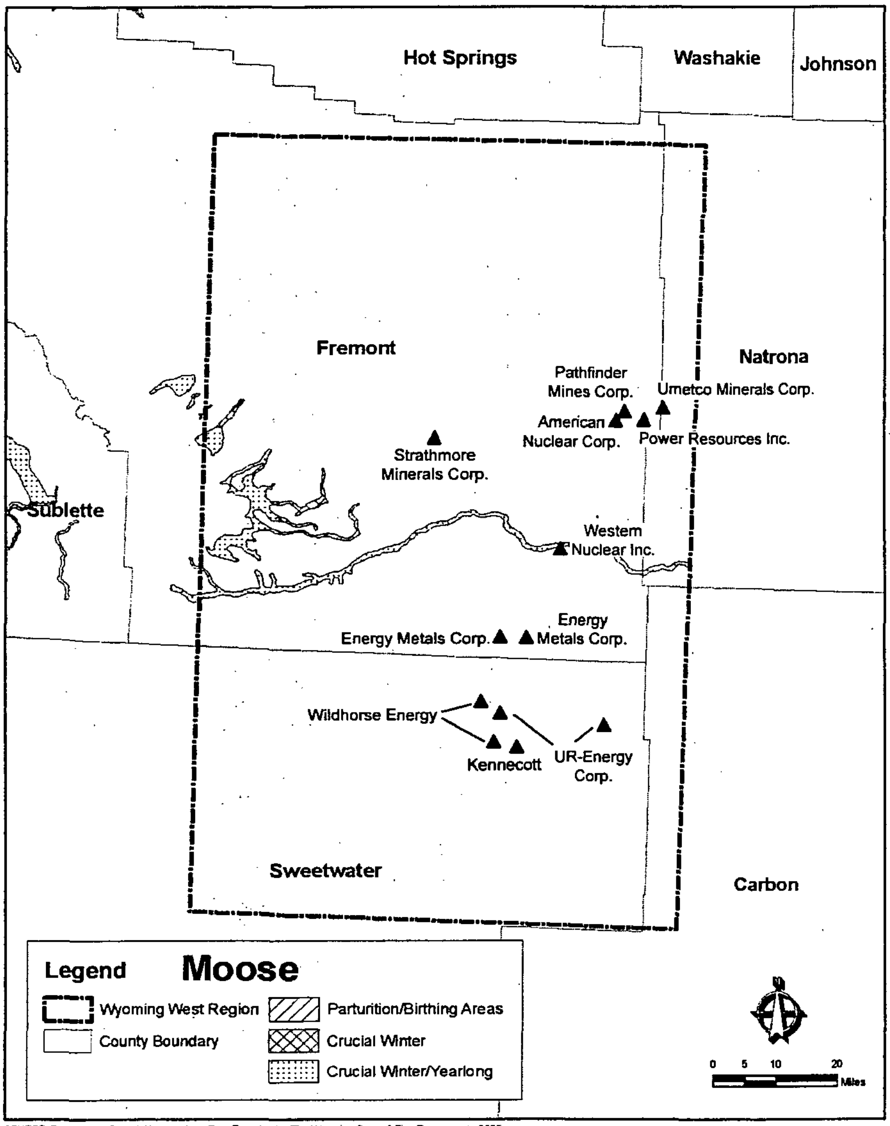



Figure 3.2-10. Elk Wintering Areas for the Wyoming West Uranium Milling Region




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.2-11. Moose Wintering Areas for the Wyoming West Uranium Milling Region**

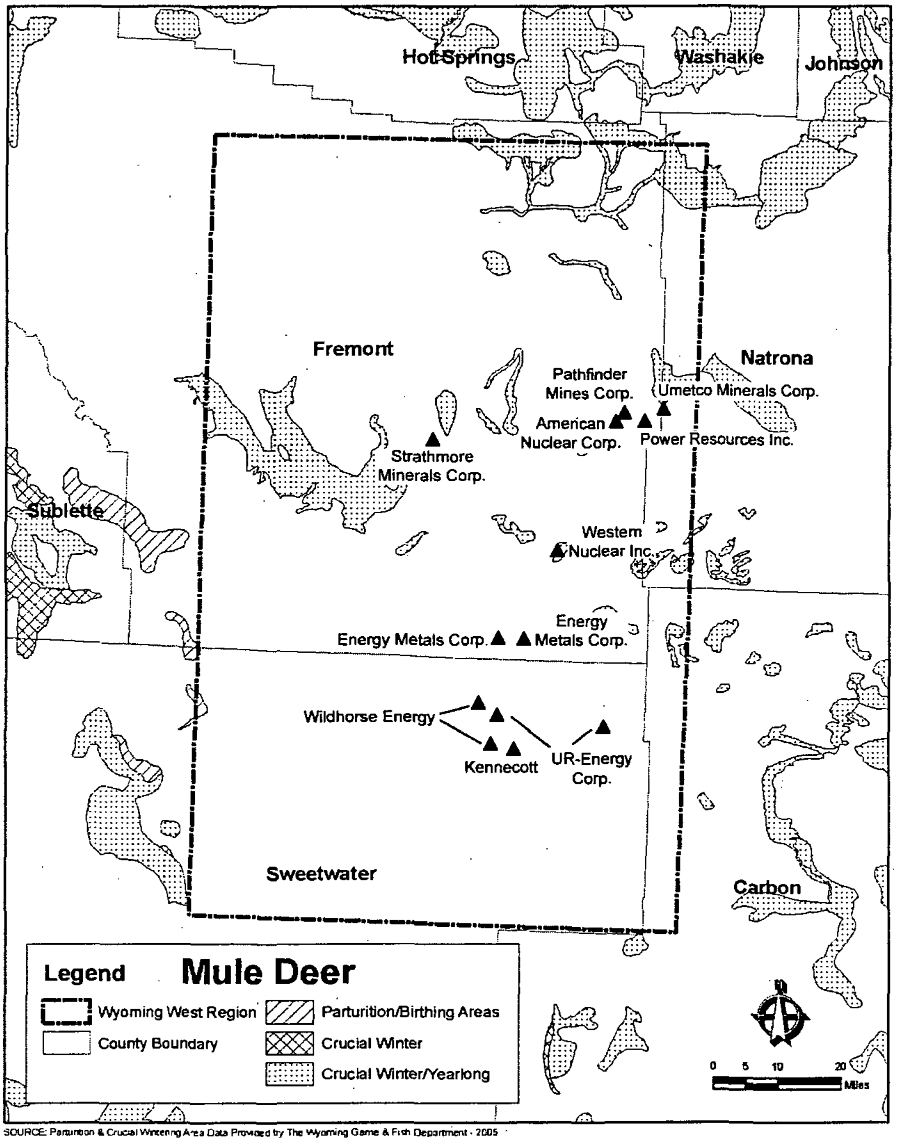



Figure 3.2-12. Mule Deer Wintering Areas for the Wyoming West Uranium Milling Region

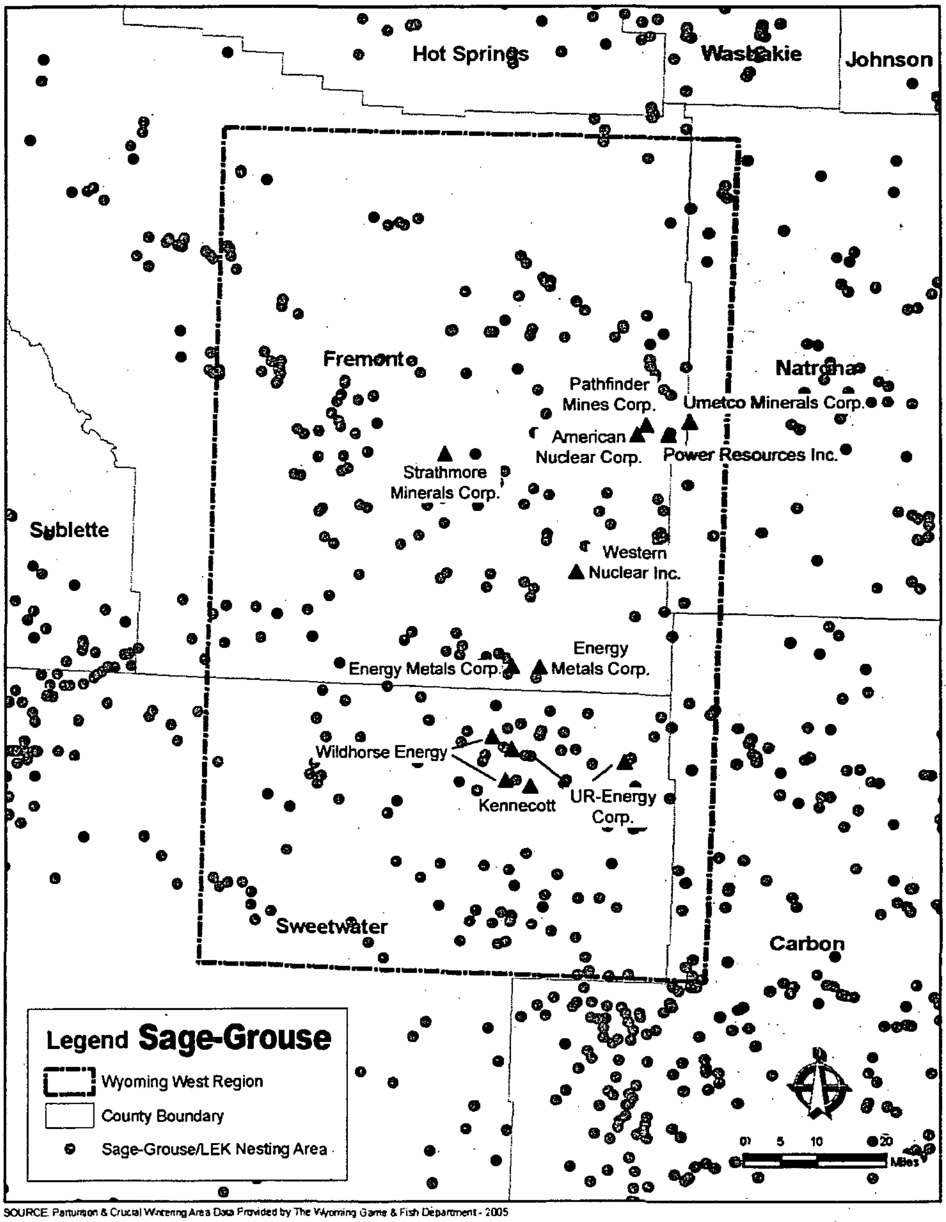



**Figure 3.2-13. Sage-Grouse/Lek Nesting Areas for the Wyoming West Uranium Milling Region**

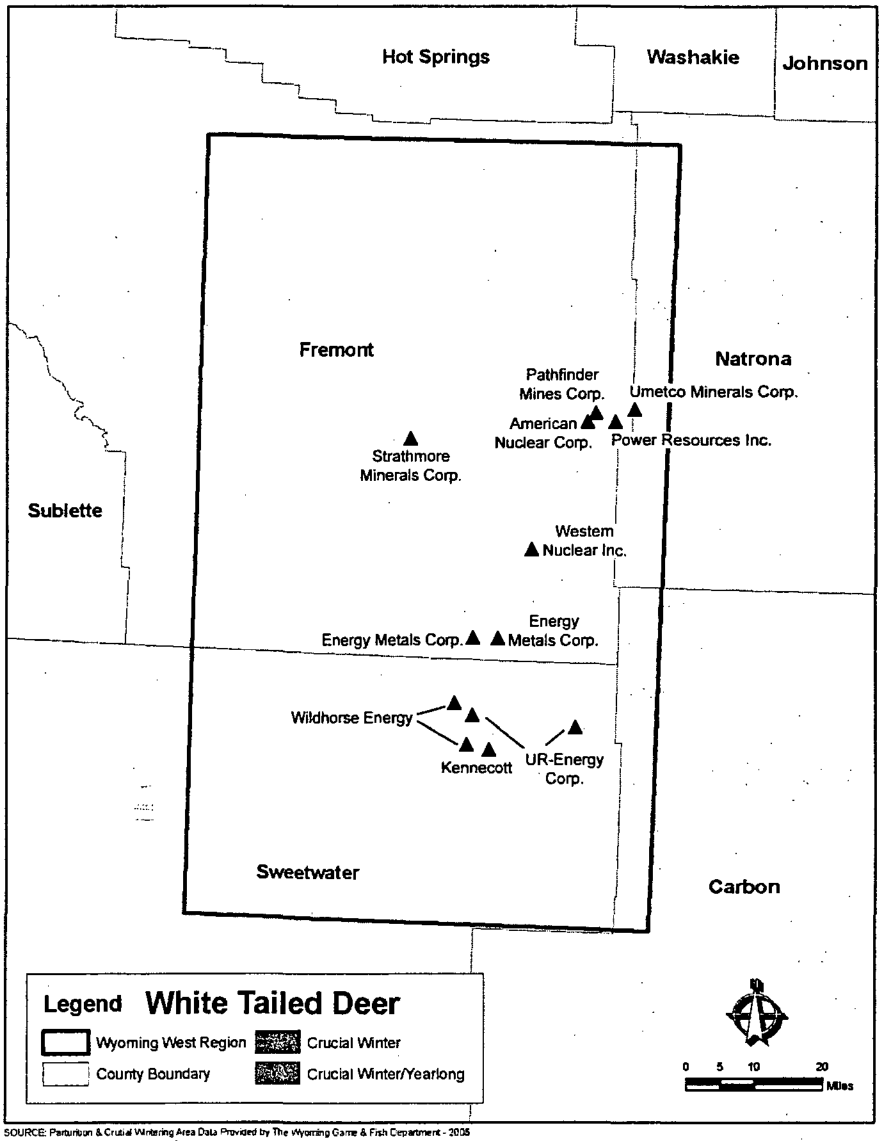



Figure 3.2-14. White Tailed Deer Wintering Areas for the Wyoming West Uranium Milling Region

Uranium Milling Region are located in the Sweetwater (Crooks Gap) and Wind River (Gas Hills) Watersheds.

According to the Wyoming Game and Fish Department (Wyoming Game and Fish Department, 2007b), there are approximately 49 native fish species found in the watersheds throughout the state. These species are identified in Table 3.2-5. Current conditions of these watersheds have been evaluated, and fish species that would benefit from conservation measures within the watersheds have been identified.

**Table 3.2-5. Native Fish Species Found in Wyoming**

| Common Name | Scientific Name |
|---|---|
| Arctic Grayling | *Thymallus arcticus* |
| Bigmouth Shiner | *Notropis dorsalis* |
| Black Bullhead | *Ameiurus melas* |
| Bluehead Sucker | *Catostomus discobolus* |
| Brassy Minnow | *Hybognathus hankinsoni* |
| Burbot | *Lota lota* |
| Central Stoneroller | *Campostoma anomalum* |
| Channel Catfish | *Ictalurus punctatus* |
| Common Shiner | *Luxilus cornutus* |
| Creek Chub | *Semotilus atromaculatus* |
| Cutthroat Trout | *Oncorhynchus clarki* |
| Fathead Minnow | *Pimephales promelas* |
| Finescale Dace | *Phoxinus neogaeus* |
| Flannelmouth Sucker | *Catostomus latipinnis* |
| Flathead Chub | *Platygobio gracilis* |
| Goldeye | *Hiodon alosoides* |
| Hornyhead Chub | *Nocomis biguttatus* |
| Iowa Darter | *Etheostoma exile* |
| Johnny Darter | *Etheostoma nigrum* |
| Lake Chub | *Couesius plumbeus* |
| Leatherside Chub | *Gila copei* |
| Longnose Dace | *Rhinichthys cataractae* |
| Longnose Sucker | *Catostomus catostomus* |
| Mottled Sculpin | *Cottus bairdi* |
| Mountain Sucker | *Catostomus platyrhynchus* |
| Mountain Whitefish | *Prosopium williamsoni* |
| Orangethroat Darter | *Etheostoma spectabile* |
| Paiute Sculpin | *Cottus beldingi* |
| Pearl Dace | *Margariscus margarita* |
| Plains Killifish | *Fundulus zebrinus* |
| Plains Minnow | *Hybognathus placitus* |
| Plains Topminnow | *Fundulus sciadicus* |
| Quillback | *Carpiodes cyprinus* |
| Red Shiner | *Cyprinella lutrensis* |
| Redside Shiner | *Richardsonius balteatus* |
| River Carpsucker | *Carpiodes carpio* |
| Roundtail Chub | *Gila robusta* |
| Sand Shiner | *Notropis stramineus* |

| Table 3.2-5. Native Fish Species Found in Wyoming (continued) | |
|---|---|
| **Common Name** | **Scientific Name** |
| Sauger | *Stizostedion canadense* |
| Shorthead Redhorse | *Moxostoma macrolepidotum* |
| Shovelnose Sturgeon | *Scaphirhynchus platorynchus* |
| Speckled Dace | *Rhinichthys osculus* |
| Stonecat | *Noturus flavus* |
| Sturgeon Chub | *Macrhybopsis gelida* |
| Suckermouth Minnow | *Phenacobius mirabilis* |
| Utah Chub | *Gila atraria* |
| Utah Sucker | *Catostomus ardens* |
| Western Silvery Minnow | *Hybognathus argyritis* |
| White Sucker | *Catostomus commersoni* |

The Lower Wind River discharges into the Boysen Reservoir. Additional waterways that are included in the basin are the Stagner Creek, Gold Creek, Cottonwood Creek, Birdseye Creek, Reservoir Creek, Muddy Creek, Poison Creek, and Cottonwood Drain. Aquatic species found in this system include sauger (*Stizostedion canadense*), burbot (*Lota lota*), mountain whitefish (*Prosopium williamsoni*), stonecat (*Noturus flavus*), channel catfish (*Ictalurus punctatus*), longnose dace (*Rhinichthys cataractae*), northern redhorse (*Moxostoma aureouim*), and flathead chub (*Platygobio gracilis*). Sport fish that occur in the watershed include rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), walleye (*Sander vitreus*), brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), and black bullhead (*Ameiurus melas*) (Wyoming Game and Fish Department, 2007b).

The Middle Fork Popo Agie Watershed is found in the western and southern portion of the Wyoming West Uranium Milling Region. Contributing waterways include Saw and Sawmill Creeks. Species in this watershed have been impacted by erosion and sediment processes that have been accelerated by human activities such as prolonged annual herbivory, increased drainage from roads and trails, removal of water for irrigation, dewatering of wetlands, and rural subdivision development. Native species found within this watershed include the lakechub (*Couesius plumbeus*), longnose dace, longnose sucker (*Catostomus catostomus*), white sucker (*Catostomus commersonii*), mountain sucker (*Catostomus platyrhynchus*), mountain whitefish, and fathead minnow (*Pimephales promelas)*. Sport fish found in this watershed include rainbow trout, brown trout, brook trout, Yellowstone trout (*Oncorhynchus clarki bouvieri*), Snake River cutthroat trout (*Oncorhynchus clarki* ssp.), and grayling (*Thymallus thymallus*) (Wyoming Game and Fish Department, 2007b).

The Upper Sweetwater River headwaters in the Wind River Mountains flows across the South Pass uplift area. Native species found within this watershed include the lake chub, creek chub (*Semotilus atromaculatus*), longnose dace, longnose sucker, white sucker, mountain whitefish, fathead minnow, Iowa darter (*Etheostoma exile*), and mountain sucker. Sport fish found in this watershed include rainbow trout, brown trout, brook trout, Fall River rainbow (*Oncorhynchus mykiss gairdnerii*), Yellowstone cutthroat trout, Snake River cutthroat, and Bear River cutthroat (Wyoming Game and Fish Department, 2007b).

The Lower Sweetwater River Watershed is found in the south central portion of the Wyoming West Uranium Milling Region. Contributing waterways include Crook Creek and Willow Creek.

Species in this watershed have been impacted by erosion and sediment processes that have been accelerated by human activities such as prolonged annual herbivory and increase drainage from roads and trails as a result of previous uranium milling operations in the Green Mountain Area. Native species found within this watershed include the lake chub, creek chub, longnose dace, longnose sucker, white sucker, mountain sucker, fathead minnow, bigmouth sucker (*Ictiobus cyprinellus*) and Iowa darter. Sport fish found in this watershed include rainbow trout, brown trout, brook trout, Fall River rainbow, and Bear River cutthroat (Wyoming Game and Fish Department, 2007b).

The South Fork Powder River-Murphy Creek basin is relatively dry and sparsely vegetated. Most of the streams are ephemeral or intermittent with few perennial streams. Many of these stream channels are degraded or actively degrading. Native fish species that can be found in this watershed include the creek chub, fathead minnow, flathead chub, longnose dace, plains minnow, sand shiner (*Notropis stramineus*), mountain sucker, and the plains killifish (*Fundulus zebrinus*) (Wyoming Game and Fish Department, 2007b).

The Middle North Platte River Corridor portion of the watershed is located on the eastern side of the Wyoming West Uranium Milling Region. Species found within this watershed include the brassy minnow (*Hybognathus hankinsoni*), common shiner, creek chub, fathead minnow, longnose dace, sand shiner (*Notropis stramineus*), stoneroller (*Campostoma anomalum*), longnose sucker, and white sucker with the rainbow trout, brown trout, cutthroat trout and channel catfish being sport fish (Wyoming Game and Fish Department, 2007b).

The Sweetwater River Muddy Creek and Horse Creek Watersheds are located in the southern portion of the Wyoming West Uranium Milling Region. This watershed region has been impacted by intense herbivory; the successional advance of big sagebrush steppe and absence of beaver dams are the perceived bottlenecks limiting watershed function. Native species found within this watershed include the bigmouth shiner, creek chub, fathead minnow, longnose dace, sand shiner, longnose sucker, white sucker, and Iowa darter. Sport fish in the watershed include rainbow trout, brown trout, cutthroat trout, and brook trout.

#### 3.2.5.3 Threatened and Endangered Species

Federally listed threatened and endangered species known to exist in habitats in the West Wyoming Uranium Milling Region include the following:

- Black-Footed Ferret (*Mustela nigripes*)—Ferrets were once found throughout the Great Plains, from Texas, New Mexico, and Arizona to southern Saskatchewan, Canada. Ferrets eat prairie dogs and live in prairie dog burrows. Typical wild ferret behavior revolves around prairie dog towns. Wild ferrets hunt prairie dogs at night, but occasionally they are active above ground during the day. This is especially true of female ferrets hunting to feed their young. In search of prey, they move from one prairie dog burrow to the next (U.S. Fish and Wildlife Service, 2008).

- Blowout Penstemon (*Penstemon haydenii*)—Limited to the sandhills region of west-central Nebraska, and sand dune habitat in the northeastern Great Divide Basin in Wyoming. In Nebraska this plant typically occurs in "blowouts"—sparsely vegetated depressions in active sand dunes created by wind erosion. In Wyoming it occurs on sandy aprons or the lower half of steep sandy slopes deposited at the base of granitic or sedimentary mountains or ridges. It occurs at elevations ranging from 850–1,150 m

[2,800–3,800 ft] in Nebraska to 2,030–2,270 m [6,680–7,440 ft] in Wyoming. This species can be found in west-central Nebraska in Box Butte, Cherry, Garden, Morrill and Thomas Counties, and in the Wyoming West Uranium Milling Region in northwestern Carbon County (Center for Plant Conservation, 2008).

- Bonytail Chub (Gila elegans)—Found in slower water habitats in the main stream such as eddies, pools, sidechannels, and coves. They are found in streams below 1,220 m [4,000 ft] elevation. The bonytail chub is endemic to the Colorado River basin and found throughout the mainstemrivers and backwaters of the Upper and Lower Basins. This species is one of the rarest of the Colorado River fishes and is close to extinction (U.S. Fish and Wildlife Service, 2008).

- Canada Lynx (*Lynx canadensis*)—The Canada lynx inhabits mountain regions, primarily at elevations between 2,356 and 2,869 m [7,730 and 9,410 ft] and on slopes of 8 to 12 percent. It usually occurs in extensive tracts of dense coniferous forest, primarily Engelmann spruce and subalpine fir. It feeds primarily on snowshoe hares, especially during winter (thereby making habitat for showshoe hares a key consideration for lynx habitat). Older forests with a substantial understory of conifers or small patches of shrubs and young trees provide good quality lynx foraging habitat. The most important component of denning habitat is large woody debris, especially dense tangles of fallen trees and root wads. Such preferred habitat is relatively limited in Wyoming and occurs primarily in multiple use areas of the Shoshone and Bridger-Teton National Forests along the western boundary of the Wyoming West Uranium Milling Region. The national parks and designated wilderness areas in Wyoming tend to be marginal lynx habitat as they are either dominated by dry even-aged lodgepole pine forests, or are too steep and at too high an elevation (Wyoming Game and Fish Department, 2008).

- Colorado Pikeminnow (*Ptychocheilus lucius*)—Colorado pikeminnow were once abundant in the main reach of the Colorado River and most of its major tributaries in Colorado, Wyoming, Utah, New Mexico, Arizona, Nevada, California and Mexico. Now, they exist primarily in the Green River below the confluence with the Yampa Rive;, the lower Duchesne River in Utah; the Yampa River below Craig, Colorado; the White River from Taylor Draw Dam near Rangely, Colorado downstream to the confluence with the Green River; the Gunnison River in Colorado; and the Colorado River from Palisade, Colorado, downstream to Lake Powell. It is believed that the Colorado pikeminnow populations in the upper Colorado River basin are now relatively stable and in some areas may even be growing (U.S. Fish and Wildlife Service, 2008).

- Humpback Chub (*Gila cypha*)—The humpback chub lives primarily in canyons with swift currents and white water. Historically, it inhabited canyons of the Colorado River and four of its tributaries: the Green, Yampa, White and Little Colorado rivers. Now, there are two populations near the Colorado/Utah border—one at Westwater Canyon in Utah and one in an area called Black Rocks, in Colorado. Though now smaller in number than they were historically, the two populations seem to be fairly stable in these two areas (U.S. Fish and Wildlife Service, 2008).

- Interior Least Tern (*Sterna antillarum athalassos*)—The nesting habitat of the interior least tern includes bare or sparsely vegetated sand, shell, and gravel beaches; sandbars; islands; and salt flats associated with rivers and reservoirs. The birds prefer open habitat and tend to avoid thick vegetation and narrow beaches. Sand and gravel bars within a wide unobstructed river channel, or open flats along shorelines of lakes and reservoirs, provide favorable nesting habitat. Nesting locations are often at the higher elevations away from the water's edge because nesting usually starts when river levels are high and relatively small amounts of sand are exposed. The size of nesting areas depends on water levels and the extent of associated sandbars and beaches. Highly adapted to nesting in disturbed sites, terns may move colony sites annually, depending on landscape disturbance and vegetation growth at established colonies (Texas Parks and Wildlife Department, 2007).

- Pallid Sturgeon (*Scaphirhynchus albus*)—This species is a bottom dweller, found in areas of strong current and firm sand bottom in the main channel of large turbid rivers such as the Missouri and Plotte River. The pallid sturgeon is a member of a primitive family that, like other sturgeon, has lengthwise rows of bony plates covering its body, rather than scales. Pallids are slow growing, late-maturing fish that feed on small fishes and immature aquatic insects. Spawning occurs from June through August (Platte River Endangered Partnership, 2008).

- Piping Plover (*Charadrius melodus*)—Piping plovers breed only in North America in three geographic regions: the Atlantic Coast, the Northern Great Plains, and the Great Lakes. Plovers in the Great Plains make their nests on open, sparsely vegetated sand or gravel beaches adjacent to alkali wetlands, and on beaches, sand bars, and dredged material islands of major river systems (U.S. Fish and Wildlife Service, 2008).

- Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*)—This species lives primarily in heavily vegetated, shrub-dominated riparian (streamside) habitats and immediately adjacent upland habitats along the foothills of southeastern Wyoming south to Colorado Springs along the eastern edge of the Front Range of Colorado. Documented distribution includes Albany, Laramie, Platte Goshen, and Converse counties in Wyoming (U.S. Fish and Wildlife Service, 2008)

- Razorback Sucker (*Xyrauchen texanus*)—This is a large river species not found in smaller tributaries and headwater streams. Found in water from 1–3 m [4–10 ft] in depth, adults are associated with areas of strong current and backwaters (Colorado Division of Wildlife, 2008). This species has been extirpated from Wyoming; however, it can be occasionally found in Sweetwater County (University of Wyoming, 2008).

- Ute Ladies' Tresses Orchid (*Spiranthes diluvialis*)—Populations of Ute ladies'-tresses orchids are known from three broad general areas of the interior western United States—near the base of the eastern slope of the Rocky Mountains in southwestern Wyoming and adjacent Nebraska and north-central and central Colorado; in the upper Colorado River basin, particularly in the Uinta Basin; and in the Bonneville Basin along the Wasatch Front and westward in the eastern Great Basin, in north-central and western Utah, extreme eastern Nevada, and southeastern Idaho. The orchid also has been discovered in southwestern Montana and in the Okanogan area and along the Columbia River in north-central Washington. The orchid occurs along riparian edges, gravel bars, old oxbows, high flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers. It also is found in wetland and seepy areas near fresh-water lakes or springs (U.S. Fish and Wildlife Service, 2008).

- Western Prairie Fringed Orchid (*Platanthera praeclara*)—The western prairie fringed orchid is a plant of the tallgrass prairie and requires direct sunlight for growth. It is most often found in moist habitats or sedge meadows (U.S. Fish and Wildlife Service, 2008).

- Whooping Crane (*Grus americana*)—The whooping crane prefers fresh-water marshes, wet prairies, shallow portions of rivers and reservoirs, grain and stubble fields, shallow lakes, and lagoons for feeding and loafing during migration. The whooping crane formerly nested from central Illinois west to eastern North Dakota and north through the Canadian prairie provinces. It presently breeds in Wood Buffalo National Park in the Northwest Territories, Canada. It overwinters on the Texas Gulf Coast on and in the vicinity of the Aransas National Wildlife Refuge. A second foster population migrates from Grays Lake National Wildlife Refuge in Idaho to the Bosque del Apache National Wildlife Refuge on the Rio Grande River in New Mexico. In South Dakota, the whooping crane is a predictable spring and fall migrant in the Missouri River drainage and in western South Dakota (Platte River Endangered Partnership, 2008).

- Yellow-Billed Cuckoo (*Coccyzus americanus*)—Candidate—Throughout their range, preferred breeding habitat includes open woodland (especially where undergrowth is thick), parks, and deciduous riparian woodland. In the West, they nest in tall cottonwood and willow riparian woodlands. Nests are found in trees, shrubs, or vines an average of 1 to 3 m [3 to 10 ft] above ground (Harrison, 1979). Western subspecies require patches of at least 10 ha [25 acres] of dense, riparian forest with a canopy cover of at least 50 percent in both the understory and overstory (Montana Natural Heritage Program, 2008).

The state of Wyoming does not maintain a list of threatened or endangered plant or animal species, but has established a nongame bird and mammal plan that includes a list of species of special concern. The state considers all of the federally listed animal species to be species of special concern. Wyoming Species of Concern are described as Wyoming Native Species Status matrix 1 (populations are greatly restricted or declining—extirpation appears possible) and 2 (populations are declining or restricted in numbers and/or distribution—extirpation is not imminent. Wyoming Species of Concern that may be found in the Wyoming West Uranium Milling Region include the following:

- Flannelmouth Sucker (*Catostomus latipinnis*) Native Species Status 1—This species prefers large rivers with deep riffles and runs, they can also be found in smaller streams and sometimes in lakes. Native to the Colorado River drainage basin, in Wyoming it is found in the Green and Little Snake River drainages. In the spring it leaves the large rivers and ascend small tributary streams to spawn; migrations of over 225 km [140 mi] have been documented (Wyoming Game and Fish Department, 2008).

- Boreal Toad (*Bufo boreas*) Native Species Status 1—The southern Rocky Mountain population occurs from south-central Wyoming southward through the mountainous regions of Colorado to extreme north-central New Mexico. The toads inhabit a variety of wet habitats (i.e., marshes, wet meadows, streams, beaver ponds, glacial kettle ponds, and lakes interspersed in subalpine forest) at altitudes primarily between 2,400–3,400 m [8,000–11,500 ft] (U.S. Fish and Wildlife Service, 2008).

- Common Loon (*Gavia Immer*) Native Species Status 1—Lakes that are suitable for breeding are extremely limited in Wyoming and must have the following characteristics (Wyoming Game and Fish Department, 2008):

    — At least 4 ha [10 acres], although reproductive success is better on lakes that are greater than 10 ha [25 acres]

    — Free of human disturbance or in areas that are secluded from human activity

    — Between 1,800 and 2,400 m [1,000 and 8,000 ft] in elevation

    — Have clear water with a minimum visibility of 3 to 4 m [10 to 13 ft], as loons are visual predators

    — Islands or protected shore areas for nesting and raising young

    — Abundant populations of small to mid-sized fish

    — Greater than 2 m [6 ft] deep to prevent winter kill of fish

    — Remain ice free for at least 4 months to allow young to fledge

    — For nesting, lakes with partially forested, rocky shorelines; an area of shallow water with emergent vegetation; and a steep slope adjacent to the shoreline for an underwater approach to the nest

- Burbot (*Lota lota*) Native Species Status 1—The burbot lives in cold, deep lakes and large rivers. Immature fish prefer rubble substrate, while adults remain in deep water to prey on other fish. In Wyoming, the burbot is native to the Big Horn and Tongue River systems. It is found in larger lakes in the Lander and Dubois area, including Boysen Reservoir and Ocean Lake. It also occurs south to Missouri and Kansas and east to New England, as well as throughout Canada (Wyoming Game and Fish Department, 2008).

- Sauger (*Sander canadensis*) Native Species Status 2—The sauger prefers large rivers but may also be found in reservoirs. The fish is tolerant of turbid waters. In rivers the key component of sauger habitat is velocity. In the summer and spring they select low velocity areas having sand or silt substrates. Pool habitats are preferred by sauger especially in winter where they tend to select low velocity pools greater than 2 m [6 ft] deep. Native to streams east of the Continental Divide, today the sauger occurs in Wyoming in the Wind Big Horn River drainage and in the Tongue and Powder River drainages. It has apparently been extirpated from the North Platte River, where it had once been common (Wyoming Game and Fish Department, 2008).

- Yellowstone Cutthroat (*Oncorhynchus clarki bouvieri*) Native Species Status 2—The Yellowstone cutthroat lives in lakes, large rivers, and small tributary streams. Native to the Yellowstone River drainage downstream to the Tongue River, including the Big Horn and Clarks Fork River drainages, this trout is also found in Pacific Creek and other Snake River tributaries. All other occupation by this species east of the Continental Divide is from introductions (Wyoming Game and Fish Department, 2008).

- Cliff Tree Lizard (*Urosaurus ornata wrightii*) Native Species Status 2—This lizard prefers cliffs and rocky canyon slopes in sagebrush desert habitats. It is often found on the vertical surfaces of large boulders or rock cliffs. In Wyoming, the cliff tree lizard occurs in the extreme southwestern part of the state. It also ranges south through Utah and western Colorado to northern Arizona and northern New Mexico (Wyoming Game and Fish Department, 2008).

- Great Basin Gopher Snake (*Pituophis melanoleucas deserticola)*, Native Species Status 1—This snake prefers sagebrush communities and deserts in the plains zone. In Wyoming, it can be found in the south-central counties at lower elevations and west of the Continental Divide in the Wyoming Basin. Elsewhere, it is distributed from the Great Basin to eastern California, Oregon, and Washington (Wyoming Game and Fish Department, 2008).

- Rubber Boa (*Charina bottae)* Native Species Status 2—The rubber boa prefers areas with an abundance of flat rocks and water nearby. It does not inhabit Wyoming's arid regions, but may be found in the foothills and lower mountain zones of the northwestern corner of the state, south into Star Valley and east to the Big Horn Mountains. It is also distributed west of Wyoming to the Pacific Coast from British Columbia to northern California (Wyoming Game and Fish Department, 2008).

- Canada Lynx (*Lynx canadensis*) Native Species Status 1—The Canada lynx inhabits mountain regions, primarily at elevations between 2,356 and 2,869 m [7,730 and 9,413 ft] and on slopes of 8 to 12 percent. It usually occurs in extensive tracts of dense coniferous forest, primarily Engelmann spruce (*Picea englemannii*) and subalpine fir (*Abies lasiocarpa*). It feeds primarily on snowshoe hares (*Lepus americanus*), especially during winter, and the prime consideration for lynx is habitat for snowshoe hares. Older forests with a substantial understory of conifers or small patches of shrubs and young trees provide good quality lynx foraging habitat. The most important component of denning habitat is large woody debris, especially dense tangles of fallen trees and root wads. Such preferred habitat is relatively limited in Wyoming and occurs primarily in multiple use areas of the Shoshone and Bridger-Teton National Forests. The national parks and designated wilderness areas in Wyoming tend to be marginal lynx habitat as they are either dominated by dry even-aged lodgepole pine forests or steep and high elevation (Wyoming Game and Fish Department, 2008).

- Pale Milk Snake (*Lampropeltis triangulum multistrata*), Native Species Status 2—The pale milk snake prefers grasslands, sandhills, and scarp woodlands below 1,800 m [6,000 ft] in elevation. It is distributed throughout the northern Great Plains. In Wyoming, it can be found in the eastern counties and the Big Horn Basin (Wyoming Game and Fish Department, 2008).

- Smooth Green Snake (*Opheodrys vernalis*), Native Species Status 2—This snake occupies forested areas of the foothills and montane zones, preferring to spend much of its time under rocks, logs, and other objects. It is usually associated with lush vegetation. Two subspecies occur in Wyoming. *O. vernalis vernalis*, the eastern smooth green snake, is a relict population that occurs only in the Black Hills of Wyoming and South Dakota. *O. vernalis blanchardi* is the western subspecies and can be found in southeast and south-central Wyoming. Additionally, the smooth green snake occurs in parts of Canada, the northeastern and north-central United States, and as far west as

Utah, Idaho and New Mexico. In the west, the snake's distribution is highly disjointed (Wyoming Game and Fish Department, 2008).

- Yellow-Billed Cuckoo (*Coccyzus americanus*) Native Species Status 2—The yellow-billed cuckoo nests primarily in large stands of cottonwood-riparian habitat below 2,100 m [7,000 ft], including such habitats that occur in urban areas. It is a riparian obligate species that prefers extensive areas of dense thickets and mature deciduous forests near water, and requires low, dense, shrubby vegetation for nest sites (Wyoming Game and Fish Department, 2008).

- Greater Sage-Grouse (*Centrocercus urophasianus*) Native Species Status 2—Sage-grouse depend on a variety of sagebrush community types and associated habitats, including basin-prairie and mountain foothill shrublands and wet-moist meadows. Alfalfa and irrigated meadows also serve as habitat when immediately adjacent to sagebrush. Sage-grouse use different habitats during different times of the year (Wyoming Game and Fish Department, 2008).

- Bald Eagle (*Haliaeetus leucocephalus*) Native Species Status 2—The bald eagle nests near large lakes and rivers in forested habitat where adequate prey and old, large-diameter cottonwood or conifer trees are available for nesting. Highly productive nesting areas in the Greater Yellowstone Area were found to have open water available in winter, low severity of early spring weather, limited human activity, and high sinuosity and an abundance of islands, riffles, runs, and pools in the river. Migrating and wintering eagles congregate near open water areas where concentrations of prey are available, such as carcasses of game animals, and spawning areas for kokanee, trout, and other fish (Wyoming Game and Fish Department, 2008).

- Trumpeter Swan (*Cygnus buccinator*), Native Species Status 2—The trumpeter swan inhabits shallow marshes, ponds, lakes, and river oxbows. It prefers stable, quiet, and shallow waters where small islands, muskrat houses, or dense emergent vegetation provide nesting and loafing sites. Nutrient-rich waters, with dense aquatic plant and invertebrate growth, provide the most suitable habitat. Adequate forage in the prenesting period (April to May) is critical for nesting success. Winter habitat must provide extensive beds of aquatic plants that remain ice free. In Wyoming, cold temperatures and ice restrict trumpeters to sites where geothermal waters, springs, or outflow from dams maintain ice-free areas (Wyoming Game and Fish Department, 2008).

- Fringed Myotis (*Myotis thysanodes*), Native Species Status 2—The fringed myotis is found in a wide range of habitats, including coniferous forests, woodlands, grasslands, and shrublands, although it is probably most common in xeric woodlands, such as juniper, ponderosa pine, and Douglas fir. It typically forages over water, along forest edges, or within forests and woodlands. During summer, it uses a variety of roosts, including rock crevices, tree cavities, caves, abandoned mines, and buildings. During winter, it hibernates in caves, abandoned mines, and buildings (Wyoming Game and Fish Department, 2008).

- Long-Eared Myotis (*Myotis evotis*), Native Species Status 2—The long-eared myotis primarily inhabits coniferous forest and woodland, including juniper, ponderosa pine, and spruce fir. It typically forages over rivers, streams, and ponds within the forest-woodland environment. During summer, it roosts in a wide variety of structures, including cavities in snags, under loose bark, stumps, buildings, rock crevices, caves, and abandoned mines. During winter, it is thought to hibernate primarily in caves and abandoned mines (Wyoming Game and Fish Department, 2008).

- Long-Legged Myotis (*Myotis volans*), Native Species Status 2—The long-legged myotis inhabits open, mature forest with standing dead trees, including montane and subalpine forest and ponderosa pine and juniper woodlands, primarily from 1,500 m to more than 3,300 m [5,000 to more than 11,000 ft]. It usually forages over open areas such as campgrounds and small forest clearings; over vegetated riparian areas; and within, above, and under the forest canopy. During summer, it roosts in tree cavities, buildings, rock crevices, caves, abandoned mines, and under loose bark. During winter, it hibernates primarily in caves and abandoned mines (Wyoming Game and Fish Department, 2008).

- Pallid Bat (*Antrozous pallidus*), Native Species Status 2—The pallid bat generally inhabits low desert shrublands, juniper woodlands, and grasslands and occasionally cottonwood riparian zones in those habitats. It is most common in low, arid regions with rocky outcroppings, particularly near water. During summer, it usually roosts in rock crevices and buildings, but also uses rock piles, tree cavities, shallow caves, and abandoned mines (Wyoming Game and Fish Department, 2008).

- Spotted Bat (*Euderma maculatum*), Native Species Status 2—The spotted bat occupies a wide variety of habitats, from desert scrub to coniferous forest, although it is most often observed in low deserts and basins and juniper woodlands. It roosts in cracks and crevices in high cliffs and canyons. It also may occasionally roost in buildings, caves, or abandoned mines, although cliffs are the only roosting habitat in which reproductive females have been documented (Wyoming Game and Fish Department, 2008).

- Townsend's Big-Eared Bat (*Plecotus townsendii*), Native Species Status 2—The Townsend's big-eared bat occupies a variety of xeric to mesic habitats, including coniferous forests, juniper woodlands, deciduous forests, basins, and desert shrublands, and is absent only from the most extreme deserts and highest elevations. However, this species requires caves or abandoned mines for roost sites during all seasons and stages of its life cycle, and its distribution is strongly correlated with the availability of these features (Wyoming Game and Fish Department, 2008).

## 3.2.6 Meteorology, Climatology, and Air Quality

### 3.2.6.1 Meteorology and Climatology

Wyoming's elevation results in relatively cool temperatures. Much of the temperature variations within the state can be attributed to elevation with average values dropping 1 to 2 °C [1.8 to 3.6 °F] per 300 m [1,000 ft] (National Climatic Data Center, 2005]. Summer nights are normally cool although daytime temperatures may be quite high. The fall, winter, and spring can experience rapid changes with frequent variations from cold to mild periods. Freezes in early fall and late spring are typical and result in long winters and a short growing season. In the mountains and high valleys, freezes can occur any time in the summer. During winter warm spells, nighttime temperatures can remain above freezing. Valleys protected from the wind by mountain ranges can provide ideal pockets for cold air to settle and temperatures in the valley

| Table 3.2-6. Information on Two Climate Stations in the Wyoming West Uranium Milling Region* | | | | |
|---|---|---|---|---|
| **Station (Map Number)** | **County** | **State** | **Longitude** | **Latitude** |
| Gas Hills 4 E (042) | Fremont | Wyoming | 107°31W | 42°50N |
| Jeffrey City (049) | Fremont | Wyoming | 107°50W | 42°30N |
| *National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004. | | | | |

can be considerably lower than on nearby mountainsides. Table 3.2-6 identifies two climate stations located in the Wyoming West Uranium Milling Region. Climate data for these stations are found in the National Climatic Data Center's Climatography of the United States No. 20 Monthly Station Climate Summaries for 1971–2000 (National Climatic Data Center, 2004). This summary contains climate data for 4,273 stations throughout the United States and some territories. Table 3.2-7 contains temperature data for two stations in the Wyoming West Uranium Milling Region.

Precipitation within Wyoming varies, with spring and early summer being the wettest time for much of the state. Mountain ranges are generally oriented in a north-south direction. This is perpendicular to the prevailing westerlies. Therefore, these mountains often act as moisture barriers. Air currents for the Pacific Ocean rise and drop much of their moisture along the western slopes of the mountains. Summer showers are frequent, but typically result in rainfall amounts of a few hundredths of an inch. Usually several times a year in the state, local thunderstorms will result in 2.5 to 5 cm [1 to 2 in] of rain in a 24-hour period. On rare occasions, rainfall in a 24-hour period can reach 7.5 to 12.5 cm [3 to 5 in] (National Climatic Data Center, 2005). Heavy rains can create flash flooding in headwater streams, and this flooding intensifies if these storms coincide with snowpack melting. Table 3.2-7 contains precipitation data for two stations in the Wyoming West Uranium Milling Region. The wettest month for both stations identified in Table 3.2-7 is May, which based on the snow depth data, coincides with snow pack melting (National Climatic Data Center, 2004). Both of these stations are in Fremont County. Data from the National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the vast majority of thunderstorms in Fremont County occur between June and September with the most occurring in July (National Climatic Data Center, 2007).

| Table 3.2-7. Climate Data for Stations in the Wyoming West Uranium Milling Region* | | | |
|---|---|---|---|
| | | **Gas Hills 4 E** | **Jeffrey City** |
| Temperature (°C)† | Mean—Annual | 5.5 | 5.3 |
| | Low—Monthly Mean | −7.0 | −7.0 |
| | High—Monthly Mean | 19.5 | 19.0 |
| Precipitation (cm)‡ | Mean—Annual | 24.9 | 27.1 |
| | Low—Monthly Mean | 0.86 | 0.89 |
| | High—Monthly Mean | 3.33 | 5.71 |
| Snowfall (cm) | Mean—Annual | 154 | 143 |
| | Low—Monthly Mean | 0 | 0 |
| | High—Monthly Mean | 34.3 | 26.9 |
| *National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.<br>†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.<br>‡To convert centimeters (cm) to inches (in), multiply by 0.3937. | | | |

Hailstorms are the most destructive storm event for Wyoming. Most hailstorms pass over open rangeland with minimal impact. When a hailstorm passes over a city or farmland, the property and crop damage can be severe. Most of the severe hailstorms occur in the southeast corner of the state.

Low elevations typically experience light to moderate snowfall from November to May. Snowfall within Wyoming varies by location with the mountain ranges typically receiving the most. Significant storms of 25 to 40 cm [10 to 16 in] of snowfall are infrequent outside of the mountains. Wind often coincides or follows snowstorms and can form snow drifts several meters [feet] deep. Snow can accumulate to considerable depths in the high mountains. Blizzards that last more than 2 days are uncommon. Table 3.2-7 contains snowfall data for two stations in the Wyoming West Uranium Milling Region.

Wyoming is windy and ranks first in the United States with an annual average speed of 6 m/s [12.9 mph]. During winter, Wyoming frequently experiences periods where wind speed reaches 13 to 18 m/s [30 to 40 mph] with gusts to 22 to 27 m/s [50 or 60 mph] (National Climatic Data Center, 2005). Prevailing wind direction varies by location but usually ranges from west-southwest through west to northwest. Because the wind is normally strong and constant from those directions, trees often lean to the east or southeast.

The pan evaporation rates for the Wyoming West Uranium Milling Region range from about 76 to 127 cm [30 to 50 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data is typically available only from May to October. Freezing conditions often prevent collection of quality data during the other parts of the year.

### 3.2.6.2 Air Quality

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. Except for Indian Country, New Source Review permits in Wyoming are regulated under the EPA-approved State Implementation Plan. For Indian Country in Wyoming, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. As promulgated in 40 CFR Part 50, National Primary and Secondary Ambient Air Quality Standards (NAAQS), the NAAQS define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. Primary NAAQS are established to protection public health, and secondary NAAQS are established to protect public welfare by safeguarding against environmental and property damage. Primary and secondary NAAQS are presented in Table 3.2-8. Some pollutants have multiple standards. Particulates are divided into two categories: $PM_{10}$ defined as particulate matter smaller than 10 μm [$3.9 \times 10^{-4}$ in], and $PM_{2.5}$, defined as particulate matter smaller than 2.5 μm [$9.8 \times 10^{-5}$ in]. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain early action compact areas. None of the 1-hour ozone Early Action Compact Areas are in Wyoming. States may develop

**Table 3.2-8. National Ambient Air Quality Standards***

| Pollutant | Primary Standards | Averaging Times | Secondary Standards |
|---|---|---|---|
| Carbon Monoxide | 9 ppm (10,000 μg/m$^3$)† | 8 hours‡ | None |
| | 35 ppm (40,000 μg/m$^3$)† | 1 hour‡ | None |
| Lead | 1.5 μg/m$^3$† | Quarterly average | Same as primary |
| Nitrogen Dioxide | 0.053 ppm (100 μg/m$^3$)† | Annual (arithmetic mean) | Same as primary |
| Particulate Matter 10-μm diameter ($PM_{10}$) | 150 μg/m$^3$† | 24 hours§ | Same as primary |
| Particulate Matter 2.5-μm diameter ($PM_{2.5}$) | 15.0 μg/m$^3$† | Annual‖ (arithmetic mean) | Same as primary |
| | 35 μg/m$^3$† | 24 hours¶ | Same as primary |
| Ozone | 0.08 ppm | 8 hours# | Same as primary |
| | 0.12 ppm | 1 hour** | Same as primary |
| Sulfur Oxides | 0.03 ppm | Annual (arithmetic mean) | Not applicable |
| | 0.14 ppm | 24 hours‡ | Not applicable |
| | Not applicable | 3 hours‡ | 0.5 ppm (1,300 μg/m$^3$)† |

*Modified from U.S. Environmental Protection Agency. "National Ambient Air Quality Standards (NAAQS)." 2007. <http://www.epa.gov/air/criteria.html> (15 October 2007).
†Multiply μg/m$^3$ value by $2.7 \times 10^{-8}$ to convert units to oz/yd$^3$.
‡Not to be exceeded more than once per year.
§Not to be exceeded more than once per year on average over 3 years.
‖To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 μg/m$^3$.
¶To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35.0 μg/m$^3$ (effective December 17, 2006).
#To attain this standard, the 3-year average of the fourth highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
**(a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤1, as determined by Appendix H. (b) As of June 15, 2005, the U.S. Environmental Protection Agency revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonatttainment Early Action Compact Areas.

standards that are stricter or supplement the NAAQS. Wyoming has a more restrictive annual average standard for sulfur dioxide at 60 μg/m$^3$ [$1.6 \times 10^{-6}$ oz/yd$^3$] and a supplemental 50 μg/m$^3$ [$1.3 \times 10^{-6}$ oz/yd$^3$] $PM_{10}$ standard with an annual averaging time (WDEQ, 2008).

As promulgated in 40 CFR Part 52, Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas. Table 3.2-9 contains the maximum allowable Prevention of Significant Deterioration increments for Class I and Class II areas. Class I areas are locations with special natural, recreational, scenic, or historic value such as national parks or wilderness areas and have the most stringent set of allowable increments. Most other areas in the United States are categorized as Class II areas and have a less stringent set of allowable increments.

**Table 3.2-9. Allowable Prevention of Significant Deterioration Class I and Class II Areas***

| Pollutant | Class 1 (μg/m³)† | Class II (μg/m³)† | Measurement |
|---|---|---|---|
| Nitrogen Dioxide ($NO_2$) | 2.5 | 25 | Annual average |
| $PM_{10}$‡ | 4 | 17 | Annual average |
| | 8 | 30 | 24 hours‡ |
| Sulfur Dioxide ($SO_2$) | 2 | 20 | Annual average |
| | 5 | 91 | 24 hours§ |
| | 25 | 512 | 3 hours§ |

*Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 52. Washington, DC: U.S. Government Printing Office. 2005.
†Multiply μg/m³ value by 2.7 × $10^{-8}$ to convert units to oz/yd³.
‡Not to be exceeded on more than 1 day/year on the average over 3 years.
§Not to be exceeded more than once per year.

One goal identified in the Clean Air Act is to address visibility impairment from haze at the Prevention of Significant Deterioration Class I areas in the country. Regional haze is visibility impairment caused by cumulative air pollutant emissions from numerous sources over a wide geographic area (EPA, 1999). Key contributors to regional haze are sulfur dioxide, nitrogen oxides, and particulate matter. One source of particulate matter is soil dust or fugitive dust. EPA, in 40 CFR Part 51, requires states to address regional haze in their implementation plans.

The Wyoming West Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and Prevention of Significant Deterioration classifications in the region.

NAAQS compliance attainment status is typically determined at the county level. Each NAAQS pollutant is designated into one of the following categories: attainment, nonattainment, or maintenance. Areas are designated as attainment for a particular pollutant if atmospheric concentrations meet NAAQS. If atmospheric concentrations of a pollutant do not meet NAAQS, that area is designated as nonattainment for that pollutant. The maintenance category describes areas formerly designated as nonattainment, but that now meet NAAQS requirements. Figure 3.2-15 identifies counties in Wyoming and surrounding areas that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). All of the area within the Wyoming West Uranium Milling Region is classified as attainment. In fact, Wyoming only has one area that is not in attainment. The city of Sheridan in Sheridan County is designated as nonattainment for $PM_{10}$. Portions of several Colorado counties along the southern Wyoming border are classified as not in attainment. However, the southern boundary of the Wyoming West Uranium Milling Region is north of the Wyoming/Colorado border.

Table 3.2-10 identifies the Prevention of Significant Deterioration Class I areas in Wyoming. These areas are shown in Figure 3.2-16. There are no Class I areas in the Wyoming West Uranium Milling Region (40 CFR Part 81).

EPA also encourages states to work with tribes and federal agencies in regional partnerships to address the regional haze issue. Wyoming is a member of the Western Regional Air Partnership. Also, specific provisions in 40 CFR Part 51 allow nine western states, including Wyoming, to implement the recommendations of the Grand Canyon Visibility Transport Commission within the regional haze program.

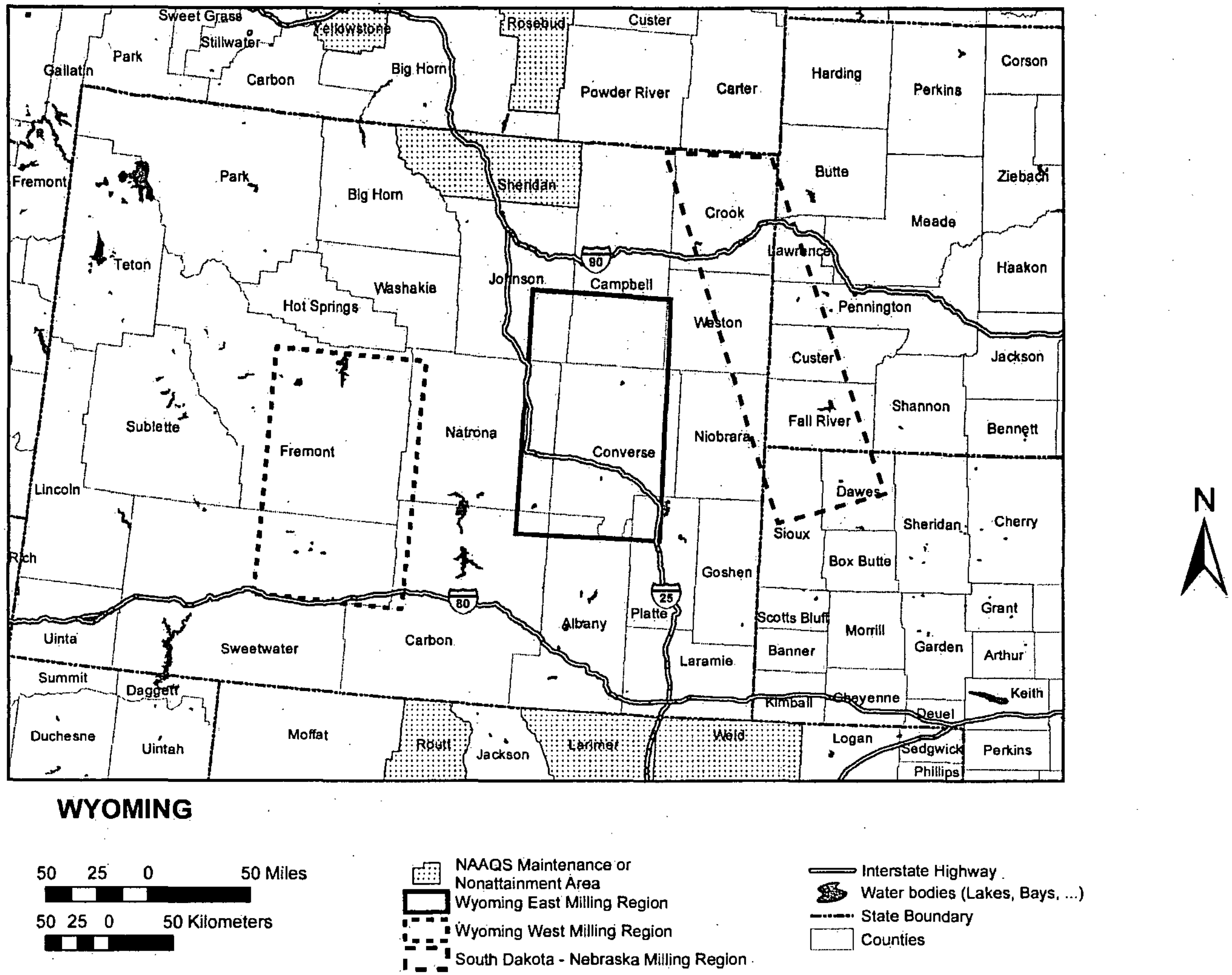



**Figure 3.2-15. Air Quality Attainment Status for Wyoming and Surrounding Areas (EPA, 2007)**

| Table 3.2-10. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in Wyoming* |
|---|
| Bridger Wilderness |
| Fitzpatrick Wilderness |
| Grand Teton National Park |
| North Absaroka Wilderness |
| Teton Wilderness |
| Washakie Wilderness |
| Yellowstone National Park |
| *Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005. |

### 3.2.7 Noise

Noise is technically defined as unwanted sound. Noise is a potential occupational hazard because prolonged exposure to noise may cause long-term hearing loss. In the United States, noise levels are regulated at the federal level by the Occupational Health and Safety Administration and the Mining Safety and Health Administration (Bauer and Kohler, 2000). To provide a sense of magnitude, noise levels associated with common activities are presented in Figure 3.2-17.

> **What are Sound and Noise?**
>
> When an object vibrates, some of the energy causes air molecules to vibrate. Nearby people or animals translate these vibrations into sound using the eardrum and brain. Noise is simply unwanted sound. Sound waves are characterized by frequency and measured in hertz (Hz); sound pressure is expressed as decibels (dB). Noises that are perceptible to human hearing range vary from 31 to 20,000 Hz. Audible sounds (those that can be heard) range from about 60 dB at a frequency of 31 Hz to less than about 1 dB between 900 and 8,000 Hz. Noise levels for perceptible frequencies are typically reported in A-weighted decibels to account for the way people respond to noise; this type of measurement assumes a human receptor to a particular noise-producing activity.

Existing ambient noise levels can be used to establish baseline conditions and determine potential site-specific disturbances associated with ISL milling activities. The Wyoming West Uranium Milling Region is predominantly rural and undeveloped. Rural areas tend to be quiet, open sagebrush-grass and forested areas where natural phenomena such as wind, rain, insects, birds, and other wildlife account for most natural background sounds. Baseline noise levels for typical undeveloped desert or arid environments range from day-night sound levels of 22 dB on calm days to 38 dB on windy days (Brattstrom and Bondello, 1983; DOE, 2007).

Larger communities in the region include Riverton and Lander, with populations of between 5,000 and 10,000. Fort Washakie (population about 1,500), the location of the headquarters for the Wind River Indian Reservation, is within the region. In addition, Rawlins (population about 8,500) is just east of the southeast corner of the region on Interstate 80 (see Section 3.2.10). In these more urbanized areas, ambient noise levels would be expected to be influenced by noise-generating activities such as street noise, traffic, emergency vehicles, and construction equipment. Noise levels in these types of suburban residential/urban areas range from 45 to about 78 dB, with lower noise levels at night (Washington State Department of Transportation, 2006).

As described in Section 2.8, several highways cross the region, including U.S. Highways 20, 26, and 287, as well as Interstate 80. A summary of noise effects on wildlife populations (Federal Highway Administration, 2004) includes reference to measured average traffic noise levels at 15 m [50 ft] of 54–62 dBA for passenger cars and 58–70 dBA for heavy trucks

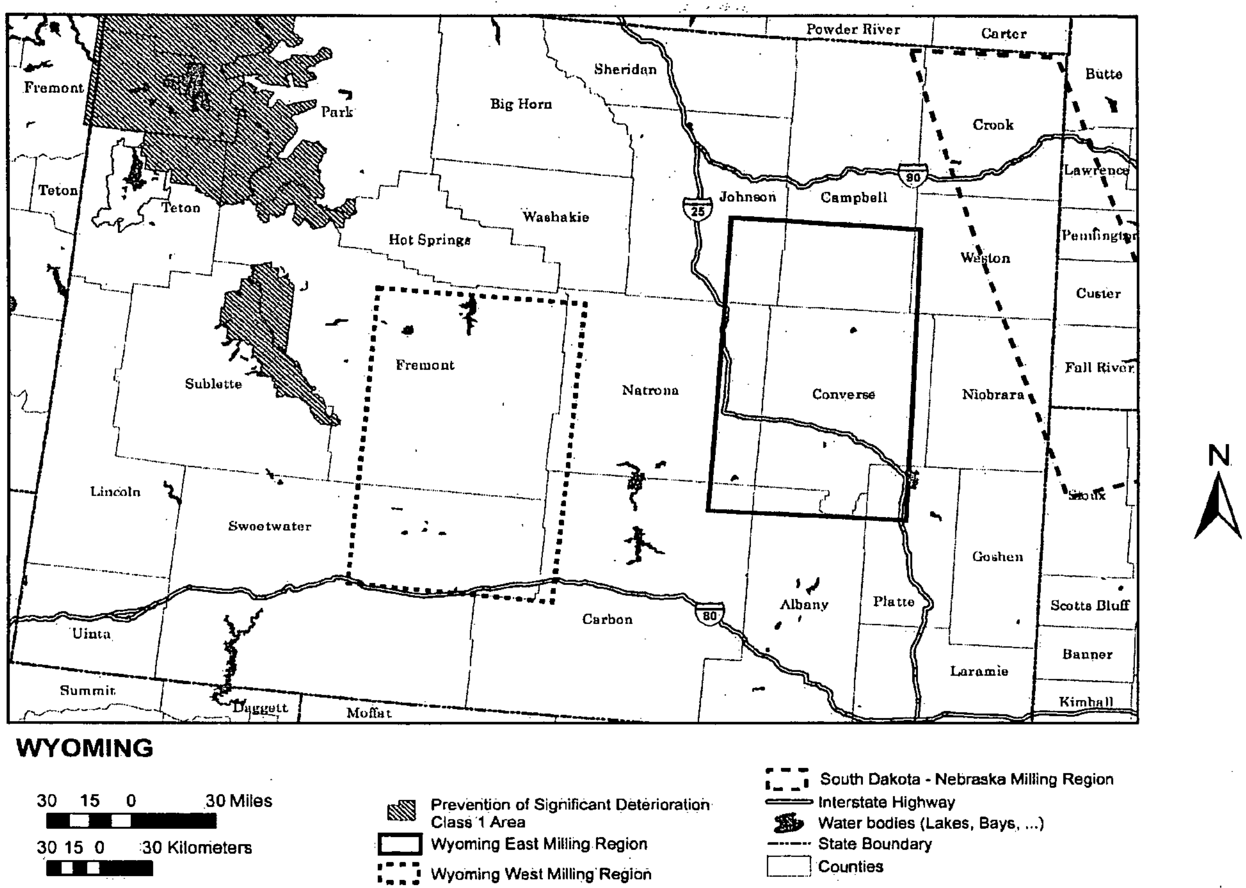



**Figure 3.2-16. Prevention of Significant Deterioration Class I Areas in the Wyoming West Uranium Milling Region and Surrounding Areas (40 CFR Part 81)**

| COMMON SOUNDS | DECIBELS* | EFFECT |
|---|---|---|
| Jet Operation | 140 | Painfully Loud |
| | 130 | |
| Jet Takeoff<br>Thunder<br>Rock Concert | 120 | Maximum Vocal Effort |
| Pile Drivers | 110 | |
| Garbage Truck | 100 | |
| Heavy Truck<br>(50 ft) | 90 | Very Annoying<br>Hearing Damage at 8 hr |
| Alarm Clock<br>Hair Dryer | 80 | Annoying |
| Freeway Traffic<br>Man's Voice (3 ft) | 70 | Telephone Use Difficult |
| Air Conditioning Unit<br>(20 ft) | 60 | Intrusive |
| Light Auto Traffic<br>(100 ft) | 50 | Quiet |
| Living Room<br>Quiet Office | 40 | |
| Library<br>Soft Whisper (15 ft) | 30 | Very Quiet |
| Broadcasting Studio | 20 | |
| | 10 | Just Audible |

*To the ear, each 10 dB increase seems twice as loud. 70 dB is the point at which noise begins to harm hearing.

**Figure 3.2-17. Comparison of Noise Levels Associated with Common Activities (After EPA, 1981)**

(Federal Highway Administration, 2004) along Interstate 80. Baseline ambient noise levels would be similar to or less than those for the U.S. and state highways in the region, as they are mostly undivided highways and tend to carry less traffic (particularly heavy trucks) than a major interstate highway like Interstate 80. For example, a 2005 traffic analysis at Interstate 80 milepost 208.65 just west of Rawlins indicates an average traffic count of about

12,400 vehicles per day. Of this, almost 50 percent was heavy truck traffic (Wyoming Department of Transportation, 2005). In comparison, for U.S. Highway 26 milepost 125.75 northwest of Riverton, the 2005 traffic count was about 3,700 vehicles with almost 90 percent passenger truck and car traffic (Wyoming Department of Transportation, 2005).

**How Is Sound Measured?**

The human ear responds to a wide range of sound pressures. The range of sounds people normally experience extends from low to high pressures by a factor of 1 million. Sound is commonly measured using decibels (dB). Another common sound measurement is the A-weighted sound level (dBA). The A-weighting measures different sound frequencies and the variation of the human ear's response over the frequency range. Higher frequencies receive less A-weighting than lower ones. Noise levels are often reported as the equivalent sound level (DOE, 2007). The equivalent sound level is expressed as an A-weighted sound level over a specified period of time—usually 1 or 24 hours. The equivalent sound level is an equivalent steady sound level that, if it continued during a specified time period, would contain the same total energy as the actual time-varying sound over the monitored or modeled time period. Noise levels are also expressed as day-night sound levels: the average of the day and nighttime A-weighted sound level with a built-in penalty of 10 dBA at night when noise levels are likely lower. The day-night sound level is particularly useful for evaluating community-level noise effects. If noise is regulated, municipalities often have local ordinances specifying upper limits on evening noise levels, with specific hours for residential and commercial zones.

The two principal uranium districts in the Wyoming West Uranium Milling Region (the Great Divide Basin in the southeast part of the region and the Wind River Basin in the northeast part of the region) are located more than about 30 to 80 km [20 to 50 mi] from the larger communities, in rural undeveloped areas where the ambient noise levels would be expected to be low. There are a number of smaller communities along highways and roads through the uranium districts, including Jeffrey City and Bairoil near U.S. Highway 287 in the Great Divide Basin and Ervay and Sand Draw in the Wind River Basin, where noise levels would be expected to be slightly higher as a result of human activities. Areas of special sensitivity may be located on the Wind River Indian Reservation in the northwest corner of the region, but the reservation boundary is more than 16 km [10 mi] from the closest potential uranium ISL facility near Sand Draw, and more than 50 km [30 mi] from the center of the two uranium districts.

## 3.2.8 Historical and Cultural Resources

The following sections summarize the historical and cultural resources background and legislation and authorities regarding historical and cultural resources for the Uranium GEIS regions in the states of Nebraska, New Mexico, South Dakota, and Wyoming. The information is provided on a state-by-state basis rather than by the regions of interest as the historical and cultural resource information and agencies are organized at the state level. A brief discussion of NHPA cultural and historical resource management processes is included in Appendix D.

### 3.2.8.1 Cultural Resources Overview

The Wyoming State Historic Preservation Office (SHPO) administers and is responsible for oversight and compliance with the National Register of Historic Places (NRHP), compliance and review for Section 106 of NHPA, traditional cultural properties review, enforcement of the Native American Graves Protection and Repatriation Act (NAGPRA), and compliance with other federal and state historic preservation laws, regulations, and statutes. The Wyoming SHPO and BLM have also entered into a programmatic agreement that describes the manner in which the Wyoming SHPO and the Wyoming BLM would interact and cooperate under the BLM national Programmatic Agreement. State level agreements between Wyoming and the National Resource Conservation Service (NRCS) and the U.S. Forest Service (USFS) are in draft form.

Wyoming SHPO's webpage with links to all of their resources can be found at: (http://wyoshpo.state.wy.us/). The state of Wyoming also has a law pertaining to archaeological sites and human remains, entitled Archaeological Sites (Wyoming Statute Ann. §36-1-114, et seq).

The following provides a brief overview of prehistoric and historical cultures recognized in the central and northern plains region, which includes the Wyoming West Uranium Milling Region. Figure 3.2-18 illustrates the division of the plains into regional subdivisions. The dating of cultural periods for the prehistoric period is provided in years before present (B.P.). Most prehistoric and historical period Native American archaeological sites are concentrated along major river systems and their tributaries, but can also be found along many drainage basins in the eastern and central portions of the state. In addition, historical period sites such as the Oregon-California National Historic Trail and the Bozeman National Historic Trail cross the Wyoming West and Wyoming East Regions.

**Paleoindian Big Game Hunters (12,000 to 6,500 B.P.).** The earliest well-defined cultural tradition in the northern and central plains region is the Paleoindian. Early humans entered the area shortly after deglaciation allowed movement onto the northern and central plains sometime after 14,000 B.P. A variety of cultures, each defined by the presence of distinctive, lanceolate projectile points, are recognized during the Paleoindian period: Clovis, Goshen, Folsom, Hell Gap-Agate Basin, Alberta, Cody Complex, and the late Paleoindian-Early Archaic Foothills/Mountain Complex. Most post-Clovis Paleoindian sites on the northern and upper central plains are known from bison kill sites. The Clovis culture (12,000 to 10,000 B.P.) is recognized by a distinctive projectile point style and a subsistence mode heavily reliant on hunting large, now-extinct mammals, notably mammoth, which became extinct at the end of the Clovis period, and ancient bison. The poorly defined Goshen Complex is found at the Carter/Kerr-McGee site in northeastern Wyoming and the Jim Pitts site in the Black Hills at the Wyoming-South Dakota border. Goshen is technologically similar to Clovis and may be contemporary with Clovis and perhaps Folsom. The Folsom culture (ca. 10,000 to 8,500 B.P.) is also known for a distinctive fluted, projectile point style, and evidence of the culture has been found at the Carter/Kerr-McGee site associated with bison and red ochre deposits. Folsom subsistence is also characterized by reliance on large game (the ancient bison). Folsom sites consist of campsites and kill sites. The latter tend to be located near cliffs and around water, such as ponds and springs.

The Hell Gap-Agate Basin Complex, Alberta Complex, and Cody Complex are widely distributed in the northern and central portions of the southern plains region at the Agate Basin, Hell Gap, and Carter/Kerr-McGee archaeological sites in eastern Wyoming. These late Paleoindian cultural complexes are, in their earliest forms, a continuation of preceding Paleoindian hunting traditions. The distinctive projectile point forms that define these cultural complexes in central and eastern Wyoming and western South Dakota are, in comparison to earlier Clovis, Goshen, and Folsom, much more restricted in geographic distribution. Toward the end of the Paleoindian period, however, there is a transition in subsistence modes following the extinction of the ancient bison, and the transition to hunting the modern form of bison ultimately leading to the transition to Archaic broad-spectrum foraging. Post molds and stone circles suggesting the presence of ephemeral shelters are sometimes found, primarily toward the end of the period.

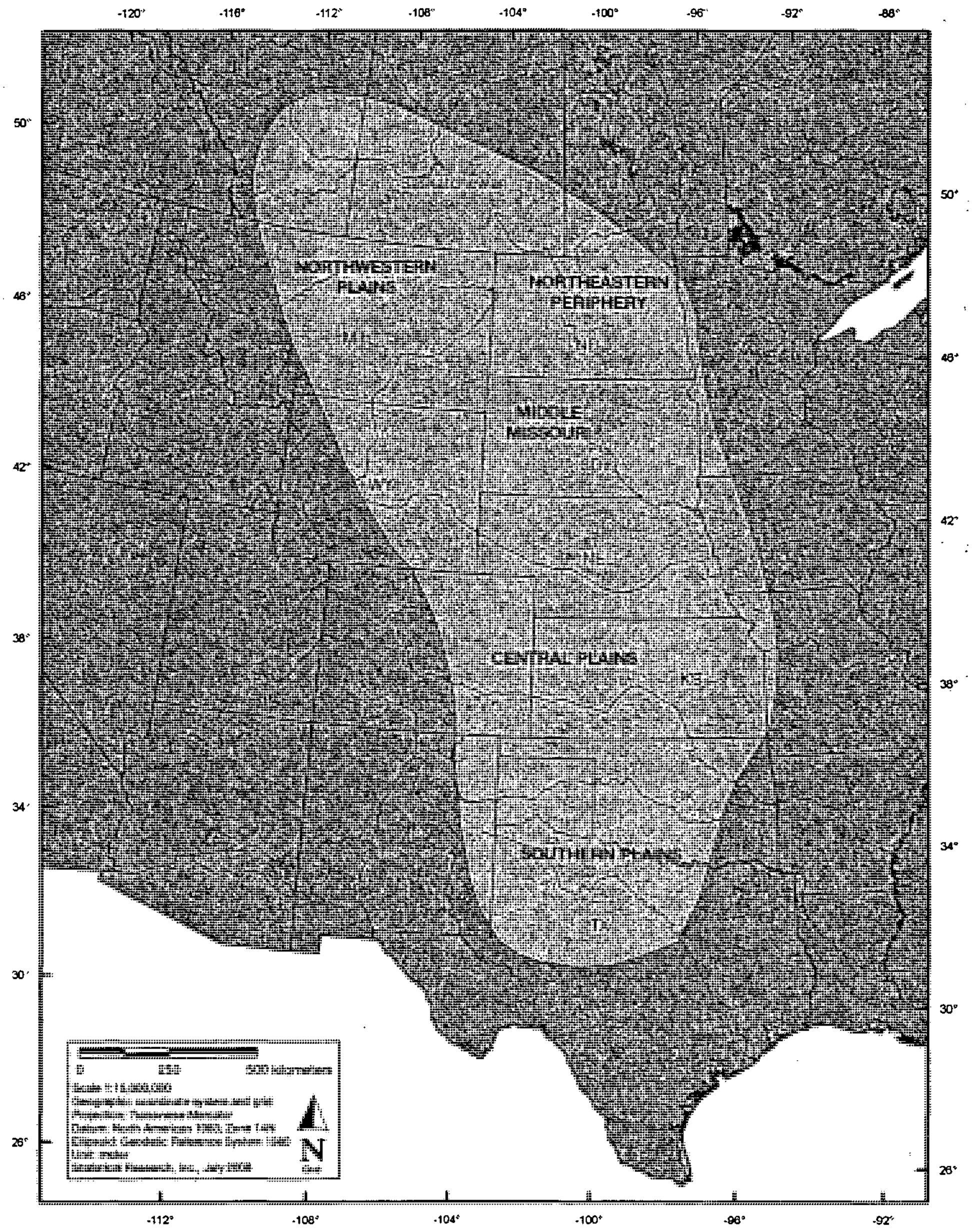



**Figure 3.2-18. General Divisions of the American Plains**

The late Paleoindian Foothills/Mountain Complex is characterized by a reliance on medium-sized game animals rather than big game hunting. Sites are found in upland, mountainous regions, leading some to suggest that Paleoindian groups may have split into lowland big game hunters and upland/mountain small- and medium-game hunters (Frison, 1991). The upland/mountain sites show increased use of small seed-bearing plants as indicated by the presence of groundstone implements and suggests the presence of an early archaic lifestyle. Habitation sites of this complex are found in rock shelters and caves such as Mummy Cave in the Absaroka Mountains of northwestern Wyoming.

**Archaic Foragers (6,500 to 2,500 B.P.).** The Plains Archaic period represents the continuation of change in subsistence and settlement linked to an increasingly arid environment that occurs in the latter portion of the preceding late Paleoindian cultures. At the end of the Paleoindian period there is also a change in projectile point styles from lanceolate to somewhat smaller corner- and side-notched projectile points, suggesting that the atlatl (spearthrower) was in use. Distinctive Archaic cultures, from early to late, include Mummy Cave, Oxbow, McKean, and Pelican Lake complexes and are found throughout the northern plains. Large bison kill sites, characteristic of the preceding Paleoindian period are virtually absent. Hunting and gathering wild plant foods is the primary mode of subsistence. Dietary breadth, indicated by increasing diversity and numbers of subsistence items, is believed to expand significantly with more medium and small mammals being hunted and the introduction of seed-bearing plants, dietary staples indicated by the introduction of stone seed-grinding implements. The Early Archaic Medicine House site in southeastern Wyoming contained evidence of structures, hearths, storage pits, and milling basins. At the McKean site in the Black Hills of Wyoming, a shallow pithouse was found. Through time, settlement is increasingly tethered to highly productive resource areas and sites tend to become larger and increasingly complex, indicating the presence of somewhat more sedentary lifestyles relative to earlier periods. Settlement is focused on river valleys and elevated areas. Artifact styles, principally projectile points, become increasingly diversified, suggesting increasing regionalization and cultural differentiation. In southeastern Wyoming, Pelican Lake projectile points are sometimes found in association with stone circles, firepits, and pithouses.

**Late Prehistoric/Plains Woodland (2,500 to 300 B.P.).** Early in the period, the preceding late Archaic broad-spectrum foraging subsistence and settlement patterns continue with little change. In the Northern Plains, the Besant and Avonlea Complexes continued virtually unchanged Archaic lifestyles until contact with European and American cultures. A significant technological change from atlatl to bow and arrow occurs during the Late Prehistoric period. Subsistence focused on scheduled small- and medium-game hunting, plant food gathering, and bison hunting according to a seasonal round. In central and northeastern Wyoming, a basic hunting and gathering lifestyle differing little from the preceding Late Archaic period predominates. Although eastern Wyoming is considered peripheral to the eastern Woodland tradition, Woodland pottery is sometimes found in association with Besant points in the northern plains. The Butler-Risser site south of Casper, Wyoming, contained both Besant points and pottery. Food procurement and site location during this period appears to be focused primarily on elevated landforms near larger riverine systems and tributaries with increasing utilization of upland resources later in time. The Late Prehistoric/Plains Woodland of Wyoming is also characterized by the appearance of ceramics late in the period (Besant and Avonlea Complexes), introduced from the Eastern Woodland cultural area. The late Avonlea Complex and later Old Woman Complex sites in northern Wyoming contain artifact types that suggest a high degree of specialization in hunting large, upland game animals, primarily bison.

In the eastem portions of Wyoming, the Upper Republican phase (ca. 1000–300 B.P.) is characterized by the presence of seasonal or permanent sedentary villages. These sites are usually on ridges and bluffs and have evidence of domesticated plants (corn, beans, squash, and sunflowers). Although horticulture was an important part of the subsistence base, wild plants and game animals formed a substantial part of the diet. Storage pits for food and other items are located within the structures, and grinding tools are common. Pottery was diverse with globular jars, and decorated exterior rims are common. The later Dismal River Aspect (ca. 500–300 B.P.) in southeastern Wyoming is focused primarily on hunting and gathering with only limited evidence of horticultural pursuits and a distinctive form of pottery.

In the 1500s to early 1700s A.D., large migrations by Native American tribes occurred. The ancestors of modern Apache, Arapaho, Comanche, Apache-Kiowa, and Kiowa migrated southward through western Wyoming in the 1500s and 1600s.

**Post-Contact Tribes (300 to 100 B.P.).** The post-contact period on the northern plains is that period after initial contact with Europeans and Americans. Although Euro-American trade goods may have appeared as early as the mid-1600s, the earliest documented contact in the northern and central plains is by Spanish and French explorers in the early 1700s A.D. The horse appears to have been introduced at about the same time. The lifeways of the late Avonlea and post-Avonlea/Old Woman nomadic bison-hunting cultural complexes in central and northeastern Wyoming and the Upper Republican and Dismal River horticulturalists of eastern and southeastern Wyoming appear to have continued well into the mid to late 1700s A.D. At the time of European exploration, the Dakota and Nakota moved into eastern Wyoming from what is now Minnesota. The Shoshone were present in southeastern Wyoming in the 1600s and 1700s. About this time, the Crow moved into northeastern and north-central Wyoming and the Apache-Kiowas moved out of the Black Hills into southeastern Wyoming. The Apache-Kiowa migration through the Black Hills was followed by that of the Cheyenne who moved through western South Dakota and then into central Wyoming where they were joined by the Arapaho who settled in southern Wyoming (Reher, 1977). By the mid-1800s, much of the eastern and central portions of the state was occupied by nomadic Siouan-speaking tribes, primarily the Hunkpapa, Minneconjou, Brule, and Oglala.

**Europeans and Americans (300 to 100 B.P.).** The earliest European presence in Wyoming was by French explorers of the de la Vénendrye family in 1743. In 1803, the United States completed the purchase of the Louisiana Territory from France. Early expeditions and trappers provide descriptions of varying quality for some of the early historical tribes in the region. In the later 1700s and early 1800s, more intensive contact and settlement occurred first through missionaries and the fur trade period in the 1810s through the 1840s. In 1807, Manuel Lisa of St. Louis established a trading post on the Bighorn River. Others, including Jedediah Smith, began fur trading companies that quickly spread along the major river systems of Wyoming. Each year the fur traders and trappers would establish a rendezvous site where they would gather. Rendezvous sites are known throughout much of central and western Wyoming. By the late 1830s, the fur trade in Wyoming was in decline. By the mid-1800s, missionary, settler, and military contacts led to increasing conflict with the Siouan tribes of Wyoming. The slowly increasing number of settlers passing through traditional tribal use areas on well-established trails in the mid-1800s led to increasing conflict over time. The establishment of military forts on tribal lands to protect the settlers was yet another irritant to tribes.

Treaties, notably the Fort Laramie Treaty of 1851, were signed with the intent of removing tribes from along the emigrant trails and allowing for the building of trails and forts to protect settlers moving west on the Texas, Oregon, California, Mormon, Bozeman, and Bridger Trails in central and eastern Wyoming. Continued conflict resulted in the creation of the Great Sioux Reservation bounded by the Missouri River on the east, the Big Horn Mountains on the west, and the 46th and 43rd parallels to the north and south, respectively. Continued conflict with the U.S. military over the failure of the government to abide by treaty obligations led to several punitive expeditions to return tribes to reservations. In 1874, General George Armstrong Custer led an expedition to the Black Hills of Wyoming and South Dakota where the presence of gold, previously only rumored, was confirmed. The intense interest by Americans to go to the Black Hills to mine for gold led to numerous treaty violations; the Black Hills regions was, by treaty, part of the Sioux reservation. The continued conflict over the Black Hills, along with reduction of the buffalo herds, led to the final military conquest of the Great Sioux Nation and their confinement to small reservations. In November 1875, President Grant ordered the Indians of the Powder River and Big Horn country in eastern and central Wyoming to return to their tribal agencies. The Sioux refused and were forced militarily onto their reservations. The Black Hills gold rush facilitated the subsequent settlement of much of Wyoming and the development of towns and cattle ranching.

Ranching, a livelihood well suited to the grassland plains of Wyoming, was practiced by settlers by the early 1870s. Most of the early ranching occurred in well-watered areas along existing trail systems to facilitate moving cattle to market. The arrival of the railroads in 1868 (first the Union Pacific in southern Wyoming, then branch lines in other parts of Wyoming) led to increased settlement and opened Wyoming to a flood of new settlers. In the 1880s, farmers began homesteading much of the open range leading to conflict with ranchers over fencing. They settled mostly around well-watered regions, with many of the new farmers pursuing newly developed dry-land farming techniques. These homestead farmers began a period of extensive agriculture throughout the state that lasted from the 1880s to the 1930s. The Great Depression and the droughts that occurred at the same time led to the abandonment of many farms and the outmigration of a significant portion of Wyoming's population. Many of the individual homesteads were bought out in the 1930s and 1940s to create larger farms that used mechanized equipment.

#### 3.2.8.2 National Register of Historic Properties and State Registers

Table 3.2-11 includes a summary of sites in the Wyoming West Uranium Milling Region that are listed on the Wyoming state and/or NRHP. Most of the sites are located in Fremont County, at least 32 km [20 mi] west of the two uranium districts in the Gas Hills and near Crooks Gap.

**Table 3.2-11. National Register Listed Properties in Counties Included in the Wyoming West Uranium Milling Region**

| County | Resource Name | City | Date Listed YYYY-MM-DD |
|---|---|---|---|
| Carbon | Duck Lake Station Site | Wamsutter | 1978-12-06 |
| Fremont | BMU Bridge Over Wind River | Ethete | 1985-02-22 |
| Fremont | Decker, Dean Sites (48FR916; 48SW541) | Honeycomb Buttes | 1986-03-12 |
| Fremont | Delfelder Schoolhouse | Riverton | 1978-03-29 |
| Fremont | ELY Wind River Diversion Dam Bridge | Morton | 1985-02-22 |
| Fremont | Fort Washakie Historic District | Fort Washakie | 1969-04-16 |
| Fremont | Green Mountain Arrow Site (48FR96) | Stratton Rim | 1986-03-12 |
| Fremont | Jackson Park Town Site Addition Brick Row | Lander | 2003-02-27 |
| Fremont | King, C.H., Company, and First National Bank of Shoshoni | Shoshoni | 1994-09-08 |

| Table 3.2-11. National Register Listed Properties in Counties Included in the Wyoming West Uranium Milling Region (continued) | | | |
|---|---|---|---|
| County | Resource Name | City | Date Listed YYYY-MM-DD |
| Fremont | Lander Downtown Historic District | Lander | 1987-05-05 |
| Fremont | Quien Sabe Ranch | Shoshoni | 1991-04-18 |
| Fremont | Riverton Railroad Depot | Riverton | 1978-05-22 |
| Fremont | Shoshone-Episcopal Mission | Fort Washakie | 1973-04-11 |
| Fremont | South Pass | South Pass City | 1966-10-15 |
| Fremont | South Pass City | South Pass City | 1970-02-26 |
| Fremont | St. Michael's Mission | Ethete | 1971-06-21 |
| Fremont | Union Pass | Unknown | 1969-04-16 |
| Fremont | U.S. Post Office and Courthouse—Lander Main | Lander | 1987-05-19 |
| Fremont | Wind River Agency Blockhouse | Ft. Washakie | 2000-12-23 |
| Natrona | Archaeological Site No. 48NA83 | Arminto | 1994-05-13 |
| Natrona | Big Horn Hotel | Arminto | 1978-12-18 |
| Natrona | Bishop House | Casper | 2001-03-12 |
| Natrona | Bridger Immigrant Road—Waltman Crossing | Casper | 1975-01-17 |
| Natrona | Casper Army Air Base | Casper | 2001-08-03 |
| Natrona | Casper Buffalo Trap | Casper | 1974-06-25 |
| Natrona | Casper Federal Building | Casper | 1998-12-21 |
| Natrona | Casper Fire Department Station No. 1 | Casper | 1993-11-04 |
| Natrona | Casper Motor Company—Natrona Motor Company | Casper | 1994-02-23 |
| Natrona | Chicago and Northwestern Railroad Depot | Powder River | 1988-01-07 |
| Natrona | Church of Saint Anthony | Casper | 1997-01-30 |
| Natrona | Consolidated Royalty Building | Casper | 1993-11-04 |
| Natrona | DUX Bessemer Bend Bridge | Bessemer Bend | 1985-02-22 |
| Natrona | Elks Lodge No. 1353 | Casper | 1997-01-30 |
| Natrona | Fort Caspar | Casper | 1971-08-12 |
| Natrona | Fort Caspar (Boundary Increase) | Casper | 1976-07-19 |
| Natrona | Independence Rock | Casper | 1966-10-15 |
| Natrona | Martin's Cove | Casper | 1977-03-08 |
| Natrona | Masonic Temple | Casper | 2005-08-24 |
| Natrona | Midwest Oil Company Hotel | Casper | 1983-11-17 |
| Natrona | Natrona County High School | Casper | 1994-01-07 |
| Natrona | North Casper Clubhouse | Casper | 1994-02-18 |
| Natrona | Ohio Oil Company Building | Casper | 2001-07-25 |
| Natrona | Pathfinder Dam | Casper | 1971-08-12 |
| Natrona | Rialto Theater | Casper | 1993-02-11 |
| Natrona | Roosevelt School | Casper | 1997-01-30 |
| Natrona | South Wolcott Street Historic District | Casper | 1988-11-23 |
| Natrona | Split Rock, Twin Peaks | Muddy Gap | 1976-12-22 |
| Natrona | Stone Ranch Stage Station | Casper | 1982-11-01 |
| Natrona | Townsend Hotel | Casper | 1983-11-25 |
| Natrona | Tribune Building | Casper | 1994-02-18 |
| Sweetwater | Eldon—Wall Terrace Site (48SW4320) | Westvaco | 1985-12-13 |

### 3.2.8.3 Tribal Consultation

There are several Native American tribes located within or immediately adjacent to the state of Wyoming that have interests in the state and in the Wyoming West Uranium Milling Region (Figure 3.2-19). These include the

- Arapaho Tribe of the Wind River Reservation
- Shoshone Tribe of the Wind River Reservation
- Cheyenne River Sioux
- Flandreau Santee Sioux
- Lower Brulé Sioux
- Oglala Sioux
- Rosebud Sioux
- Sisseton-Whapeton Oyate
- Standing Rock Sioux
- Yankton Sioux
- Crow Tribe of Montana

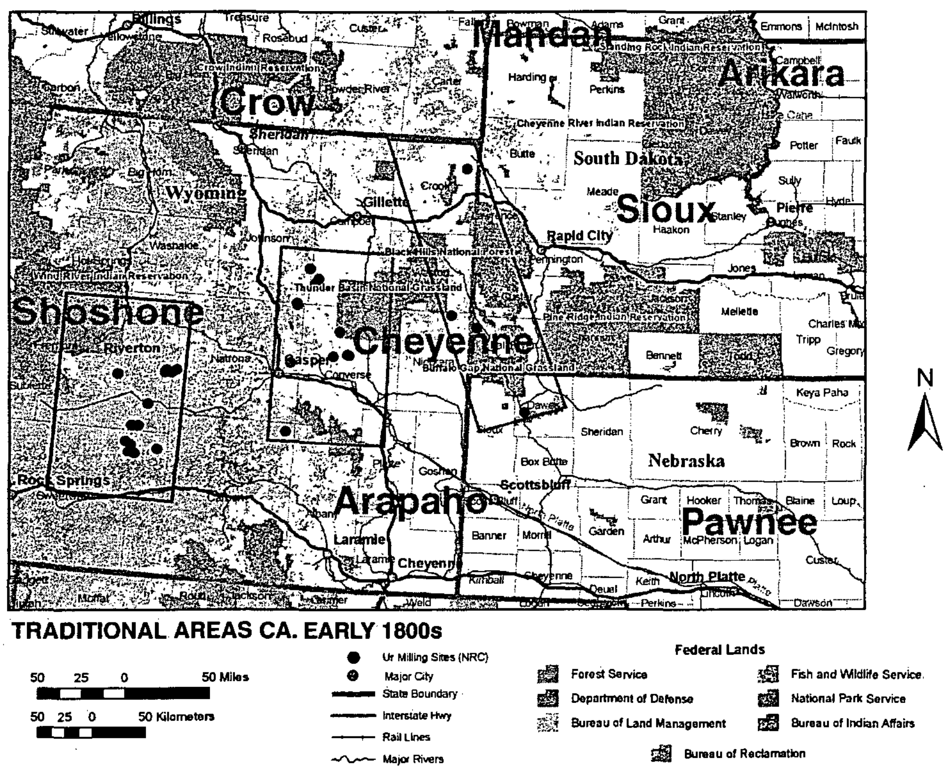



**Figure 3.2-19. Regional Distribution of Native American Tribes in the Early 1800s in Wyoming, South Dakota, and Nebraska**

The Siouan tribes are located throughout South and North Dakota, and the Crow are located in Montana but have interests in Wyoming. Other Siouan-speaking tribes as well as other tribes in North Dakota, Wyoming, Montana, and Nebraska may have traditional land use claims in the Wyoming West Uranium Milling Region.

The U.S. government and the State of Wyoming recognize the sovereignty of certain Native American tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires executive branch federal agencies to undertake consultation and coordination with Native American tribal governments on a government-to-government basis. NRC, as an independent federal agency, has agreed to voluntarily comply with Executive Order 13175.

In addition, the NHPA provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a Tribal Historic Preservation Officer (THPO). To date, the Northern Arapaho Tribe is the only tribe in Wyoming to have attained status as a THPO as provided for in the NHPA. Some tribes have historic and cultural preservation offices that are not recognized as THPOs, but they should be consulted where they exist. NRC, in meeting its responsibilities under the NHPA, contacts tribal cultural resources personnel as part of the consultation process, along with consulting with the Wyoming SHPO.

#### 3.2.8.4 Places of Cultural Significance

Traditional cultural properties are places of special heritage value to contemporary communities because of their association with cultural practices and beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (Parker and King, 1998; King, 2003). Religious places are often associated with prominent topographic features like mountains, peaks, mesas, springs, and lakes. In addition, shrines may be present across the landscape to denote specific culturally significant locations and vision quest sites where an individual can place offerings.

Information on traditional land use and the location of culturally significant places is often protected information within the community (e.g., King, 2003). Therefore, the information presented on religious places is limited to those that are identified in the published literature and is therefore restricted to a few highly recognized places on the landscape within southwestern South Dakota.

There are no culturally significant places in the NRHP or state register located in the Wyoming West Uranium Milling Region. However, the Lakota Sioux or other Sioux bands (Cheyenne River Sioux, Lower Brulé Sioux, Oglala Sioux, Rosebud Sioux) along with the Crow Tribe, the Arapaho, the Kiowa, and Wind River Shoshone who once occupied portions of the Wyoming West Uranium Milling Region consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant; these were once used for personal rituals and the Sun Dance and are the source of origin legends.

Areas of central and eastern Wyoming once used by these tribes may contain additional, undocumented culturally significant sites and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional culturally significant landscape.

Traditional cultural properties are those that have been passed down over the generations and that refer to beliefs, customs, and practices of a living community. Native American traditional cultural properties are often not found on the state or national registers of historic properties nor described in the extant literature or in SHPO files. There is, however, a range of cultural property types of religious or traditional use that might be identified during the tribal consultation process. These might include

- Sites of ritual and ceremonial activities and related features
- Shrines
- Marked and unmarked burial grounds
- Traditional use areas
- Plant and mineral gathering areas
- Traditional hunting areas
- Caves and rock shelters
- Springs
- Trails
- Prehistoric archaeological sites

The U.S. Bureau of Indian Affairs website contains a list, current as of May 2007, of tribal leaders and contact information <http://www.doi.gov/bia/Tribal%20Leaders-June%202007-2.pdf>. The National Organization of Tribal Historic Preservation Officers also maintains a list of THPOs on its website at http://www.nathpo.org/THPO/state_list.htm. These tribal groups should be contacted for consultations associated with ISL milling activities in their respective states (see Table 3.2-12). Additional tribal contact information may be obtained from the respective SHPO in Nebraska, Montana, South Dakota, and Wyoming.

| **Table 3.2-12. List of Tribal Contacts for Tribes With Interests in Nebraska, Montana, South Dakota, and Wyoming** |
|---|
| ***Nebraska*** |
| Santee Sioux Nation, 108 Spirit Lake Ave. West, P(402) 857-2772 F(402) 857-2307, Roger Trudell, Chairman, Niobrara, NE 68760-7219 |
| Ponca Tribe of Nebraska, P.O. Box 288, P(402) 857-3391 F(402) 857-3736, Larry Wright, Jr., Chairman, Niobrara, NE 68760 |
| Omaha Tribal Council, P.O. Box 368, P(402) 837-5391 F(402) 837-5308, Mitchell Parker, Chairperson, Macy, NE 68039 |
| Iowa Tribe of Kansas & Nebraska, 3345 Thrasher Rd., P(785) 595-3258 F(785) 595-6610, Leon Campbell, Chairman, White Cloud, KS 66094 |
| Sac and Fox Nation of Missouri, 305 N. Main Street, P(785) 742-7471 F(785) 742-3785, Fredia Perkins, Chairperson, Reserve, KS 66434 |
| Ponca Tribe of Nebraska, P.O. Box 288, P(402) 857-3391 F(402) 857-3736, Larry Wright, Jr., Chairman, Niobrara, NE 68760 |
| ***Montana*** |
| Blackfeet Tribal Business Council, P.O. Box 850, P(406) 338-7276 F(406) 338-7530, Earl Old Person, Chairman, Browning, MT 59417 <btbc@3rivers.net> |
| Chippewa Cree Business Committee, RR 1, P.O. Box 544, P(406) 395-4282 F(406) 395-4497, John "Chance" Houle, Chairman, Box Elder, MT 59521 |
| Crow Tribal Council, P.O. Box 169, P(406) 638-3715 F(406) 638-3773, Carl Venne, Chairman, Crow Agency, MT 59022 |

| **Table 3.2-12. List of Tribal Contacts for Tribes With Interests in Nebraska, Montana, South Dakota, and Wyoming (continued)** |
|---|
| ***Montana (continued)*** |
| Fort Belknap Community Council, RR 1, Box 66, P(406) 353-2205 F(406) 353-4541, Julia Doney, President, Harlem, MT 59526 |
| Fort Peck Tribal Executive Board, P.O. Box 1027, P(406) 768-5155 F(406) 768-5478, John Morales, Chairman, Poplar, MT 59255 |
| Northern Cheyenne Tribal Council, P.O. Box 128, P(406) 477-6284 F(406) 477-6210, Eugene Littlecoyote, President, Lame Deer, MT 59043 |
| Confederated Salish & Kootenai Tribes, Tribal Council, Box 278, P(406) 675-2700 F(406) 675-2806, James Steele, Jr., Chairman, Pablo, MT 59855 <csktadmn@ronan.net> |
| ***South Dakota*** |
| Cheyenne River Sioux Tribe, P.O. Box 590, P(605) 964-4155 F(605) 964-4151, Joseph Brings Plenty, Chairman, Eagle Butte, SD 57625 |
| Crow Creek Sioux Tribal Council, P.O. Box 50, P(605) 245-2221 F(605) 245-2470, Lester Thompson, Chairman, Fort Thompson, SD 57339 |
| Flandreau Santee Sioux Executive Committee, P.O. Box 283, P(605) 997-3891 F(605) 997-3878, Joshua Weston, President, Flandreau, SD 57028 <president@fsst.org> |
| Lower Brule Sioux Tribal Council, 187 Oyate Circle, P(605) 473-5561 F(605) 473-5606, Michael Jandreau, Chairman, Lower Brule, SD 57548 |
| Oglala Sioux Tribal Council, P.O. Box 2070, P(605) 867-6074 F(605) 867-6076, John Yellow Bird Steele, President, Pine Ridge, SD 57770 |
| Rosebud Sioux Tribal Council, P.O. Box 430, P(605) 747-2381 F(605) 747-2905, Rodney Bordeaux, President, Rosebud, SD 57570 <www.rosebudsiouxtribe.org> |
| Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, P.O. Box 509, P(605) 698-3911 F(605) 698-7907, Michael Selvage, Sr., Chairman, Agency Village, SD 57262 <http://swcc.cc.sd.us/> |
| Standing Rock Sioux Tribal Council, P.O. Box D, P(701) 854-8500 F(701) 854-7299, Ron His Horse Is Thunder, Chairman, Fort Yates, ND 58538 |
| Yankton Sioux Tribal Business & Claims Committee, P.O. Box 248, P(605) 384-3641 F(605) 384-5687, Robert Cournoyer, Chairman, Marty, SD 57361-0248 <bobbycournoyer@yahoo.com> <www.yanktonsiouxtribe.org/index.html> |
| ***Wyoming*** |
| Arapaho Business Committee, P.O. Box 396, P(307) 332-6120 F(307) 332-7543, Richard B. Brannon, Chairman, Fort Washakie, WY 82514 |
| Shoshone Business Committee, P.O. Box 217, P(307) 332-3532 F(307) 332-3055, Ivan D. Posey, Chairman, Fort Washakie, WY 82514 |

### 3.2.9 Visual/Scenic Resources

Assigning values to visual and scenic resources is subjective, but basic design elements such as form, line, color, and texture can be used to describe and evaluate landscapes.

Modifications that repeat the landscape's basic elements tend to match the surroundings well. Modifications that do not match basic landscape features can look out of place and jar the viewer. Potential visual impacts can be evaluated based on likely features that may result from anticipated activities (drilling masts, well heads, header houses, satellite ion exchange facilities, and centralized milling facilities) from the perspective of both design (space, height, color) and time (permanent versus temporary structures).

Federal land management agencies such as the BLM and the USFS have established guidelines to inventory and manage visual resources. Because there are a variety of visual values, different levels of management are necessary. These activities are typically part of a visual resource management (VRM) system.

The BLM guidelines for VRM are identified in BLM Manual 8400 (BLM, 2007a). The VRM system identifies and inventories existing scenic values (BLM, 2007a–c) and establishes management objectives for those values. These area-specific objectives provide the standards for planning, designing, and evaluating the potential visual resource impacts resulting from future management projects. The VRM system also provides for mitigation measures that can reduce potentially adverse visual impacts.

In practice, the VRM system as described by BLM consists of two stages:

- Inventory—Visual Resource Inventory (BLM, 2007b)
- Analysis—Visual Resource Contrast Rating (BLM, 2007c)

**Objectives for Visual Resource Classes (After BLM, 2007a,b)**

**Class I:** To preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

**Class II:** To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

**Class III:** 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:** To provide for management activities that require major modifications 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.

Landscape inventories are determined by taking scenic quality, visual sensitivity, and distance from the existing travel routes and dividing these factors into as many as four classes. The final VRM class determinations are typically established in the resource management plans developed by BLM field offices. The USFS system for VRM is slightly different from that used by the BLM, with five classifications based on visual quality and scenic integrity objectives (USFS, 1974, 1995).

Based on the BLM Visual Resource Handbook, the uranium districts in the Wyoming West Uranium Milling Region are located in the Wyoming Basin physiographic province (BLM, 2007a). Although BLM does not manage all of the land in the Wyoming West Uranium Milling Region, the BLM resource management plans prepared by the regional field offices establish VRM classifications for all of the region, including private land or land managed by other agencies. The regional management plans that cover the Wyoming West Uranium Milling

Region include the Casper (BLM, 2007d; Bennett, 2003), Lander (BLM, 1987), Rock Springs (BLM, 2007e), and Rawlins (BLM, 2008b) field offices (see the BLM Wyoming website at http://www.blm.gov/wy/st/en.html). The VRM classifications assigned within these resource plans are presented in Figure 3.2-20. The Lander resource management plan is in the process of being revised; as a result, the current VRM classification for the northern part of the Wyoming West Uranium Milling Region is not available at this time (BLM, 2007f). Public concerns expressed to BLM include visual and scenic resources relating to the quality of recreational experiences on public lands and the protection of landscapes along sensitive resources such as the National Historic Trails (BLM, 2007d).

**Visual Quality and Scenic Integrity Objectives of the USFS**
**(From USFS, 1974, 1995)**

The USFS established visual quality objectives as part of a visual management system in its 1974 forest landscape management handbook. These objectives described the different degrees of alteration associated with a proposed management strategy that the USFS would find acceptable in terms of visual contrast with the surrounding natural landscape. The visual quality objectives have been updated and replaced by scenic integrity objectives as part of the USFS scenery management system (USFS, 1995). There has been some overlap in their application, and both systems have been used by the USFS to define visual resources.

**Preservation**: This visual quality objective represents essentially unaltered landscape with only minute if any deviations. This is equivalent to an area with very high scenic integrity.

**Retention**: This visual quality objective represents landscape that appears to be intact to the casual viewer. Alterations may be present, but are consistent with the form, line, color, and texture of the landscape. It is equivalent to a classification of high scenic integrity.

**Partial Retention**: This visual quality objective represents landscape that appears slightly altered. New form, line, color, or texture may be introduced as long as it remains visually subordinate. This objective is equivalent to a classification of moderate scenic integrity.

**Modification**: This visual quality objective represents landscape that appears moderately altered. Changes may be introduced that visually dominate the characteristic landscape, but must reflect naturally established form, line, color, and texture to be compatible with natural surroundings. This objective is equivalent to a classification of low scenic integrity.

The bulk of the southern part of the Wyoming West Uranium Milling Region is categorized by BLM as VRM Class III (along highways) and Class IV (open grassland, oil and natural gas, urban areas) (Figure 3.2-20). The BLM resource management plans do not identify any VRM Class I (most sensitive) resources that fall entirely within the Wyoming West Uranium Milling Region. Located in the northwestern corner of Carbon County, however, the Ferris Mountains Wilderness Study Area is identified as Class I (BLM, 2008b) and borders the eastern boundary of the region, about 72 km [45 mi] north of Rawlins. The closest potential uranium ISL facility, however, is located about 24 km [15 mi] from the closest boundary of the Ferris Mountains Wilderness Study Area. VRM Class II areas are generally identified in ranges such as the Granite Mountains, and the Rock Springs field office identifies Red Lake, Alkali Basin, Alkali Draw, South Pinnacles, and Honeycomb Buttes Wilderness Study Areas in the southwestern corner of the region as Class II (Figure 3.2-20). These Class II areas, however, are more than 32 km [20 mi] from the closest point in either of the two uranium districts located within the Wyoming West Uranium Milling Region. In addition, scenic areas along the Sweetwater and Powder Rivers provide unique viewsheds (USFS, 2005). One potential facility may be located near Jeffrey City, within a few kilometers [miles] of the Sweetwater. All of the other potential facilities are located 24 km [15 mi] or more from these two rivers. As described in Section 3.2.6.2, there are no areas identified by EPA as Class 1 Prevention of Significant Deterioration areas in the Wyoming West Uranium Milling Region (see Figure 3.2-16). In addition, the state of Wyoming Environmental Quality Council also has developed two

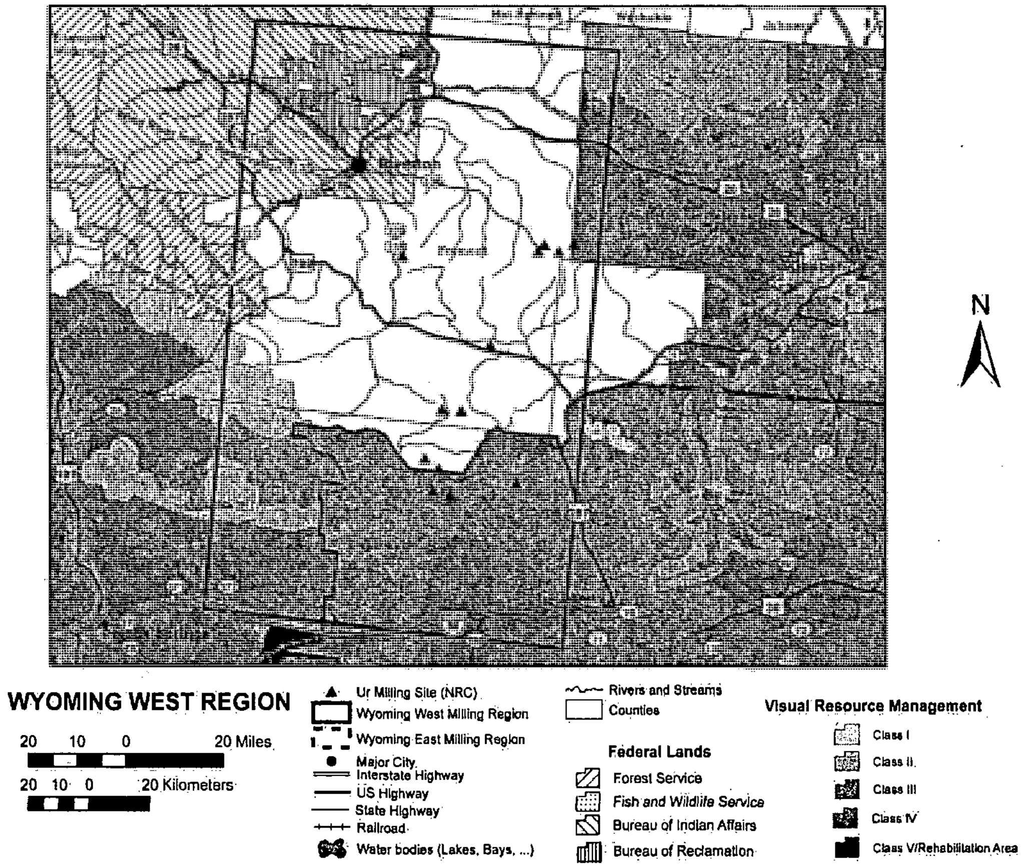



**Figure 3.2-20 BLM Visual Resource Classifications for the Wyoming West Uranium Milling Region (BLM, 2008b, 2007d,e)**

designations for scenic resources: (1) Unique and Irreplaceable and (2) Rare or Uncommon. These designations are limited to a small number of locations (seven), and none are located within the two uranium districts in the Wyoming West Uranium Milling Region (Girardin, 2006).

The Wind River Indian Reservation occupies the northwestern corner of the region, including the Boysen and Pilot Reservoirs managed by the U.S. Bureau of Reclamation. These areas fall within the area covered by the BLM Lander field office, and VRM classifications are not available. These regions are more than 16 km [10 mi] northwest from the closest potential ISL facility at Sand Draw, however, and more than 50 km [30 mi] from the center of the two uranium districts at Gas Hills and Crooks Gap.

### 3.2.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Wyoming West Uranium Milling Region includes communities within the region of influence for a potential ISL facility. Communities that have the highest potential for socioeconomic impacts are considered the affected environment. These potentially affected communities are defined by (1) proximity to an ISL facility {generally within 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environments are listed in Table 3.2-13.

The following subsections describe areas most likely to have implications to socioeconomics. In some sub-sections, Core-Based Statistical Areas (CBSAs) and Metropolitan Areas are also discussed. A CBSA, according to the U.S. Census Bureau, is a collective term for areas ranging from a population of 10,000 to 50,000. A Metropolitan Area is greater than 50,000, and a town is considered less than 10,000 in population (U.S. Census Bureau, 2008). A number of small towns with populations less than 1,000 exist in the affected environment but are not called out by name in Table 3.2-13 or in data presented in this section. Towns such as Moneta, Jeffrey City, Bairoil, Lamont, Wamsutter, and others are represented collectively by the applicable county-level socioeconomic information provided in this section.

**Table 3.2-13. Summary of the Affected Environment Within the Wyoming West Uranium Milling Region**

| Counties Within Wyoming West | Towns Within Wyoming West | Native American Communities Within Wyoming West |
|---|---|---|
| Carbon | Arapaho | Wind River Indian Reservation |
| Fremont | Ethete | |
| Natrona | | |
| Sweetwater | Ft. Washakie | |
| | Lander | |
| | Riverton | |
| | St. Stephens | |

### 3.2.10.1 Demographics

For the GEIS, demographics are based on 2000 U.S. Census data on population and racial characteristics of the affected environment (Table 3.2-14), Figure 3.2-21 illustrates the populations of communities within the Wyoming West Uranium Milling Region. Most 2006 data compiled by the U.S. Census Bureau was not available for the region at the time of writing.

The most populated county in the Wyoming West Uranium Milling Region is Natrona County and the most sparsely populated county is Carbon County. Riverton has the largest population in the region, and and the smallest populated town is Ethete (Wind River Indian Reservation). The county with the largest percentage of nonminorities is Natrona County with a white population of 94.2 percent, and Lander has a white population of 90.8 percent. The largest minority-based county is Fremont County with a white population of 76.5 percent. The largest minority-based town is Ethete, with a white population of only 4.9 percent.

Although not listed in Table 3.2-14, the 2000 U.S. Census total population count for the Wind River Indian Reservation was 23,250. The Wind River Indian Reservation is shared by the Eastern Shoshone and Northern Arapaho tribes and is located in Fremont and Hot Springs Counties, Wyoming. Riverton is the largest town on the reservation (U.S. Census Bureau, 2008).

### 3.2.10.2 Income

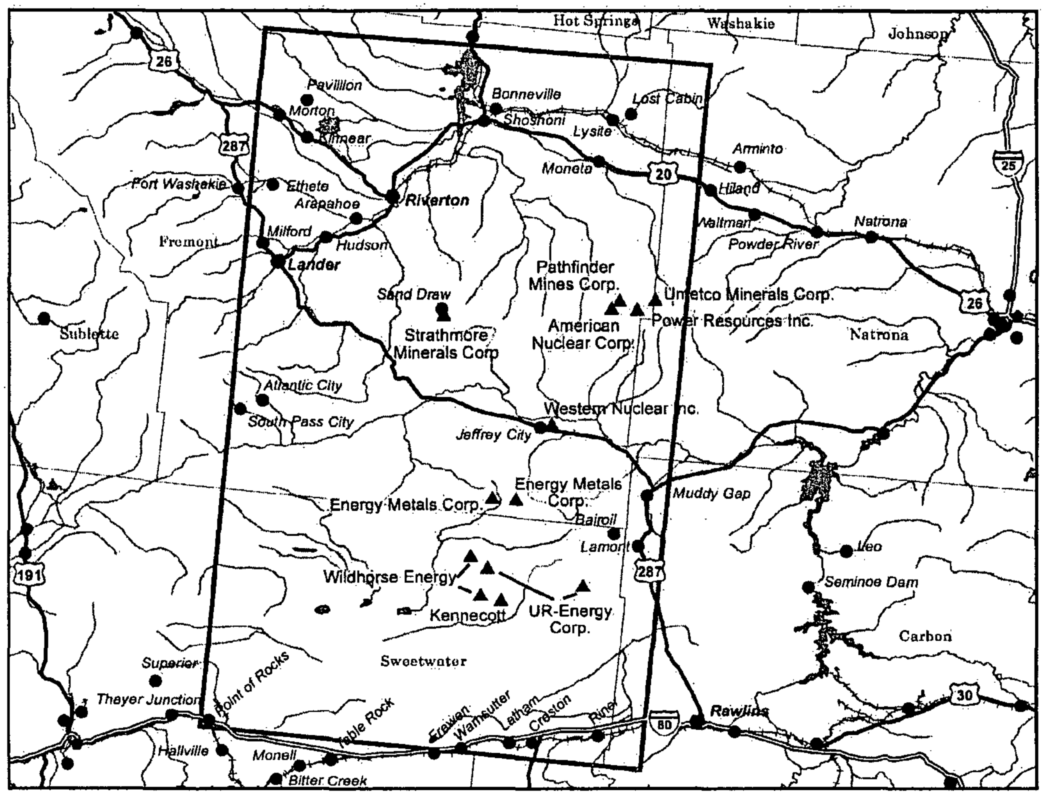
Income information from the 2000 U.S. Census including labor force, income, and poverty levels for the affected environment, is based on data collected at the state and county levels. Data collected at the state level also includes information on towns, CBSAs, or Metropolitan Areas and considers an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [greater than 30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if local workforce is unavailable or does not have the appropriate skill set). In Wyoming, the workforce frequently commutes long distances to work. For example, in the Wyoming West Uranium Milling Region, all of the affected counties experienced net inflows of workers during the fourth quarter of 2005. Net inflows ranged from 370 for Carbon County to 10,600 for Natrona County, predominantly for jobs related to the energy industry (Wyoming Workforce Development Council, 2007). Data collected at the county level is generally the same as for the affected environment presented in Table 3.2-13 and also includes information on Native American communities. State-level information for the surrounding region is provided in Table 3.2-15 for comparison, and county data is listed in Table 3.2-16.

For the surrounding region, the state with the largest labor force population is Montana. The population with the largest labor force is Billings, Montana, 320 km [200 mi] to the nearest potential ISL facility. The population in the surrounding region with the highest per capita income is Cheyenne, Wyoming, 225 km [140 mi] from the nearest potential ISL facility. The lowest per capita income population is Laramie, Wyoming, 160 km [100 mi] to the nearest potential ISL facility. The population with the highest percentage of individuals and families below poverty level is in Billings, Montana.Based on review of Table 3.2-16, the county in the Wyoming West Uranium Milling Region with the largest labor force population is Natrona County and the smallest labor force population is in Carbon County. The town with the largest labor force population in the region is Riverton (Wind River Indian Reservation), and the smallest labor force population is in Ethete (Wind River Indian Reservation). Sweetwater County has the highest per capita income, and the smallest per capita income is in Fremont County. Per capita

| Table 3.2-14. 2000 U.S. Bureau of Census Population and Race Categories of the Wyoming West Uranium Milling Region* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Affected Environment** | **Total Population** | **White** | **African American** | **Native American** | **Some Other Race** | **Two or More Races** | **Asian** | **Hispanic Origin†** | **Native Hawaiian and Other Pacific Islander** |
| Wyoming | 493,782 | 454,670 | 3,722 | 11,133 | 12,301 | 8,883 | 2,771 | 31,669 | 302 |
| *Percent of total* | | 92.1% | 0.8% | 2.3% | 2.5% | 1.8% | 0.6% | 6.4% | 0.1% |
| Carbon County | 15,639 | 14,092 | 105 | 9 | 808 | 321 | 105 | 2,163 | 9 |
| *Percent of total* | | 90.1% | 0.7% | 0.1% | 5.2% | 2.1% | 0.7% | 13.8% | 0.1% |
| Fremont County | 35,804 | 27,388 | 44 | 7,047 | 417 | 793 | 106 | 1,566 | 9 |
| *Percent of total* | | 76.5% | 0.1% | 19.7% | 1.2% | 2.2% | 0.3% | 4.4% | 0.0% |
| Natrona County | 66,533 | 62,644 | 505 | 686 | 1,275 | 1,121 | 277 | 3,257 | 25 |
| *Percent of total* | | 94.2% | 0.8% | 1.0% | 1.9% | 1.7% | 0.4% | 4.9% | 0.0% |
| Sweetwater County | 37,613 | 34,461 | 275 | 380 | 1,349 | 892 | 240 | 3,545 | 16 |
| *Percent of total* | | 91.6% | 0.7% | 1.0% | 3.6% | 2.4% | 0.6% | 9.4% | 0.0% |
| Lander | 6,867 | 6,236 | 10 | 411 | 48 | 140 | 22 | 239 | 0 |
| *Percent of total* | | 90.8% | 0.1% | 6.0% | 0.7% | 2.0% | 0.3% | 3.5% | 0.0% |
| Arapaho (Wind River Indian Reservation) | 1,766 | 318 | 2 | 1,423 | 9 | 13 | 0 | 91 | 1 |
| *Percent of total* | | 18.0% | 0.1% | 80.6% | 0.5% | 0.7% | 0.0% | 5.2% | 0.1% |
| Ethete (Wind River Indian Reservation) | 1,455 | 72 | 0 | 1,371 | 1 | 10 | 1 | 30 | 0 |
| *Percent of total* | | 4.9% | 0.0% | 94.2% | 0.1% | 0.7% | 0.1% | 2.1% | 0.0% |

| Table 3.2-14. 2000 U.S. Bureau of Census Population and Race Categories of the *Wyoming West* Uranium Milling Region (continued)* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Affected Environment** | **Total Population** | **White** | **African American** | **Native American** | **Some Other Race** | **Two or More Races** | **Asian** | **Hispanic Origin†** | **Native Hawaiian and Other Pacific Islander** |
| Fort Washakie (Wind River Indian Reservation) | 1,477 | 87 | 1 | 1,368 | 10 | 11 | 0 | 48 | 0 |
| *Percent of total* | | 5.9% | 0.1% | 92.6% | 0.7% | 0.7% | 0.0% | 3.2% | 0.0% |
| Riverton (Wind River Indian Reservation) | 9,310 | 8,082 | 16 | 752 | 173 | 240 | 44 | 660 | 3 |
| *Percent of total* | | 86.8% | 0.2% | 8.1% | 1.9% | 2.6% | 0.5% | 7.1% | 0.0% |
| St. Stephens (Wind River Indian Reservation) | NA‡ | NA | NA | NA | NA | NA | NA | NA | NA |
| *Percent of total* | | NA | NA | NA | NA | NA | NA | NA | NA |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100 percent).
‡NA—not available.




**WYOMING WEST REGION**

20 10 0 20 Miles

20 10 0 20 Kilometers

| | |
|---|---|
| ▲ Ur Milling Site (NRC) | Railroad |
| Wyoming West Milling Region | Water bodies (Lakes, Bays, ...) |
| Interstate Highway | Rivers and Streams |
| US Highway | Counties |

**Cities by population**

- Over 50,000
- 10,001 - 50,000
- 1,000 - 10,000
- Less than 1,000

**Figure 3.2-21. Wyoming West Uranium Milling Region With Population**

**Table 3.2-15. U.S. Bureau of Census State Income Information for the Region Surrounding the Wyoming West Uranium Milling Region***

| Affected Environment | 2000 Labor Force Population (16 years and over) | Median Household Income in 1999 | Median Family Income in 1999 | Per Capita Income in 1999 | Families Below Poverty Level in 2000 | Individuals Below Poverty Level in 2000 |
|---|---|---|---|---|---|---|
| Montana | 458,306 | $33,024 | $40,487 | $17,151 | 25,004 | 128,355 |
| Wyoming | 257,808 | $37,892 | $45,685 | $19,134 | 10,585 | 54,777 |
| Billings, Montana | 47,584 | $35,147 | $45,032 | $19,207 | 2,130 | 10,402 |
| *Percent of total†* | 67.7% | NA | NA | NA | 9.2% | 12.0% |
| Cheyenne, Wyoming | 27,647 | $38,856 | $46,771 | $19,809 | 891 | 4,541 |
| *Percent of total†* | 66.7% | NA | NA | NA | 6.3% | 8.8% |
| Lander, Wyoming | 3,337 | $32,397 | $41,958 | $18,389 | 178 | 859 |
| *Percent of total†* | 62.5% | NA | NA | NA | 9.95% | 13.2% |
| Laramie, Wyoming | 15,504 | $27,319 | $43,395 | $16,036 | 633 | 5,618 |
| *Percent of total†* | 67.2% | NA | NA | NA | 11.1% | 22.6% |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 15 April 2008).

†Percent of total based on a population of 16 years and over.

| Table 3.2-16. U.S. Bureau of Census County and Native American Income Information for the Wyoming West Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 years and over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Carbon County, Wyoming | 7,744 | $36,060 | $41,991 | $18,375 | 411 | 1,879 |
| *Percent of total*† | 62.5% | NA‡ | NA | NA | 9.8% | 12.9% |
| Fremont County, Wyoming | 17,637 | $32,503 | $37,983 | $16,519 | 1,267 | 6,155 |
| *Percent of total*† | 64.9% | NA | NA | NA | 13.3% | 17.6% |
| Natrona County, Wyoming | 35,081 | $36,619 | $45,575 | $18,913 | 1,548 | 7,695 |
| *Percent of total*† | 68.3% | NA | NA | NA | 8.7% | 11.8% |
| Sweetwater County, Wyoming | 20,022 | $46,537 | $54,173 | $19,575 | 548 | 2,871 |
| *Percent of total*† | 70.6% | NA | NA | NA | 5.4% | 7.8% |
| Arapaho (Wind River Indian Reservation) | 636 | $22,679 | $24,659 | $8,943 | 134 | 784 |
| *Percent of total*† | 58.1% | NA | NA | NA | 35.5% | 45.0% |
| Ethete (Wind River Indian Reservation) | 517 | $24,130 | $24,762 | $7,129 | 95 | 453 |
| *Percent of total*† | 60.5% | NA | NA | NA | 33.9% | 34.4% |

**Table 3.2-16. U.S. Bureau of Census County and Native American Income Information for the Wyoming West Uranium Milling Region* (continued)**

| Affected Environment | 2000 Labor Force Population (16 years and over) | Median Household Income in 1999 | Median Family Income in 1999 | Per Capita Income in 1999 | Families Below Poverty Level in 2000 | Individuals Below Poverty Level in 2000 |
|---|---|---|---|---|---|---|
| Fort Washakie (Wind River Indian Reservation) | 567 | $18,906 | $20,658 | $7,700 | 151 | 636 |
| *Percent of total†* | 57.6% | NA‡ | NA | NA | 42.9% | 42.7% |
| St. Stephens (Wind River Indian Reservation) | na | na§ | na | na | na | na |
| *Percent of total†* | na | NA | NA | NA | na | na |
| Riverton (Wind River Indian Reservation) | 4,694 | $31,531 | $37,079 | $16,720 | 267 | 1,400 |
| *Percent of total†* | 64.5% | NA | NA | NA | 11.0% | 15.7% |

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Percent of total based on a population of 16 years and over.
‡NA—Not applicable.
§na—not available.

income ranges from Lander ($18,389) to the town of Ethete ($7,129). The county with the highest percentage of individuals and families below poverty level is Fremont County. The town with the highest percentage of individuals and families below poverty level is Fort Washakie (Wind River Indian Reservation).

### 3.2.10.3 Housing

Housing information from the 2000 U.S. Census is provided in Table 3.2-17. Housing information for the Wind River Indian Reservation was only available for the town of Riverton (U.S. Census Bureau, 2008).

The availability of housing within the immediate vicinity of the potential ISL facilities in the Wyoming West Uranium Milling Region is limited. The majority of housing is available in larger populated areas such as the towns of Riverton (20 miles to nearest ISL facility) and Casper {97 km [60 mi] to nearest ISL facility}. Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the proposed ISL facilities is not as limited. The majority of apartments are available in larger populated areas such as the towns of Lander, Riverton, and Rawlins with a total of 18 apartment complexes (MapQuest, 2008). There are also five hotels/motels along major highways or towns near potential ISL facilities in the two uranium districts in the Wyoming West Uranium Milling Region. In addition to apartments and lodging, there are trailer camps situated near potential ISL facilities (along major roads or near towns) in this region (MapQuest, 2008).

**Table 3.2-17. U.S. Bureau of Census Housing Information for Wyoming***

| Affected Environment | Single Family Owner-Occupied Homes | Median Value in Dollars | Median Monthly Costs With a Mortgage | Median Monthly Costs Without a Mortgage | Occupied Housing Units | Renter-Occupied Units |
|---|---|---|---|---|---|---|
| Wyoming | 95,591 | $96,600 | $825 | $229 | 193,608 | 55,793 |
| Carbon County | 7,744 | $76,500 | $685 | $196 | 6,129 | 1,708 |
| Fremont County | 6,281 | $89,300 | $714 | $217 | 13,545 | 3,496 |
| Natrona County | 15,250 | $84,600 | $746 | $218 | 26,819 | 7,993 |
| Sweetwater County | 7,283 | $104,200 | $953 | $231 | 14,105 | 3,488 |
| Lander | 1,479 | $97,300 | $701 | $226 | 2,777 | 833 |
| Riverton (Wind River Indian Reservation) | 2,146 | $83,200 | $683 | $203 | 3,792 | 1,221 |

*U.S. Census Bureau. "American FactFinder." 2000. <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).

### 3.2.10.4 Employment Structure

Employment structure from the 2000 U.S. Census including employment rate and type is based on data collected at the state and county level. Data collected at the state level also includes information on towns, CBSAs, or Metropolitan Areas and considers an outside workforce. An outside workforce includes workers willing to commute long distances {more than 48 km [30 mi]} for employment opportunities or external labor necessary to fulfill specialized positions (if the local workforce is unavailable or does not have the necessary skill sets). Data collected at the county level is the same as for the affected environment presented in Table 3.2-13 and also includes information on Native American communities.

Based on review of state-level information, Wyoming has a low unemployment rate (3.5 percent).

Unemployment at the county level ranges from 3.3 percent (Carbon County) to 5.7 percent (Fremont County). The town with the highest percentage of employment is Lander, and the town with the highest unemployment rate is Arapaho on the Wind River Indian Reservation.

#### 3.2.10.4.1 State Data

##### 3.2.10.4.1.1 Montana

The state of Montana has an employment rate of 60.8 percent and unemployment rate of 4.1 percent. The largest sector of employment is management, professional, and related occupations at 33.1 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Billings

Billings has an employment rate of 64.8 percent and unemployment rate of 2.8 percent. The largest sector of employment is sales and office occupations at 31.9 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

##### 3.2.10.4.1.2 Wyoming

The state of Wyoming has an employment rate of 63.1 percent and unemployment rate of 3.5 percent. The largest sector of employment is sales and office occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Cheyenne

Cheyenne has an employment rate of 59.2 percent and unemployment less than the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 33.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Lander

Lander has an employment rate of 59.4 percent and an unemployment rate lower than that of the state at 2.8 percent. The largest sector of employment is management, professional, and related occupations at 39.3 percent. The largest type of industry is educational, health, and social services at 37.9 percent. The largest class of worker is private wage and salary workers at 62.6 percent (U.S. Census Bureau, 2008).

Laramie

Laramie has an employment rate of 63.4 percent and unemployment less than the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 40.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.2.10.4.2 County Data

Carbon County, Wyoming

Carbon County has an employment rate of 59.2 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 23.4 percent followed by sales and office occupations at 21.9 percent. The largest type of industry is educational, health, and social services at 17.1 percent. The largest class of worker is private wage and salary workers at 65.6 percent (U.S. Census Bureau, 2008).

Fremont County, Wyoming

Fremont County has an employment rate of 59.0 percent and an unemployment rate relatively high at 5.7 percent when compared to the state average. The largest sector of employment is management, professional, and related occupations at 33.9 percent followed by sales and office occupations at 22.5 percent. The largest type of industry is educational, health, and social services at 28.5 percent. The largest class of worker is private wage and salary workers at 64.1 percent (U.S. Census Bureau, 2008).

Natrona County, Wyoming

Natrona County has an employment rate of 64.6 percent and an unemployment rate similar to that of the state at 3.5 percent. The largest sector of employment is sales and office occupations at 29.9 percent followed by management, professional, and related occupations at 28.5 percent. The largest type of industry is educational, health, and social services at 21.2 percent. The largest class of worker is private wage and salary workers at 76.2 percent (U.S. Census Bureau, 2008).

Sweetwater County, Wyoming

Sweetwater County has an employment rate of 66.4 percent and an unemployment rate slightly higher than that of the state at 4.0 percent. The largest sector of employment is sales and office occupations at 23.4 percent followed by management, professional, and related occupations at 23.3 percent. The largest type of industry is educational, health, and social services at

18.2 percent. The largest class of worker is private wage and salary workers at 76.5 percent (U.S. Census Bureau, 2008).

Native American Communities

Information on labor force and poverty levels for the Wind River Indian Reservation is based on 2003 Bureau of Indian Affairs data and is provided in Table 3.2-18. The Northern Arapaho Tribe reports unemployment rates much higher than the statewide levels (U.S. Department of the Interior, 2003).

### 3.2.10.5 Local Finance

Local finance such as revenue and tax information for the affected environment is provided in this section. Table 3.2-19 shows 2007 annual sales and use tax distribution of the affected counties (including cities and towns) in the Wyoming West Uranium Milling Region.

Wyoming

The State of Wyoming does not have an income taxnor does it assess tax on retirement income received from another state. . Wyoming has a 4 percent state sales tax, 2 percent to 4 percent county lodging tax, and 4 percent use tax. Counties have the option of collecting an

**Table 3.2-18. Employment Structure of the Wind River Indian Reservation Within the Affected Area***

| Affected Environment | 2003 Labor Force Population | Unemployed as Percent of Labor Force | Employed Below Poverty Guidelines | |
|---|---|---|---|---|
| Arapaho Tribe of the Wind River Indian Reservation | 1,386 | 72% | 106 | 8% |

* U.S. Department of the Interior. "Affairs American Indian Population and Labor Force Report 2003." <http://www.doi.gov/bia/labor.html>. Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs, Office of Tribal Affairs. 2003.

**Table 3.2-19. 2007 State and Local Annual Sales and Use Tax Distribution of Affected Counties Within the Wyoming West Uranium Milling Region***

| Affected Counties | Use Tax | | Sales Tax | | Gross Revenue |
|---|---|---|---|---|---|
| | State | Local | State | Local | |
| Carbon County | $3,778,037 | $4,328,728 | $15,087,797 | $16,953,793 | $40,812,784 |
| Fremont County | $1,520,637 | $734,665 | $20,205,131 | $9,710,326 | $32,624,896 |
| Natrona County | $4,135,490 | $3,322,747 | $51,551,636 | $41,420,622 | $102,046,519 |
| Sweetwater County | $9,856,907 | $11,435,504 | $51,423,220 | $59,342,366 | $133,613,150 |

*Wyoming Department of Revenue. "State of Wyoming Department of Revenue 2007 Annual Report." <http://revenue.state.wy.us/PortalVBVS/uploads/2007%20DOR%20Annual%20Report.pdf>. (7 April 2009).

additional 1 percent tax for general revenue and 2 percent tax for specific purposes. Wyoming also imposes "ad valorem taxes" on mineral extraction properties. Taxes levied for uranium production were 10.0 percent in 2007 (6.0 percent "ad valorem" and 4 percent severance) totaling $1.7 million dollars (Wyoming Department of Revenue, 2007). For 2007, in the Wyoming West Uranium Milling Region a small portion of this uranium tax revenue ($715.90) was generated in Sweetwater County. Annual sales and use tax distribution information for the affected counties (including cities and towns) in the Wyoming East Uranium Milling Region are presented in Table 3.3-14.

Native American Communities

The Wind River Indian Reservation's largest sources of revenue come from the Northern Arapaho and Eastern Shoshone Tribal Governments; the Bureau of Indian Affairs; the Ethete, Fort Washakie, and Arapaho School Districts; the Indian Health Service; and Native American household income (University of Wyoming, 1997).

### 3.2.10.6 Education

Based on review of the affected environment, the county with the largest number of schools is Natrona County and the county with the smallest number of schools is Carbon County. The town with the largest number of schools is Lander and the towns with the smallest number of schools (Ethete, Aropaho) are located on the Wind River Indian Reservation.

Lander

Lander has one school district, Fremont County School District No. 1, with a total 2007 enrollment of approximately 1,930 students. There are five elementary schools, four middle schools, three high schools, seven public schools, and one private school. The majority of schools provide bus services (Greatschools.com, 2008).

Carbon County

Carbon County has two school districts, Carbon County School Districts #1 and #2, with a combined total 2007 enrollment of approximately 2,650 students. There are a total of nine elementary schools, two middle school, two high school, and two private schools. The majority of schools within each school district provide bus services (Carbon County School District No.1 and No. 2, 2008a,b).

Fremont County

Fremont County has over eight school districts, with a combined total 2007 enrollment of approximately 7,125 students. There are more than 25 public and private elementary, middle, and high schools. The majority of school districts provides bus services (Schoolbug.org, 2007).

Natrona County

Natrona County has one school district: Natrona County School District No. 1, with a total enrollment of approximately 11,500 students in 2007. There are more than 30 public and private elementary and secondary schools. The majority of schools provide bus services (Natrona County School District No. 1, 2007).

Sweetwater County

Sweetwater County has 2 school districts with a total of 10 elementary schools, 3 intermediate/middle schools, 4 high schools, and 4 private or parochial schools. There are a total of about 7,175 students. The majority of schools within each district provides bus services (Sweetwater County School District No.1, 2007; Sweetwater County School District No. 2, 2005).

Native American Communities

The Wind River Indian Reservation has several school districts in the towns of Arapaho, Ethete, Fort Washakie, and Saint Stephens. There are a total of approximately 1,060 students. Schools are the Arapaho School, Wyoming Indian School, Fort Washakie School, and Saint Stephens Indian School. All four schools accommodate elementary through 12$^{th}$ grades. There is no information available as to whether bus services are provided by any of these schools (Easternshoshone.net, 2008).

#### 3.2.10.7 Health and Social Services

Health Care

The majority of the health care facilities that provide service in the vicinity of the Wyoming West Uranium Milling Region is located within the larger population centers. The closest health care facilities within the vicinity of the potential ISL facilities are located in Riverton, Lander, Casper, Cheyenne, Laramie, and Thermopolis with a total of 14 facilities (MapQuest, 2008). These consist of hospitals, clinics, emergency centers, and medical services. Hospitals located within the vicinity of the potential ISL facilities include Lander (one), Riverton (one), Rock Springs (one), Rawlins (one), Casper (one), Laramie (one), and Thermopolis (one).

Local Emergency

Local police in the Wyoming West Uranium Milling Region are under the jurisdiction of each county. There are 16 police, sheriff, or marshals offices within the region: Carbon County (6), Fremont County (3), Natrona County (4), and Sweetwater County (3) (USACops, 2008a).

Fire departments within the Wyoming West Uranium Milling Region are comprised at the county, town, CBSA, or city level. There are 7 fire departments within the milling region: Lander (one), Natrona County (one), Dubois (one), Rawlins (two), Fort Washakie (one), and Riverton (one) (50States, 2008).

## 3.2.11 Public and Occupational Health

### 3.2.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council of Radiation Protection and Measurements, 1987). In addition, the

> **How Is Radiation Measured?**
>
> Radiation dose is measured in units of either sievert or rem and often referred to in either milliSv/mSv or millirem/mrem where 1,000 mSv=1 Sv and 1,000 mrem=1 rem. The conversion for sieverts to rem is Sv=100 rem. These units are used in radiation protection to measure the amount of damage to human tissue from a dose of ionizing radiation. Total effective dose equivalent, or TEDE, refers to the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). See Table 3.2-20 for public radiation doses from common activities.

| Table 3.2-20. Public Radiation Doses* | |
|---|---|
| **Activity or Event** | **Dose** |
| Flying from NY to LA | 2.5 mrem/trip |
| Chest x-ray | 10 mrem/exam |
| Full mouth dental x-ray | 9 mrem/exam |
| U.S. average background | 360 mrem/yr |
| * Voss, J.T. "Los Alamos Radiation Monitoring Notebook." LA–UR–00–2584. Los Alamos, New Mexico: Los Alamos National Laboratory. 2000. | |

average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite have higher radon levels than those with other types of soils/bedrock (EPA, 2006). For the Wyoming West Uranium

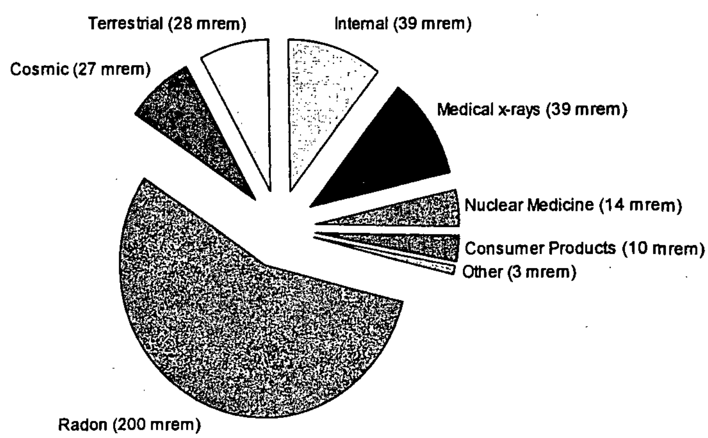



**Figure 3.2-22 Average Annual Background Radiation in the United States {Units of mrem [1 mSv=100 mrem]} (NRC, 2006)**

Milling Region, the average background radiation dose for the state of Wyoming is used, which is 3.16 mSv/yr [316 mrem/yr] (EPA, 2006). This value includes natural and man-made sources. This dose is slightly lower than the U.S. average primarily because the radon dose is lower {U.S. average of 2 mSv/yr [200 mrem/yr] versus Wyoming average of 1.33 mSv/yr [133 mrem/yr]}. Because of the higher elevation, the dose from cosmic radiation is slightly higher than the U.S. average: 0.515 mSv/yr [51.5 mrem/yr] versus 0.27 mSv/yr [27 mrem/yr]. The remaining contributions from terrestrial, internal, and man-made radiation combined are the same as the U.S. average of 1.318 mSv/yr [131.8 mrem/yr].

Outdoor radon concentrations are generally a small fraction of the average indoor concentrations. Outdoor radon concentrations can also be influenced by prior mining of any mineral (e.g., uranium, copper) in the area. To develop an open-pit or underground mine, soil and rock need to be excavated to reach the ore. This excavated rock, or overburden, can naturally contain higher levels of uranium and thorium than was present on the surface. Additionally, low grade ore may be left in the area around the mine, especially in the case of abandoned mines. Also, ore processed to extract elements other than uranium and thorium (such as copper, titanium, ruthenium, and other rare earth elements) could result in concentrating the natural uranium or thorium that was in the ore. The process of removing the rock or processing these ores could also change the physical and chemical characteristics controlling radon release, thus allowing additional radon to be released. The overburden and any ore left around the mine could elevate the local outdoor radon concentrations above the levels seen in other parts of the region. In close proximity to the mines, the level of terrestrial radiation could be elevated by the presence of mine waste. The overburden, low grade ore, and tailings from ore processed for other than uranium or thorium is called technologically enhanced naturally occurring radioactive material. Technologically enhanced naturally occurring radioactive material is not regulated by NRC. Radiation from these sources is considered part of the background for compliance with NRC regulations.

#### 3.2.11.2 Public Health and Safety

NRC has the statutory responsibility, under the Atomic Energy Act of 1954, as amended, to protect the public health and safety and the environment. NRC's regulations in 10 CFR Part 20 specify annual dose limits to members of the public of 1 mSv [100 mrem] total effective dose equivalent and 0.02 mSv/hr [2 mrem/hr] from any external sources.

#### 3.2.11.3 Occupational Health and Safety

Occupational health and safety risks to workers include exposure to radioactive materials. Radiation safety practices for workers at uranium ISL facilities should be such that the dose to the workers is kept as low as is reasonably achievable. Radiation exposure limits are specified in 10 CFR Part 20. Occupational dose is determined by the more limiting of (1) 0.05 Sv [5 rem] total effective dose equivalent or (2) sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv [50 rem]. The lens of the eye is limited to a dose equivalent of 0.15 Sv [15 rem] and the skin (of the whole body or any extremity) is limited to a shallow dose equivalent of 0.5 Sv [50 rem]. The monitoring requirements for occupational dose are covered in greater detail in Section 2.9 and Chapter 8.

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## 3.3 Wyoming East Uranium Milling Region

### 3.3.1 Land Use

As shown in Figure 3.3-1, the Wyoming East Uranium Milling Region encompasses parts of eight counties (Albany, Campbell, Carbon, Converse, Johnson, Natrona, Platte, and Weston), although it predominantly lies within Converse and Campbell Counties. This region straddles portions of the Wyoming Basin to the west and the upper part of the Missouri Plateau to the north (U.S. Geological Survey, 2004). In this region, past, current, and potential uranium milling operations are generally found in the four-corner area of Campbell, Converse, Natrona, and Johnson Counties (known as the Pumpkin Buttes District) and in the northern-central part of Converse County (known as the Monument Hill District). The Shirley Basin Uranium District located south of Casper is the past site of a conventional uranium milling facility (Figures 3.3-1 and 3.3-2). The geology and soils of these three uranium districts are detailed in Section 3.3.3.

While 53.3 percent of the land in Wyoming is federal and state public land, surface land ownership in this region is predominantly private (68 percent) (Table 3.3-1). Within the Wyoming East Uranium Milling Region there are portions of two large tracts of federal land that are managed by the USFS:

- The Thunder Basin National Grassland, which straddles Campbell, Converse, and Weston Counties in the Powder River Basin between the Big Horn Mountains to the west and the Black Hills to the east, represents 15 percent of the region.

- The Medicine Bow National Forest, which occupies the southern part of Converse County and extends farther south into Albany County, represents almost 6 percent of the region.

Although federal grasslands and forests occupy an important portion of the region (approximately 21 percent), most rangeland is privately owned (68 percent) and is primarily used for grazing cattle and sheep. Campbell County, for example, has more private land ownership than any other county in Wyoming. Other federal lands managed by BLM, the U.S. Bureau of Reclamation, and the Department of Defense (Table 3.3-1) comprise scattered tracts mixed with state and private lands and represent only approximately 10 percent of the land in the Wyoming East Uranium Milling Region (Figure 3.3-1). As described for the Wyoming West Uranium Milling Region in Section 3.1.1, there are also in this region privately owned surface rights and publicly owned subsurface mineral rights resulting in split estate situations (BLM, 2008a) (Section 3.1.2.2).

The open rangelands of this region consist of gently rolling hills covered by sagebrush and short grass prairies capable of supporting year-round cattle and sheep grazing. Compared to the productivity of the open rangeland, farmland is marginal. It consists of dry or locally irrigated grain, hay, and pasture crops for livestock grazing or for preparing livestock feed. Agriculture is limited in the region due to low precipitation and because other water resources are insufficient for irrigation.

In addition to providing forage for livestock and grazing, the Thunder Basin National Grassland provides a variety of recreational activities, such as sightseeing, hiking, camping, hunting, and fishing (USFS, 2008). The historic Bozeman, Oregon, and Bridger Trail Corridors (see

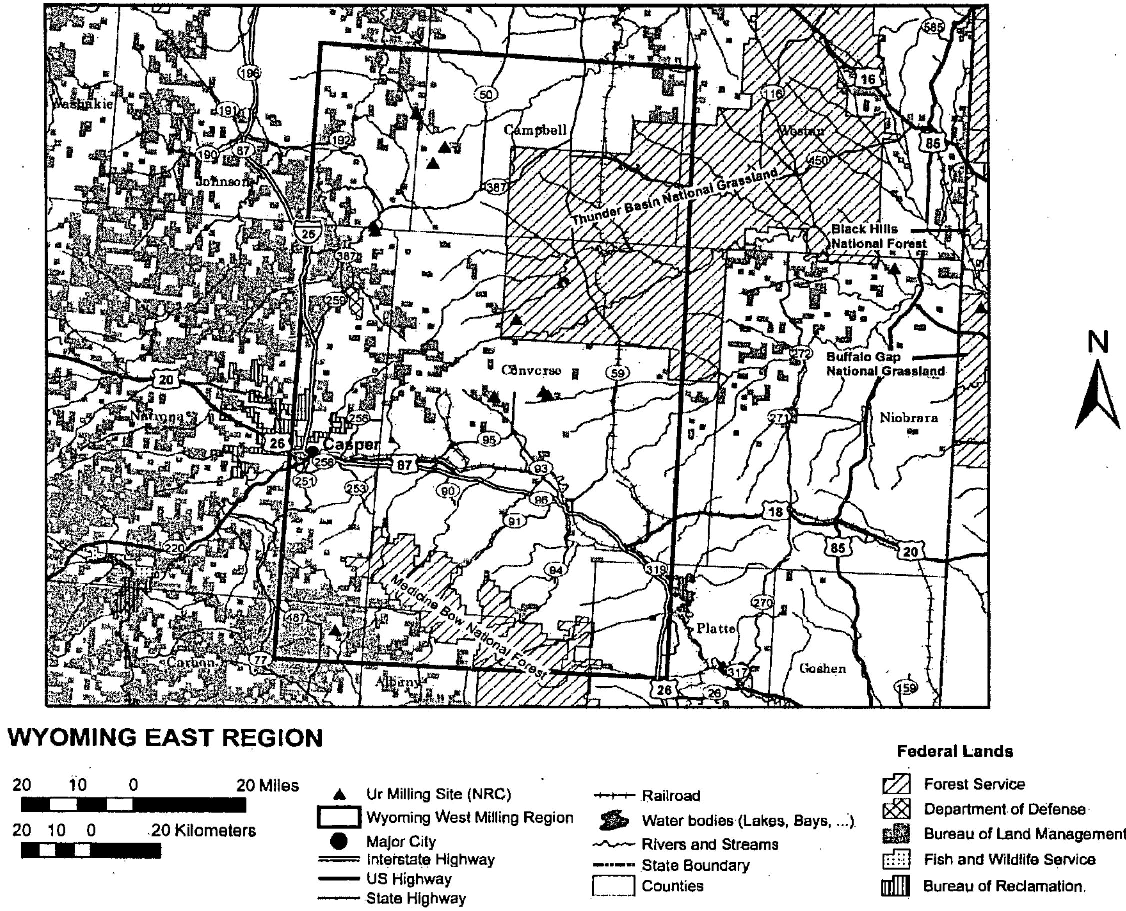



**Figure 3.3-1. Wyoming East Uranium Milling Region General Map With Past, Current, and Future Uranium Milling Site Locations**

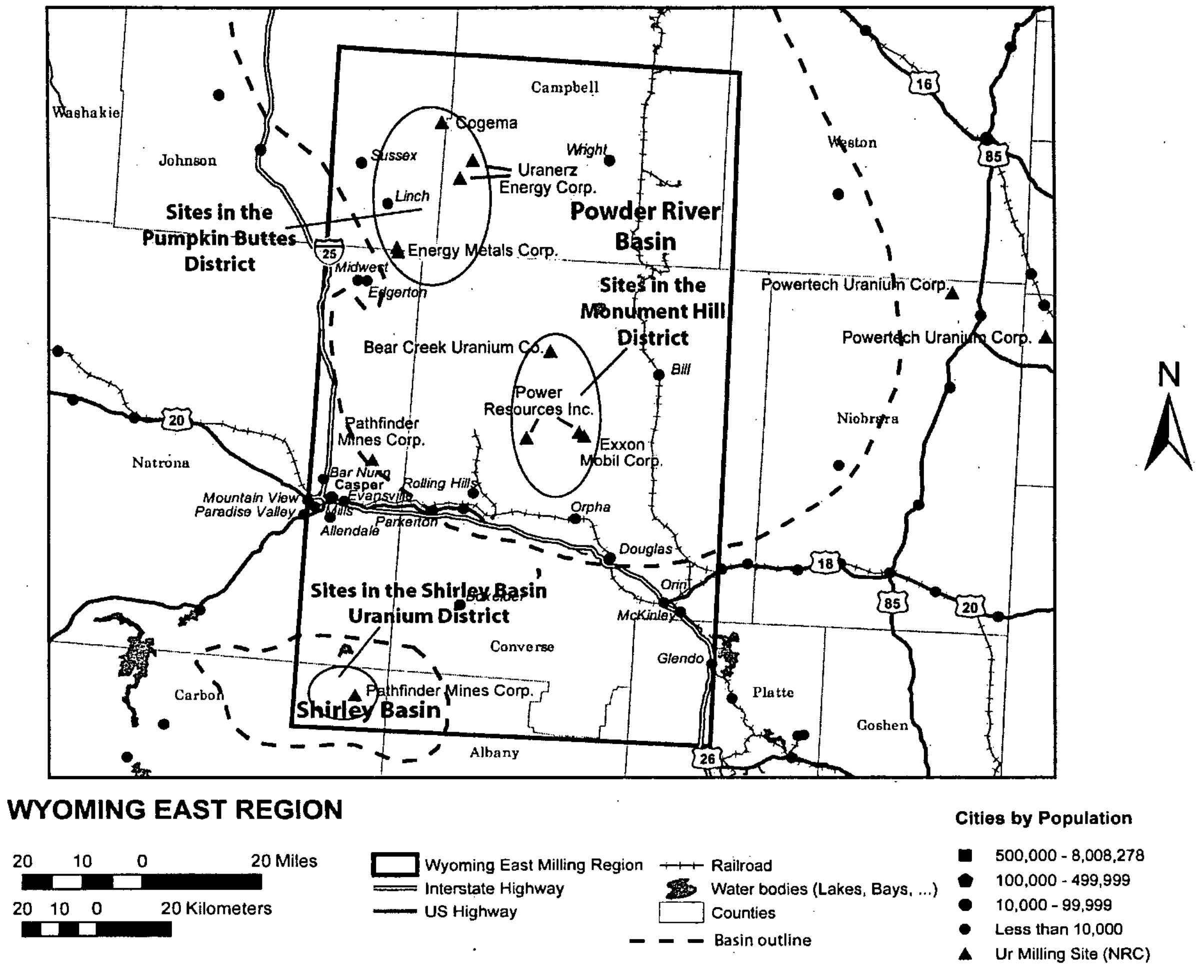



**Figure 3.3-2. Map Showing Outline of the Wyoming East Region and Locations of the Pumpkin Buttes and Monument Hill Districts in the Powder River Basin and the Shirley Basin Uranium District in the Shirley Basin**

| Table 3.3-1. Land Surface Ownership and General Use in the Wyoming East Uranium Milling Region | | | |
|---|---|---|---|
| Land Surface Ownership and General Use | Area ($mi^2$) | Area ($km^2$) | Percent |
| Private Lands | 5,503 | 14,252 | 68.3 |
| U.S. Forest Service, National Grassland | 1,238 | 3,207 | 15.4 |
| U.S. Bureau of Land Management, Public Domain Land | 797 | 2,064 | 9.9 |
| U.S. Forest Service, National Forest | 466 | 1,208 | 5.8 |
| Bureau of Reclamation | 36 | 92 | 0.4 |
| U.S. Department of Defense (Navy) | 14 | 35 | 0.2 |
| **Totals** | 8,054 | 20,859 | 100 |

Figure 3.1-2), extending north and north-northeast through Natrona and Johnson Counties along the western edge of the Wyoming East Uranium Milling Region, also offer a variety of recreational activities, including sightseeing, museums, historic sites, and small state parks (Fort Phil Kearny/Bozeman Trail Association, 2008).

Oil and gas production facilities, coal mines, and coal bed methane facilities have been, and continue to be, developed throughout the federal and private rangeland of the Powder River Basin. These coal, coal bed methane, and oil and gas facilities are more prevalent and concentrated in the central and northern part of the Powder River Basin in Campbell and Johnson Counties. Given the abundance and density of coal bed methane facilities in these counties, current and future permitted areas of ISL facilities of the Pumpkin Buttes District would be likely near or intermixed with such coal bed methane sites. In the southern part of the Powder River Basin in the Monument Hill District, there are only a few scattered coal bed methane sites (U.S. Geological Survey, 2001). Future ISL facilities in the Monument Hill District therefore would not interfere with land use for coal bed methane facilities.

### 3.3.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of goods and personnel (Section 2.8). As shown in Figure 3.3-3, the Wyoming East Uranium Milling Region is accessible from the west by Interstate 25, U.S. Highway 20, and State Route 220. From the north, the region is accessible via Gillette by State Route 59 or State Route 50. Travel from the east reaches the Wyoming East Uranium Milling Region using State Route 450 in the northern portion of the region and U.S. Highway 18 or U.S. Highway 26 farther to the south. Southern access is from U.S. Highway 26 in the southeastern corner near Glendo and State Route 487 from the southwestern corner of the region. Rail lines traverse the southern part of the region following the path of Interstate 25. A rail spur forks north of Orin and generally follows State Route 59 north in the direction of Gillette.

Areas of interest in uranium milling in the region are shown in Figure 3.3-3. For discussion purposes, these areas are located in four main subregions when considering site access by local roads. Areas of milling interest that are located in the northwestern part of the region between Edgerton and Wright are accessed from Gillette to the north or from Casper to the south. A cluster of northernmost sites is accessed by local roads leading east to State Route 50 and then south to State Route 387 and either north to Gillette or south to Casper and Interstate 25. Along State Route 387, north of Edgerton, is another subregion of uranium milling

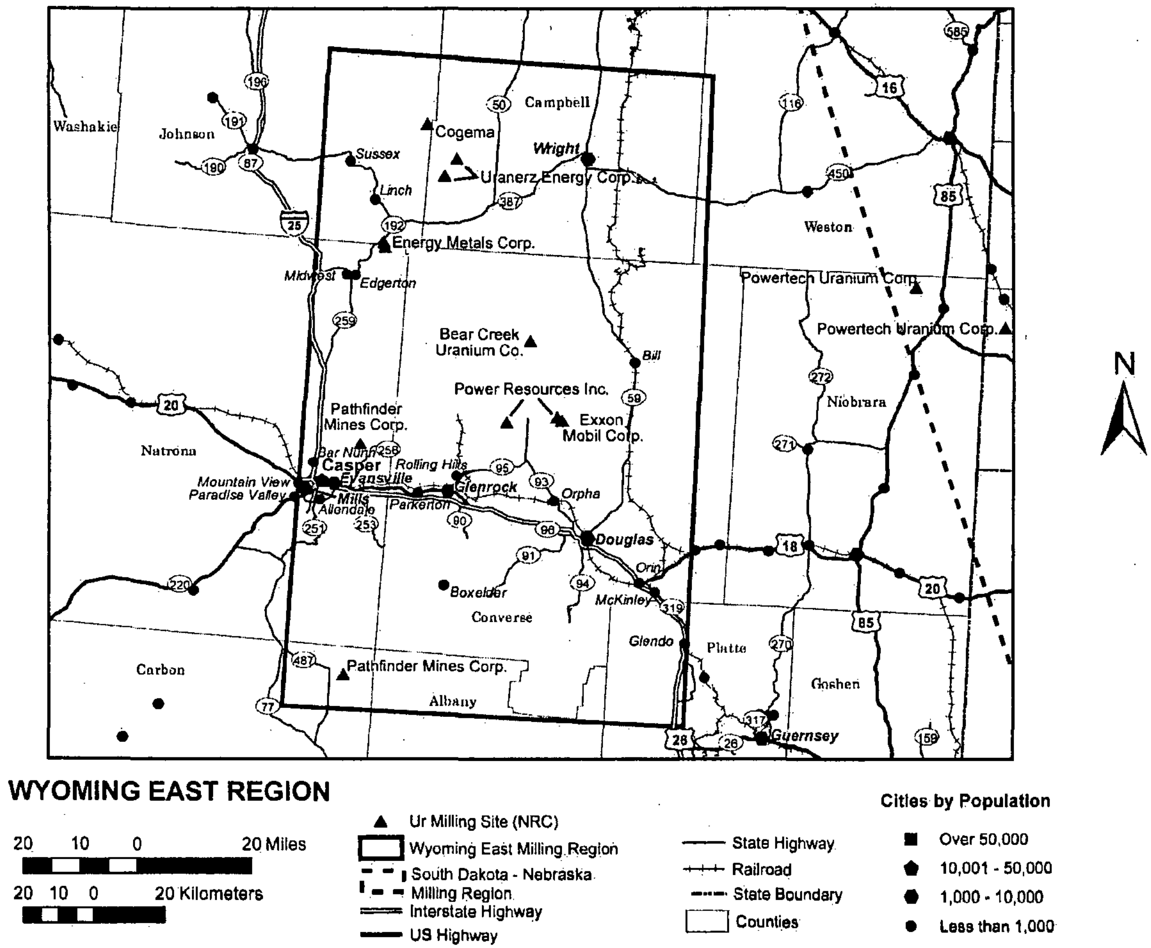



**Figure 3.3-3. Wyoming East Uranium Milling Region General Map With Current and Future Uranium Milling Site Transportation Corridor**

interest. The midsection of the Wyoming East Uranium Milling Region, north of Douglas, Orpha, and Rolling Hills, is the third subregion of concentrated milling interest. Local roads including Ross Road provide access to this subregion from the south using State Routes 93 and 95 that connect to Interstate 25. A rail spur runs north and dead ends into this area from the main line that follows Interstate 25. Further to the west in the direction of Casper, State Route 256 from Interstate 25 provides access for another milling site. The fourth subregion of interest is in the southwestern corner of the Wyoming East Uranium Milling Region. This is the location of the Shirley Basin conventional milling site, which is accessed using State Route 487 and 251 from Casper (and Interstate 25) to the north, or from the south on State Route 487 and U.S. Highway 30 from Laramie.

Table 3.3-2 provides available traffic count data for roads that support areas of past or future milling interest in the Wyoming East Uranium Milling Region. Counts are variable with the minimum all-vehicle count at 340 vehicles per day on State Route 93 at Orpha and the

**Table 3.3-2. Average Annual Daily Traffic Counts for Roads in the Wyoming East Uranium Milling Region***

| Road Segment | Distance (mi) | Trucks | | All Vehicles | |
|---|---|---|---|---|---|
| | | 2005 | 2006 | 2005 | 2006 |
| State Route 59 at Reno Junction (north of intersection with State Route 387) | — | 690 | 750 | 3,630 | 3,930 |
| State Route 387 at Pine Tree Junction (between State Routes 50 and 59) | 20 | 210–410 | 220–410 | 970–3,130 | 970–3,130 |
| State Route 387 at Edgerton North | — | 380 | 440 | 2,110 | 2,140 |
| Interstate 25 at Casper North (between Casper and State Route 259) | 20 | 570–690 | 610–690 | 2,460–3,760 | 2,560–3,800 |
| State Route 487 at Shirley Basin North (at intersection with State Route 251) | — | 70 | 80 | 710 | 700 |
| State Route 256 North of Interstate 25 | — | 140 | 140 | 2,270 | 2,290 |
| U.S. Highway 20/26 at Casper East (between Evansville and Parkerton) | 0.5 | 200 | 230 | 2,900 | 2,900 |
| Interstate 25 Casper to State Route 95 | 21 | 570–1,030 | 610–1,030 | 2,610–10,220 | 2,710–10,220 |
| State Route 95 at Rolling Hills | — | 50 | 50 | 1,800 | 1,810 |
| State Route 93 at Orpha | — | 50 | 50 | 340 | 340 |
| State Route 59 Douglas to Bill | 35 | 380–450 | 410–440 | 1,940–3,690 | 1,940–3,690 |

*Wyoming Department of Transportation. "Wyoming Department of Transportation Vehicle Miles." Data for Calendar Year 2005 and 2006 Provided on Request. District 2 Office, Casper, Wyoming: Wyoming Department of Transportation. April 18, 2008.
1 mi = 1.61 km

maximum on Interstate 25 at Casper to State Route 95 at 10,220 vehicles per day. Most all-vehicle counts in the Wyoming East Uranium Milling Region are above 900 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.3-3 describes representative routes and distances for shipments of yellowcake from locations of uranium milling interest in the Wyoming East Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

**Table 3.3-3. Representative Transportation Routes for Yellowcake Shipments From the Wyoming East Uranium Milling Region**

| Origin | Destination | Major Links | Distance* (mi) |
|---|---|---|---|
| West of Savageton, Wyoming | Metropolis, Illinois | Local access road east to State Route 50<br>State Route 50 south to Route 387<br>State Route 387 south to Edgerton, Wyoming<br>State Route 259 south to Interstate 25<br>Interstate 25 south to Casper, Wyoming<br>Interstate 25 south to Denver, Colorado<br>Interstate 70 east to St. Louis, Missouri<br>Interstate 64 east to Interstate 57 | 1,420 |
| | | Interstate 57 south to Interstate 24<br>Interstate 24 south to U.S. Highway 45<br>U.S. Highway 45 west to Metropolis, Illinois | |
| Northwest of Douglas, Wyoming | Metropolis, Illinois | Ross Road south to State Route 93<br>State Route 93 south to Interstate 25<br>Interstate 25 south to Denver, Colorado<br>Denver, Colorado, to Metropolis, Illinois (as above) | 1,300 |
| Shirley Basin Area, Wyoming | Metropolis, Illinois | Local access roads west to State Route 487<br>State Route 487 north to State Route 251<br>State Route 251 north to Casper, Wyoming<br>Interstate 25 south to Denver, Colorado<br>Denver, Colorado, to Metropolis, Illinois (as above) | 1,370 |

*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.
1 mi = 1.61 km

### 3.3.3 Geology and Soils

As noted in Section 3.2.3, Wyoming contains the largest known reserves of uranium in the United States and has been the nation's leading producer of uranium ore since 1995 (Wyoming State Geological Survey, 2005). Sandstone-hosted uranium deposits account for the vast majority of the ore produced in Wyoming (Chenoweth, 1991). In the Wyoming East Uranium Milling Region, uranium mineralization is found in fluvial sandstones in two major areas: the Powder River Basin and the Shirley Basin (Figure 3.3-2). Uranium mineralization in sandstones in these two districts is in a geologic setting favorable for recovery by ISL milling. Since 1991, all uranium produced from sandstones in the Wyoming East Uranium Milling Region has been by the ISL method (Wyoming State Geological Survey, 2005).

The Powder River Basin encompasses an area of about 31,000 $km^2$ [12,000 $mi^2$] in Converse and Campbell Counties. Uranium was first discovered in the Powder River Basin in 1951 near Pumpkin Buttes in the central part of the basin (Davis, 1969). Other uranium deposits were found along a 97-km [60-mi] northwest-southeast trend in the southwest part of the Powder River Basin, and production began in 1953. Prior to 1968, total production from the Powder River Basin was slightly over 455,000 metric tons [500,000 tons] of $U_3O_8$ (Davis, 1969). The most important uranium deposits are in the Monument Hill District, which produced over 90 percent of the ore from the basin prior to 1968.

The Shirley Basin uranium area is mainly in the northeastern part of Carbon County (Figure 3.3-4). Uranium was discovered in the Shirley Basin in 1955 (Melin, 1969). Production began in 1960 from underground and open-pit mines. Milling by ISL began in 1964. Prior to 1970, approximately 1,500 metric tons [1,600 tons] of $U_3O_8$ was produced from mines in the Shirley Basin (Chenoweth, 1991). The dominant source of sediment in the Powder River Basin and the Shirley Basin was Precambrian (greater than 540-million-year old) granitic rock of the Sweetwater Arch and northern Laramie Range (Rackley, 1972; Harris and King, 1993). The Sweetwater Arch is also referred to as the Granite Mountains (Bailey, 1969; Anderson, 1969; Lageson and Spearing, 1988). The Sweetwater Arch and northern Laramie Range are mountain ranges composed of uraniferous granitic rock. The Powder River Basin formed during the Laramide Orogeny (mountain-building era) during the Paleocene to early Eocene (50 to 65 million years ago). Uplift of the Sweetwater Arch and Laramie Range began to affect sedimentation in the adjacent Powder River Basin and Shirley Basin in Late Cretaceous time (65 to 99 million years ago). Rapidly subsiding portions of these basins received thick clastic wedges (i.e., wedges made of fragments of other rocks) of predominantly arkosic sediments (i.e., sediments containing a significant fraction of feldspar), while larger, more slowly subsiding portions of the basins received a greater proportion of paludal (marsh) and lacustrine (lake) sediments.

Sediment in the west Shirley Basin was deposited on an alluvial fan, but in the east Shirley Basin and in the Powder River Basin, sedimentation was channel and floodplain deposits of a meandering stream (Rackley, 1972). Beginning in the middle Eocene (41 to 49 million years ago) and increasing in the Oligocene (23.8 to 33.7 million years ago), regional volcanic activity contributed a significant amount of tuffaceous materials (i.e., materials made from volcanic rock and mineral fragments in a volcanic ash matrix) to local sediments. Deposition within the basins probably continued through the Miocene (5.3 to 23.8 million years ago). With the exception of the Pumpkin Buttes in the Powder River Basin, which are capped by remnants of the Oligocene White River Formation, post-Miocene erosion has removed most Oligocene and Miocene units.

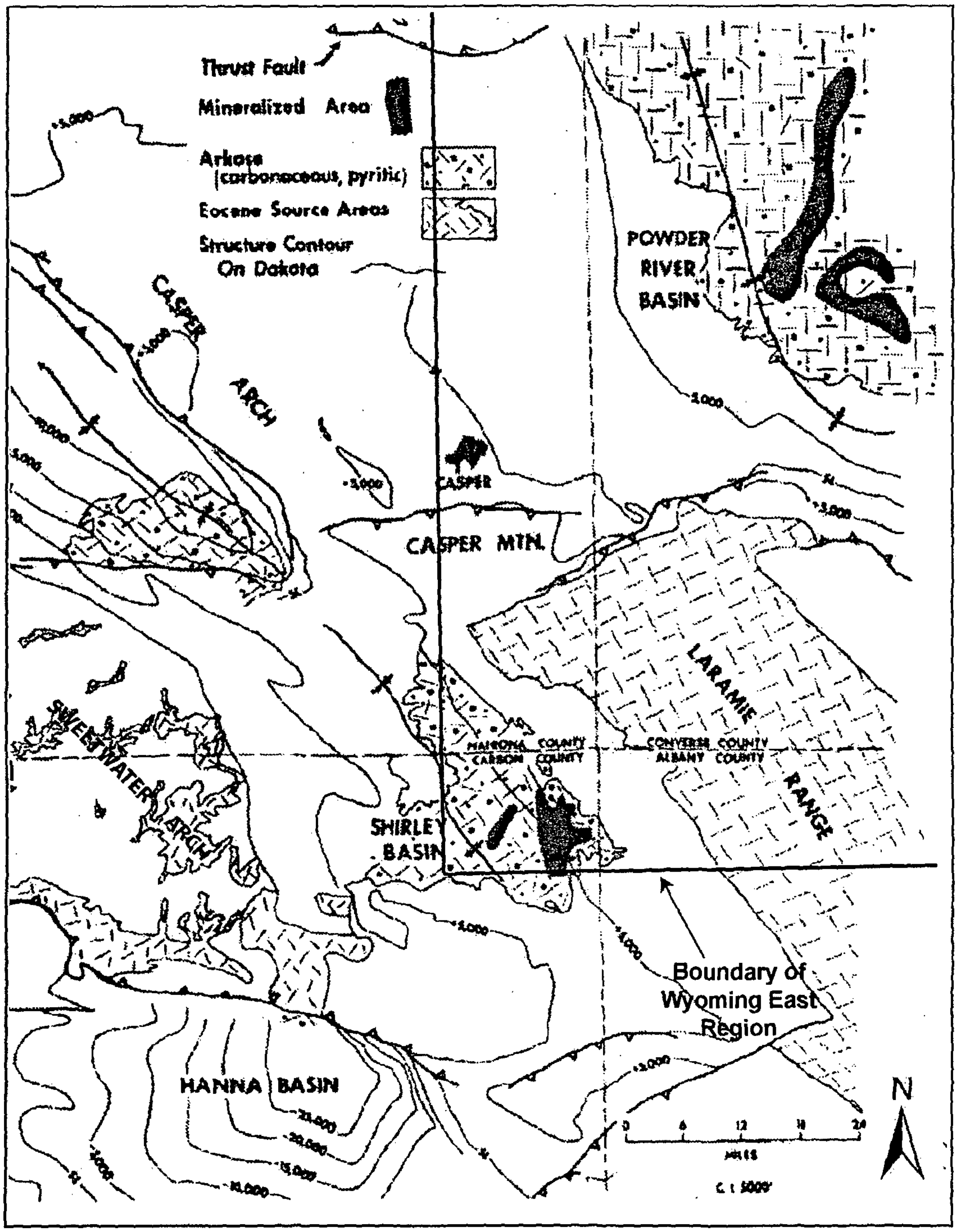



**Figure 3.3-4. Index and Structure Map of East-Central Wyoming Showing Relation of the Sweetwater Arch and Laramie Range to the Powder River Basin and the Shirley Basin. The Distribution of Arkosic, Carbonaceous Sediments and Mineralized Areas in the Powder River and Shirley Basins Are Also Shown (Modified From Rackley, 1972).**

3.3-9

A generalized stratigraphic section of Tertiary (1.8- to 65-million-year old) formations in the Shirley Basin and the Powder River Basin is shown in Figure 3.3-5. Stratigraphic descriptions presented here are limited to formations that may be involved in potential milling operations or formations that may have environmental significance, such as important aquifers and confining units above and below potential milling zones.

Formations hosting major sandstone-type uranium deposits in the Wyoming East Uranium Milling Region are the Wasatch Formation in the Powder River Basin and the Wind River Formation in the Shirley Basin. Both the Wasatch and Wind River are lower Eocene (49 to 54.8 million years old) in age (Houston, 1969) and consist of interbedded, arkosic sandstone, conglomerate, siltstone, mudstone, and carbonaceous shale, all compacted but poorly cemented (Harshman, 1968). The Wasatch Formation in the Powder River Basin also contains thick coal beds. In the Powder River Basin, recoverable ore that can be exploited by ISL milling is located in parts of the Wasatch Formation extending from depths of 120 to 300 m [400 to 1,000 ft] below the surface (Davis, 1969). Uranium deposits in the Shirley Basin lie at depths of 30 to 150 m [100 to 500 ft], almost entirely in the lower 90 m [300 ft] of the Wind River Formation (Melin, 1969; Bailey, 1969).

The Wagon Bed Formation conformably overlies the Wind River Formation in the Shirley Basin, but is absent in the Powder River Basin. The Wagon Bed comprises a series of interbedded arkosic sandstones and silicified claystones. In the central part of the Shirley Basin, the Wagon Bed Formation may not be present, having been removed by erosion. In the Shirley Basin, the White River Formation unconformably overlies the Wagon Bed Formation of the Wind River

**Central Wyoming**

| System | Series | | Formation | |
|---|---|---|---|---|
| Tertiary | Pliocene | | Moonstone Formation | |
| | Miocene | | Split Rock Formation | Arikaree Formation |
| | Oligocene | | White River Formation | |
| | Eocene | Upper | Wagon Bed Formation | |
| | | Middle | | |
| | | Lower | Wind River Formation | Wasatch Formation |
| | Paleocene | | Fort Union Formation | |
| Cretaceous | Upper | | Lance Formation | |

**Figure 3.3-5. Stratigraphic Section of Tertiary Age Formations in the Powder River Basin and Shirley Basin of Wyoming. Major Sandstone-Type Uranium Deposits Are Hosted in the Wasatch Formation in the Powder River Basin and the Wind River Formation in the Shirley Basin (Modified From Harshman, 1968).**

Formation where the Wagon Bed has been removed by erosion. In the Powder River Basin, the White River Formation overlies the Wasatch Formation. White River consists of tuffaceous siltstone, claystone, and conglomerate with subordinate amounts of tuff. In the Shirley Basin, the White River overlaps older Tertiary formations and wedges out against pre-Tertiary rocks on the flanks of the basin. The White River Formation has been removed by erosion throughout most of the Powder River Basin, but remnants cap the Pumpkin Buttes. The White River Formation is overlain by the Split Rock Formation in the Shirley Basin. The Split Rock consists of tuffaceous siltstone and sandstone beds that sometimes cap prominent ridges (Harshman, 1968).

The Fort Union Formation underlies the Wasatch and Wind River formations in the Powder River and Shirley Basins and, to a limited extent, is also a host to sandstone-type uranium deposits (Davis, 1969; Langden, 1973). The Fort Union is a fluvial deposit consisting of alternating and discontinuous mudstones, siltstones, carbonaceous shales, and coarser arkosic sandstone. In the Powder River Basin, the Fort Union also contains thick, continuous coal beds. The Fort Union is unconformably underlain by sediments of the Lance Formation, which is in turn underlain by a thick sequence of older sandstones, mudstones, and shales.

The uranium deposits in the Wyoming East Uranium Milling Region are stratabound and genetically related to geochemical interfaces, or roll fronts (see Section 3.1.2). The roll-front ore deposits in the Powder River Basin are usually multiple C-shaped rolls distorted by variations in gross lithology (Davis, 1969). The principal ore minerals are uraninite, coffinite, metatyuyamunite, and carnotite. Gangue minerals (i.e., low-value minerals intermixed with ore minerals) are calcite, gypsum, pyrite, iron oxide, and barite (Mrak, 1968). Although most of the uranium in the Shirley Basin is in roll-front deposits, important amounts also occur in tabular bodies near the rolls. Tabular sandstone-hosted uranium deposits are found as blanketlike, roughly parallel ore bodies along sandstone trends. The uranium mineralization in both the roll-front and tabular deposits consists of disseminations and impregnations of uraninite, calcite, pyrite, and marcasite in arkosic sandstones.

The source of uranium in sandstone-type uranium deposits in central Wyoming is a topic of conjecture. Four theories on the source of uranium in these occurrences have been suggested: (1) leached uranium from overlying ash-fall tuffs, (2) leached uranium from igneous and metamorphic rocks in the highlands surrounding the basins, (3) leached uranium from the host sandstones themselves, and (4) hydrothermal uranium from a magma source at depth (Harris and King, 1993). Combinations of these theories have been proposed as well (Boberg, 1981). The most popular theories are the (1) tuff leach and (2) highland leach. The tuff leach theory is supported by extensive geochemical studies on uranium removal from tuff (Zielinski, 1983, 1984; Trentham and Orajaka, 1986). Further, it was the tuff leach theory that led to the discovery of most of the large uranium deposits in Wyoming (Love, 1952). On the other hand, many sandstone-hosted uranium deposits in Wyoming are found adjacent to crystalline rocks, especially the uraniferous granites of the northern Laramie and Granite Mountains (Harris and King, 1993). Oxidized uranium leached from these crystalline terrains could have been transported to the sites of present mineralization.

Soils within the Wyoming East Uranium Milling Region are diverse and can vary substantially in terms of characteristics over relatively short distances. The distribution and occurrence of soils in east-central Wyoming can vary both on a regional basis (mountains, foothills, basins) and locally with changes in slope, geology, vegetation, climate, and time. In the Powder River Basin and Shirley Basin, old, tilted sedimentary rocks occur in bands along the margins of the basins, whereas younger sediments showing varying degrees of incision by erosion are found in the basin centers.

The topographic position and texture of typical soils in the Powder River Basin and Shirley Basin areas of east-central Wyoming were obtained from tMunn and Arneson (1998). This map was designed primarily for statewide study of ground water vulnerability to contamination and would not be expected to be used for site-specific soil interpretations at proposed ISL milling facilities. For site-specific evaluations, detailed soils information would be expected to be obtained from published county soil surveys or the NRCS.

In the Powder River and Shirley Basins, shallow loamy-skeletal (stony) soils with little or no subsoil development occupy ridge crests along the margins of the basins. These soils contain hard clasts (i.e., rock fragments) and tend to be much coarser than soils on the adjacent lower slopes. Loamy-skeletal soils with little subsoil development are also found in the foothills along the margins of the basin and along eroded drainageways. Fine to fine-loamy soils with moderate- to well-developed soil horizons are found on gently sloping to moderately steep slopes associated with alluvial fans and alluvial terraces. These soils are generally light colored and depleted in moisture. Moderately deep soils with well-developed soil horizons occur on low relief surfaces, such as stream terraces and floodplains, across broad expanses of the basins. Fine loamy over sandy and coarse loamy soils occurs on stream terraces. Soils found on floodplains include fine loamy and fine-sand loams. Dark-colored, base-rich soils formed under grass are generally associated with floodplains along streams with permanent high water.

### 3.3.4 Water Resources

#### 3.3.4.1 Surface Waters

The Wyoming East Uranium Milling Region (Figure 3.3-6) includes portions of Albany, Campbell, Carbon, Converse, Johnson, Natrona, Platte, and Weston Counties in east-central Wyoming. Surface runoff to streams, in terms of average annual flow per unit area of a watershed, in the Wyoming East Uranium Milling Region varies from more than 13 cm/yr [5 in/yr] to less than 1 cm/yr [0.5 in/yr] in the mountains to less than 1.3 cm/yr [0.5 in/yr] in the intermontane valleys and on the plains (Gebert, et al., 1987). The potential uranium milling sites are located in the intermontane areas and on the plains. The watersheds within the Wyoming East Uranium Milling Region are listed in Table 3.3-4 along with the range of designated uses of surface water bodies assigned by the State of Wyoming (WDEQ, 2001). Because surface water uses are designated for specific water bodies (such as stream segments and lakes) within a watershed and the specific locations of future uranium milling activities are not known at this time, the range of designated uses is provided rather than a listing of designated uses for each water body within a watershed. Not all water bodies within a watershed may have all of the designated uses listed in Table 3.3-4. For example, a watershed may contain perennial streams, intermittent streams that flow only during portions of the year, and ephemeral streams that flow only because of surface runoff from local precipitation events. The perennial streams and possibly portions of intermittent streams may be designated as "fisheries" whereas ephemeral streams are unlikely to be designated as fisheries. The descriptions of the water bodies and their classifications in this section focus on perennial streams that generally have higher designated uses than the intermittent and ephemeral streams. For information regarding specific water bodies, refer to the Wyoming Department of Environmental Quality Surface Water Standards webpage (deq.state.wy.us/wqd/watershed/surfacestandards).

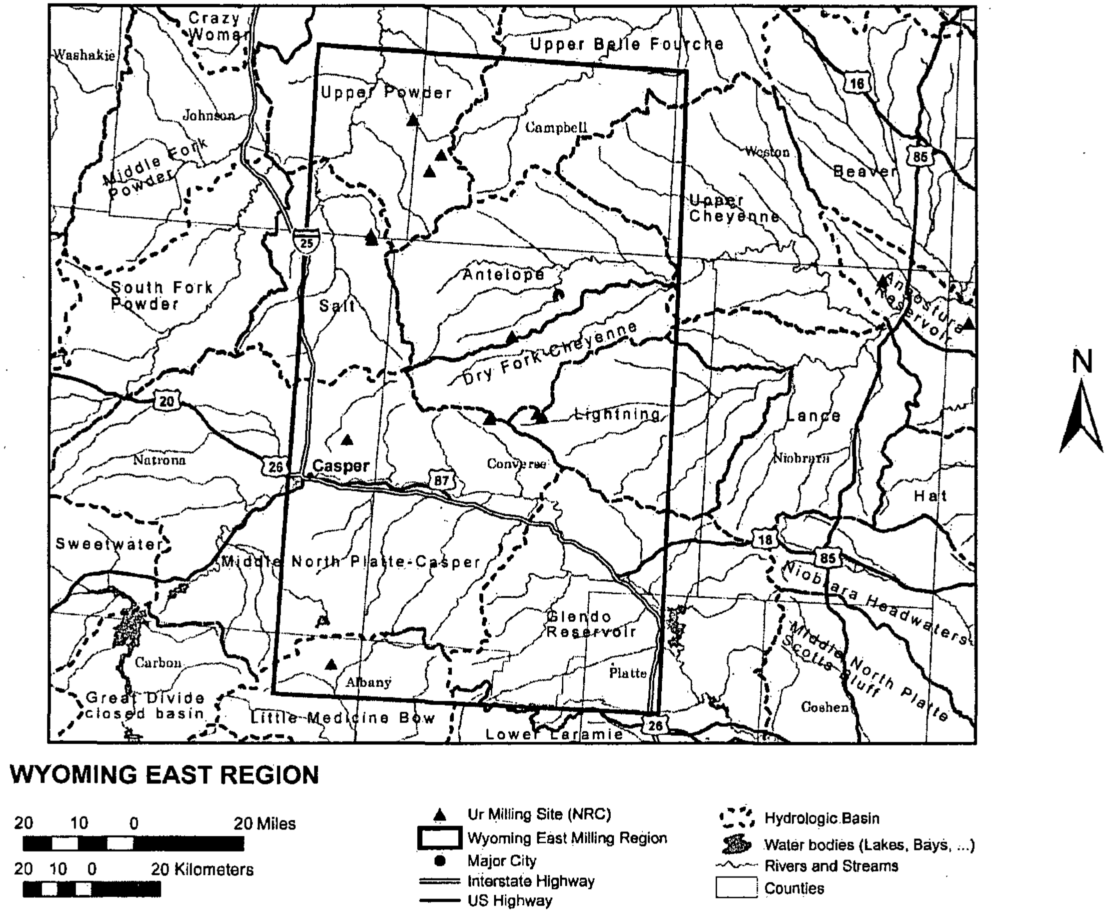



**Figure 3.3-6. Watersheds Within the Wyoming East Uranium Milling Region**

| Table 3.3-4. Primary Watersheds in the Wyoming East Uranium Milling Region Range of Designated Uses of Water Bodies Within Each Watershed | |
|---|---|
| **Watershed** | **Range of State Classification of Designated Uses*** |
| Little Medicine Bow River and Tributaries | Generally 2AB with some tributaries 2B and 3C |
| Glendo Reservoir and Tributaries | 2AB and 3B |
| Middle North Platte River | 2AB with some tributaries 3B |
| Salt Creek | 2C with some tributaries 3B |
| Lightning Creek | 3B |
| Dry Fork Cheyenne River | 3B |
| Antelope Creek | 3B |
| Upper Cheyenne River | 3B |
| Upper Powder River | 2ABww with some tributaries 3B |
| Upper Belle Fourche River and Tributaries | 2ABww and 3B |

*Class 2AB waters have designated uses including Drinking Water, Game Fish, Non-Game Fish, Fish Consumption, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2A waters have designated uses including Drinking Water, Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Class 2B waters exclude Drinking Water from the Class 2AB uses. Class 2C waters exclude drinking water and game fish from the Class 2AB uses.
Class 3A, 3B and 3C waters have designated uses including Other Aquatic Life, Recreation, Wildlife Agriculture, Industry, Scenic Value.
Classes 4A, 4B and 4C waters have designated uses including Recreation, Wildlife Agriculture, Industry, Scenic Value.
Classes 2ABww and 2Bww are warm water fisheries.
Official definitions of surface water classes and uses are in Wyoming Department of Environmental Quality Water Quality Rules and Regulations, <http://soswy.state.wy.us/Rules/RULES/6547.pdf> (29 January 2009).

The historical uranium milling districts included in the Wyoming East Uranium Milling Region are the Shirley Basin within the Little Medicine Bow River Watershed in the southwest and uranium deposits in the area known as the Powder River Basin that actually includes watersheds in addition to those contributing to the Powder River. Watersheds containing historical or potential uranium milling sites are Middle North Platte-Casper, Lightning Creek, Dry Fork Cheyenne River, Antelope Creek, Salt Creek, and Upper Powder River.

The Shirley Basin uranium district is located within the Little Medicine Bow River Watershed (Figure 3.3-6) in Carbon and Albany counties. In addition to the Little Medicine Bow River, other significant surface water features associated with the Shirley Basin are Sand Creek and Muddy Creek. Several small reservoirs are located on these streams. Several unnamed springs are also shown on the topographic maps covering the Shirley Basin. The Little Medicine Bow River and most of its tributaries are generally Class 2AB waters with some classified as 2C and 3B (Table 3.3-4). The difference between Class 2AB and Class 2C waters is that Class 2C waters do not have drinking water supply or game fish as designated uses. Class 3B also excludes nongame fish and fish consumption as designated uses. Although the Little Medicine Bow River flows directly through an area of historic uranium mining and milling, it is not listed as an impacted or threatened water body (WDEQ, 2008). The average flow of the Little Medicine Bow River at Boles Spring, Wyoming, is 1.1 $m^3/s$ [38 $ft^3/s$] (U.S. Geological Survey, 2008).

The Powder River Basin contains the most extensive uranium deposits in Wyoming, covering a large portion of east-central Wyoming in Converse, Campbell, and Johnson Counties. Principal watersheds within the Powder River Basin uranium district are (from south to north), Glendo Reservoir (on the North Platte River), Middle North Platte-Casper, Lightning Creek, Dry Fork of the Cheyenne River, Antelope Creek, Salt Creek, Upper Cheyenne River, Upper Belle Fourche, and Upper Powder River. The Lightning Creek, Antelope Creek, Dry Fork of the Cheyenne River, and Upper Cheyenne River watersheds contain ephemeral and intermittent streams that flow to the Cheyenne River east of the uranium districts in the Powder River Basin. Other surface water features in these watersheds include stock ponds. The ephemeral and intermittent water bodies are generally Class 3B. These watersheds include areas of oil and natural gas as well as coal bed methane development.

The Middle North Platte-Casper watershed is drained by the North Platte River, which is fed by numerous small tributaries. The North Platte River and most of its tributaries are classed as 2AB (Table 3.3-4). Portions of the North Platte River and some tributaries are impacted by elevated selenium concentrations (WDEQ, 2008). The flow of the North Platte River is not measured in this watershed. The Middle North Platte-Casper watershed is located within the area covered by the Platte River Recovery Implementation Program. The purpose of this program is to manage the land and water resources within the Platte River Basin to support the U.S. Fish and Wildlife Service recovery plan for four target species (interior least tern, whooping crane, piping plover, and pallid sturgeon) listed as threatened or endangered species (Platte River Recovery Implementation Program, 2006). The cooperative agreement between the federal agencies and the states of Colorado, Nebraska, and Wyoming requires that federal agencies consult with the U.S. Fish and Wildlife Service on federally licensed or permitted water projects within the Platte River Recovery Implementation Program area.

The Salt Creek watershed is located north of Casper, Wyoming, in Natrona County, upstream from the Upper Powder River watershed. Salt Creek is a Class 2C water body (Table 3.3-4). The water quality of Salt Creek is impaired due to elevated chloride and threatened by oil and grease attributed to oil and natural gas production in the watershed. Flow in Salt Creek is not measured.

The Upper Belle Fourche River watershed is located in the northeastern portion of the Wyoming East Uranium Milling Region in Campbell County (Figure 3.3-6). The Upper Belle Fourche River in Wyoming is classed as 2ABww where "ww" indicates "warm water fishery" (Table 3.3-4). Water quality in some portions of the Upper Belle Fourche River is listed as impaired due to fecal coliform from livestock grazing east of the Wyoming East Uranium Milling Region (WDEQ, 2008). Average flow in the Upper Belle Fourche River at Moorcroft, Wyoming (just east of the Wyoming East Uranium Milling Region), for water years 1991 through 2008 is 0.62 $m^3/s$ [22 $ft^3/min$] (U.S. Geological Survey, 2008).

The Upper Powder River watershed is located downstream of the Salt Creek watershed in Johnson and Campbell Counties. The Upper Powder River is classified as 2ABww with its smaller tributaries classified as 3B (Table 3.3-4). The Upper Powder River is listed as impacted by high chloride (WDEQ, 2008). Annual average flow in the Upper Powder River at Sussex, Wyoming, varied between 2.4 and 14 $m^3/s$ [86 and 487 $ft^3/s$] between 1939 and 2007 (U.S. Geological Survey, 2008).

### 3.3.4.2 Wetlands and Waters of the United States

The majority of waterways in this region are composed of ephemeral and intermittent streams. Some perennial slow moving rivers are also present in the region. Regulatory guidance and jurisdictional determination are the same as those found in Section 3.2.4.2 for the Wyoming West Uranium Milling Region.

Freshwater emergent marshes are found in depressions, as fringes around lakes, and sloughs along slow-moving streams. These wetlands maybe temporarily to permanently inundated and are typically dominated by floating-leaved plants in deeper areas (e.g., *Lemna, Potamogeton, Brasenia, Nuphar*) and sedges (*Carex, Cyperus, Rhynchospora*), bulrushes (*Scirpus, Schoenoplectus*), spikerushes (*Eleocharis*), cattails (*Typha*), rushes, (*Juncus*), and grasses (e.g., *Phalaris, Spartina*) in seasonal wetlands (USACE, 2006).

Floodplain and riparian systems occur along rivers and streams across the Wyoming East Uranium Milling Region. Common woody species in riparian and floodplain wetlands in the region include plains cottonwood (*Populus deltoides* ssp. *monilifera*), narrowleaf cottonwood (*P. angustifolia*), various willows, green ash (*Fraxinus pennsylvanica*), cedar elm, eastern swampprivet (*Forestiera acuminata*), and the introduced saltcedar (*Tamarix ramosissima*) (USACE, 2006).

Waters of the United States and special aquatic sites that include wetlands would need to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be obtained from the local USACE district. Section 401 state water quality certification is required for work in Waters of the United States. Within this region, the State of Wyoming regulates isolated wetlands and waters. Cumulative total project impacts greater than .4 ha [1 acre] would require a general permit for wetland mitigation by the WDEQ.

### 3.3.4.3 Groundwater

Groundwater resources in the Wyoming East Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of Wyoming. Uranium-bearing aquifers exist within these regional aquifer systems in the Wyoming East Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in the Wyoming East Uranium Milling Region, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

#### 3.3.4.3.1 Regional Aquifer Systems

The location of the Wyoming East Uranium Milling Region is shown in Figures 3.3-1 and 3.3-2. The Northern Great Plains aquifer system is the major regional aquifer system in the Wyoming East Uranium Milling Region. The Northern Great Plains aquifer system extends over one-third of Wyoming (Whitehead, 1996).

Whitehead (1996) grouped the Northern Great Plains aquifer system into five major aquifers. These aquifers, from shallowest to deepest, are the Lower Tertiary, Upper Cretaceous, Lower Cretaceous, Upper Paleozoic, and Lower Paleozoic aquifers. The Lower Tertiary aquifers consist of sandstone beds within the Wasatch Formation and the Fort Union Formation. Both formations consist of alternating beds of sandstone, siltstone, and claystone and beds containing lignite and subbituminous coal, but most water is stored in and flows through the more permeable sandstone beds. In the Powder River Basin, the Fort Union Formation and the Wasatch Formation are as thick as 1,095 and 305 m [3,600 and 1,000 ft], respectively. In the Lower Tertiary aquifers, the regional groundwater flow direction is northward and northeastward from recharge areas in northeastern Wyoming. Recharge to the aquifer is by precipitation in outcrop areas, water seeps from streambeds, and local irrigation. Discharge from the aquifer system is mainly by upward leakage of water into the shallower aquifers. The clinker layers that consist of fractured rocks along the coal outcrop appear to be a recharge area to the coal beds.

The Upper Cretaceous aquifers consist of sandstone beds interbedded with siltstone and claystone in the Lance and the Hell Creek Formations and the Fox Hills Sandstone, which are 105 to 1,035 m [350 to 3,400 ft] and 90 to 135 m [300 to 450 ft thick]. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. Groundwater in the Upper Cretaceous aquifers moves from aquifer recharge areas at higher altitudes toward discharge areas along major rivers. The general groundwater flow direction is northward in the Powder River Basin. In Wyoming, the potentiometric surface of the Lower Tertiary aquifers is locally 122 m [400 ft] higher than that of the underlying upper Cretaceous aquifers. Hence, groundwater moves locally vertically downward from the lower Tertiary aquifers into the Upper Cretaceous aquifers through the confining layer separating these two aquifers.

The Lower Cretaceous aquifers are separated from the overlying Upper Cretaceous aquifers by several thick confining units. The Pierre Shale, the Lewis Shale, and the Steele Shale are the regionally thickest and most extensive confining units. Water across the Pierre Shale can leak into the underlying Lower Cretaceous aquifers where the Pierre Shale is fractured.

The Lower Cretaceous aquifers are the most widespread aquifers in the Northern Great Plains aquifer system and contain several sandstones. The principal water-yielding units are the Muddy Sandstone and the Inyan Kara Group in the Powder River Basin. The Lower Cretaceous aquifers contain little freshwater. The water becomes saline in the deep parts of the Powder River Basin. Locally, the Sundance, Swift, Rierdon, and Piper Formations yield small to moderate quantities of water.

The Paleozoic aquifers cover a larger area, but they are deeply buried in most places and contain little freshwater. They are divided into Upper Paleozoic aquifers and Lower Paleozoic aquifers. In much of the Powder River Basin, the Upper and Lower Paleozoic aquifers are hydraulically connected and locally are called the Madison Aquifer System.

The Upper Paleozoic aquifers are confined everywhere except in recharge areas. They consist primarily of the Madison Limestone, the Tensleep Sandstone in the western parts of the Powder River Basin, and sandstone beds of the Minnelusa Formation in the eastern part of the Powder River Basin. The Pennsylvanian sandstones yield less water than the Madison Limestone and contain freshwater locally at the outcrop areas. Pennsylvanian rocks are not usually considered to be a principal aquifer. In the Upper Paleozoic aquifers, the regional groundwater flow direction is northeastward from recharge areas where the aquifers crop out adjacent to structural uplifts near the southern and western limits of the aquifer system.

Lower Paleozoic aquifers consist of sandstone and carbonate rocks. The principal geologic units that compose the Lower Paleozoic aquifers are the Flathead Sandstone, sandstone beds of the Winnipeg Formation, limestones of the Red River and the Stonewall Formations, and the

Bighorn and the Whitehead Dolomites. The groundwater flow direction is generally northeastward. Lower Paleozoic aquifers contain freshwater only in a small area in north-central Wyoming. These aquifers contain slightly saline to moderately saline water throughout the southern half of their extent.

The Madison Limestone exhibits karst features (features formed by the dissolution of a layer or layers of soluble bedrock, usually carbonate rock such as limestone or dolomite) at the outcrop areas in north-central Wyoming (Wyoming East Uranium Milling Region). Several large springs formed from some of the solution conduits in the Madison Limestone, including the Thermopolis hot springs system in central Wyoming with a discharge rate of about 11,355 L/min [3,000 gal/min] of geothermal water.

Recharge to the aquifers in most of the area is likely small, due to low annual precipitation and high evaporation. The mean annual precipitation in the Wyoming East Uranium Milling Region is typically in the range of 28–38 cm/yr [11–15 in/yr], but at high elevations, it locally exceeds 50 cm/year [20 in/year] based on precipitation data from 1971 to 2000. The evaporation rate was estimated to be 105.9±7.1 cm/year [41.7±2.8 in/year] using the Kohler-Nordenson-Fox equation with data from the station in Lander, Wyoming (Curtis and Grimes, 2004).

#### 3.3.4.3.2 Aquifer Systems in the Vicinity of Uranium Milling Sites

The hydrogeological system in areas of uranium milling interest in the Wyoming East Uranium Milling Region consists of a thick sequence of primarily sandstone aquifers and shale aquitards. Uranium-bearing sandstone aquifers in the Fort Union Formation at the active uranium milling sites are also important for water supplies in the milling region.

Areas of uranium milling interest at the Reynolds and Smith Ranch areas are underlain, from shallowest to deepest, by the alluvium, the Wasatch Formation, the Fort Union Formation, the Lance Formation, and the Fox Hills Formation. The alluvium has a thickness of 0–9 m [0–30 ft] and has small yields in stream valleys. The Wasatch Formation and the Fort Union Formation contain important sandstone aquifers for water supplies. Groundwater production from the Lance and the Fox Hills Formations is largely unknown at the ISL facilities in the Reynolds and Smith Ranch areas in Converse County (Power Resources, Inc., 2004).

As discussed in Section 3.3.4.3.1, this aquifer system is separated from the underlying aquifers including, from shallowest to deepest where they are continuous, the Muddy Sandstone, the Inyan Kara Group, and the Paleozoic aquifers by shale layers. The Paleozoic aquifers are deeply buried in most places and contain little freshwater (Whitehead, 1996).

#### 3.3.4.3.3 Uranium-Bearing Aquifers

Uranium mineralization at locations of milling interest is typically hosted by Paleocene-age confined sandstone aquifers (at the Smith Ranch and Reynolds Ranch ISL sites) or Eocene-age confined sandstone aquifers (at the Irigaray and Christensen Ranch ISL sites) in the Wyoming East Uranium Milling Region.

Confined sandstone beds in the Fort Union Formation are the uranium-bearing aquifers at the Smith Ranch and Reynolds Ranch ISL sites in Converse County. The Fort Union Formation contains multiple confined sandstone aquifers in the eastern and northeastern parts of the permit area at the Smith Ranch and Reynolds Ranch ISL sites, but it is unconfined in the southwestern and western parts. Among the confined sandstone aquifers, the U- and

S-Sandstones are the primary uranium mineralization zone, and they are referred to as the U/S sand. O-Sandstone aquifers also contain economic uranium mineralization in the Fort Union Formation (NRC, 2006). Confined sandstone units in the Wasatch Formation are the uranium-bearing units at the Irigaray and Christensen Ranch ISL sites. These units are L, K, and J fluvial units in an ascending order at the Christensen Ranch ISL site and these fluvial units correspond to the Lower Irigaray sandstone, the Upper Irigaray sandstone, and the Unit 1 sandstone at the Irigaray Ranch ISL site. The K unit is the primary uranium mineralization zone (Cogema Mining, Inc., 1998).

For ISL operations to begin, portions of the uranium-bearing sandstone aquifers in the Fort Union Formation in the Wyoming East Uranium Milling Region would need to be exempted by the UIC program administered by WDEQ (Section 1.7.2.1).

**Hydrogeological characteristics:** In the Wyoming East Uranium Milling Region, the production aquifer system typically consists of confined sandstone aquifers. Aquifer properties (e.g., transmissivity, thickness, storage coefficient) vary spatially in the region.

At the Smith Ranch and Reynolds Ranch areas, the mean effective transmissivity of the U/S sandstone aquifer and O-sandstone aquifer is 6,700 L/day/m {8.2 $m^2$/day [540 gal/day/ft} and 7,900 L/day/m {9.7 $m^2$/day} [640 gal/day/ft]}, respectively. The storage coefficient for the U/S sandstone aquifer and O-sandstone aquifer ranges between $1.5 \times 10^{-5}$ and $1.7 \times 10^{-5}$ and $6.3 \times 10^{-5}$ and $7.8 \times 10^{-5}$, respectively, indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from $10^{-5}$ to $10^{-3}$ (Driscoll, 1986, p. 68). The average groundwater velocities through the U/S-sandstone aquifer and O-sandstone aquifer were reported to be 2.4 and 0.17 m/yr [8 and 0.56 ft/yr] (NRC, 2006). The approximate thickness of the Fort Union Formation is 910–1,100 m [3,000–3,600 ft] in the Powder River Basin (PRI, 2004; Whitehead, 1996). Groundwater production from the Fort Union Formation is generally good with water yields as high as 2,080 L/min [550 gal/min] (PRI, 2004; NRC, 2006).

The average thickness of the K unit is 54 m [180 ft]. The K unit has a mean hydraulic conductivity of 0.13 m/day [0.42 ft/day] (Cogema Mining, Inc., 1998).

**Level of confinement:** The production aquifer is typically confined in the Wyoming East Uranium Milling Region. The thickness of the confinement varies spatially.

At the Smith Ranch and Reynolds Ranch ISL sites, the U/S sandstone is confined above by a 6- to 20-m [20- to 70-ft]-thick shale aquitard (V Shale). It is confined below by a 45-m [150-ft]-thick shale aquitard (R Shale) (NRC, 2006). Aquifer tests revealed that the confining shale members would be effective aquitards to the vertical movement of leaching solution (Power Resources Inc., 2006, 2005).

At the Irigaray and Christensen Ranch ISL sites, the K unit is confined above by a 23-m [76-ft]-thick aquitard. It is confined below by a 27-m [90-ft]-thick aquitard. The vertical hydraulic conductivity of the upper confining layer ranges from $8.2 \times 10^{-6}$ to $1.1 \times 10^{-4}$ m/day [$27 \times 10^{-6}$ to $3.6 \times 10^{-4}$ ft/day]. The vertical hydraulic conductivity of the lower confining layer ranges from $7.4 \times 10^{-6}$ to $1.2 \times 10^{-3}$ m/day [$24 \times 10^{-6}$ to $3.9 \times 10^{-3}$ ft/day]. The confining strata are continuous over the commercial area of the Irigaray and Christensen Ranch ISL sites (Cogema Mining, Inc., 1998).

As discussed in Section 3.3.4.3.1, the aquifer sequence that includes, from the shallowest to deepest, the Wasatch Formation, the Fort Union Formation, the Lance Formation, and the Fox Hills Formation are confined below by regionally extensive and thick low permeability layers that include the Pierre Shale, the Lewis Shale, and the Steele Shale. The vertical hydraulic conductivity of the Pierre Shale is reported to be $1.5 \times 10^{-8}$ to $1.5 \times 10^{-4}$ m/day [$5 \times 10^{-8}$ to $5 \times 10^{-4}$ ft/day] outside the Wyoming East Uranium Milling Region (Kansas Geological Survey, 1991). The Pierre Shale is fractured in some parts of the region and may leak water to the underlying lower Cretaceous aquifers (Whitehead, 1996). Hence, where the Pierre Shale is fractured, the aquifer sequence may not be effectively confined below.

**Groundwater quality:** In some parts of the Wyoming East Uranium Milling Region, the total dissolved solids (TDS) levels in the uranium-bearing aquifers exceed the EPA's drinking water standards. The uranium and radium-226 concentrations in the uranium-bearing aquifers typically exceed their respective EPA Maximum Contaminant Levels.

At the Smith Ranch and Reynolds Ranch ISL area, the water quality is usually good in the U/S-sandstone and O-sandstone aquifers and meets the EPA's drinking water standards except for radium-226. Radium-226 naturally exists in the U/S sandstone and O-sandstone aquifers at a level of 296 pCi/L and 86 pCi/L, respectively, which exceeds the EPA's primary drinking water standard of 5 pCi/L. Both aquifers have TDS ranging from 234–952 mg/L [234–952 ppm] {the limit of dissolved solids recommended by the EPA for drinking water is 500 mg/L [500 ppm]} (NRC, 2006).

At the Irigaray and Christensen Ranch ISL sites, the TDS concentrations are usually below the drinking water standard, but groundwater is not considered as potable in the ore production zone due to elevated concentrations of radium-226 in excess of the EPA primary drinking standards of 5 pCi/L.

**Current groundwater uses:** In the vicinity of the Smith Ranch and Reynolds Ranch ISL area permit area, groundwater is largely pumped for livestock watering, and to a lesser extent, for domestic water supply (NRC, 2006).

3.3.4.3.4 Other Important Surrounding Aquifers for Water Supply

At the regional scale, the Wasatch Formation and the Fort Union Formation are important aquifers for water supplies. The Fox Hills Sandstone is one of the most continuous water-yielding formations in the Northern Great Plains aquifer system. Except at outcrop areas, the Paleozoic aquifers are not usually used for water production, because they are either deeply buried or contain saline water (Whitehead, 1996).

At the ISL facilities in the Reynolds and Smith Ranches, the Wasatch Formation and the Fort Union Formation contain important sandstone aquifers for water supplies. The thickness of the Wasatch Formation ranges from 0–150 m [0–500 ft] and yields as high as 530 L/min [140 ga/min]. Water yields from the Lance Formation and the Fox Hills Formation are largely unknown at the Reynolds and Smith Ranch areas. The thickness of the Lance Formation is about 915 m [3,000 ft], and its water yield is estimated to not exceed 75 L/min [20 gal/min]. The thickness of the underlying Fox Hills Formation is about 150–210 m [500–700 ft], and its water yield is estimated to not exceed 380 L/min [100 gal/min] (PRI, 2004 and the references therein).

## 3.3.5 Ecology

### 3.3.5.1 Terrestrial

**Wyoming East Uranium Milling Flora**

According to the EPA, the identified ecoregions in the Wyoming East Uranium Milling Region primarily consist of Wyoming Basin, Northern Great Plains, Southern Rockies, and the Western High Plains ecoregions (Figure 3.3-7). Uranium milling districts in this region are generally found in the Rolling Sagebrush Steppe and the Powder River Basin of the Wyoming Basin. Habitat types and species found in these areas are based on the Wyoming Gap Analysis project (Wyoming Geographic Information Science Center, 2007) as described in Section 3.2.5.

The Rolling Sagebrush Steppe and the Salt Desert Shrub Basin ecoregions of the Wyoming Basin have been described in the Wyoming West Uranium Milling Region (Section 3.2.5). An excellent description of the Wyoming East Uranium Milling Region Fauna is provided by Chapman, et al. (2004) and is summarized next.

The Southern Rockies are characterized by rugged, steep mountains, intermontane depressions and open meadows, and high-elevation plateaus. Ponderosa pines are found at lower elevations with pinyon-juniper woodlands below that grasslands are located in the lowest areas. Lodgepole pine is more common in the Middle Rockies region; white pine (*Pinus* spp.), grand fir (*Abies grandis)*, and cedar, prevalent in the Northern Rockies region, are absent from the alpine zone. A greater portion of the Middle Rockies is used for summer grazing of livestock (Chapman, et al., 2004).

The Subalpine Forests ecoregion of the Southern Rockies is a forested area found on the steep forested slopes of the Medicine Bow and Sierra Madre Mountains with a greater extent on the north slopes. The dense forests are dominated by lodgepole pine, Englemann spruce and subalpine fir; some areas are locally dominated by aspen (*Populus tremula*). Whortleberry dominates the forest understory. Subalpine meadows also occur in some areas (Chapman, et al., 2004).

The Mid-Elevation Forests and Shrublands ecoregion of the Southern Rockies is found in the 2,300 to 2,750 m [7,500 to 9,000 ft] elevation range within the Laramie, Medicine Bow, and Sierra Madre mountains. Vegetation located in the region from the southwest to northeast are composed of aspen, Douglas fir, lodgepole pine, limber pine (*Pinus flexilis*), and ponderosa pine. Due to the increased availability of moisture ponderosa pine grows mainly on the eastern slopes of the Laramie Mountains, as it does on the eastern Bighorn Mountains. The understory is composed of grasses and shrubs. Perennial streams are diverted for irrigation in lower elevations and are often dry in their lower reaches in the summer (Chapman, et al., 2004).

The Foothill Shrublands ecoregion of the Southern Rockies is a transition between the higher elevation forests of the Laramie, Medicine Bow, and Sierra Madre Mountains and the more arid grassland and sagebrush regions in the Wyoming Basin and the High Plains. On the east side of the Laramie Mountains, this ecoregion is a continuation of high plains prairie grasslands of blue grama, prairie junegrass, and western wheatgrass interspersed with mountain big sagebrush and mountain mahogany shrubland. Pockets of aspen, limber pine, and Douglas fir are often found on north-facing slopes. Riparian vegetation along the water courses originating in higher mountains include willow species and narrowleaf cottonwood, with boxelder (*Acer*

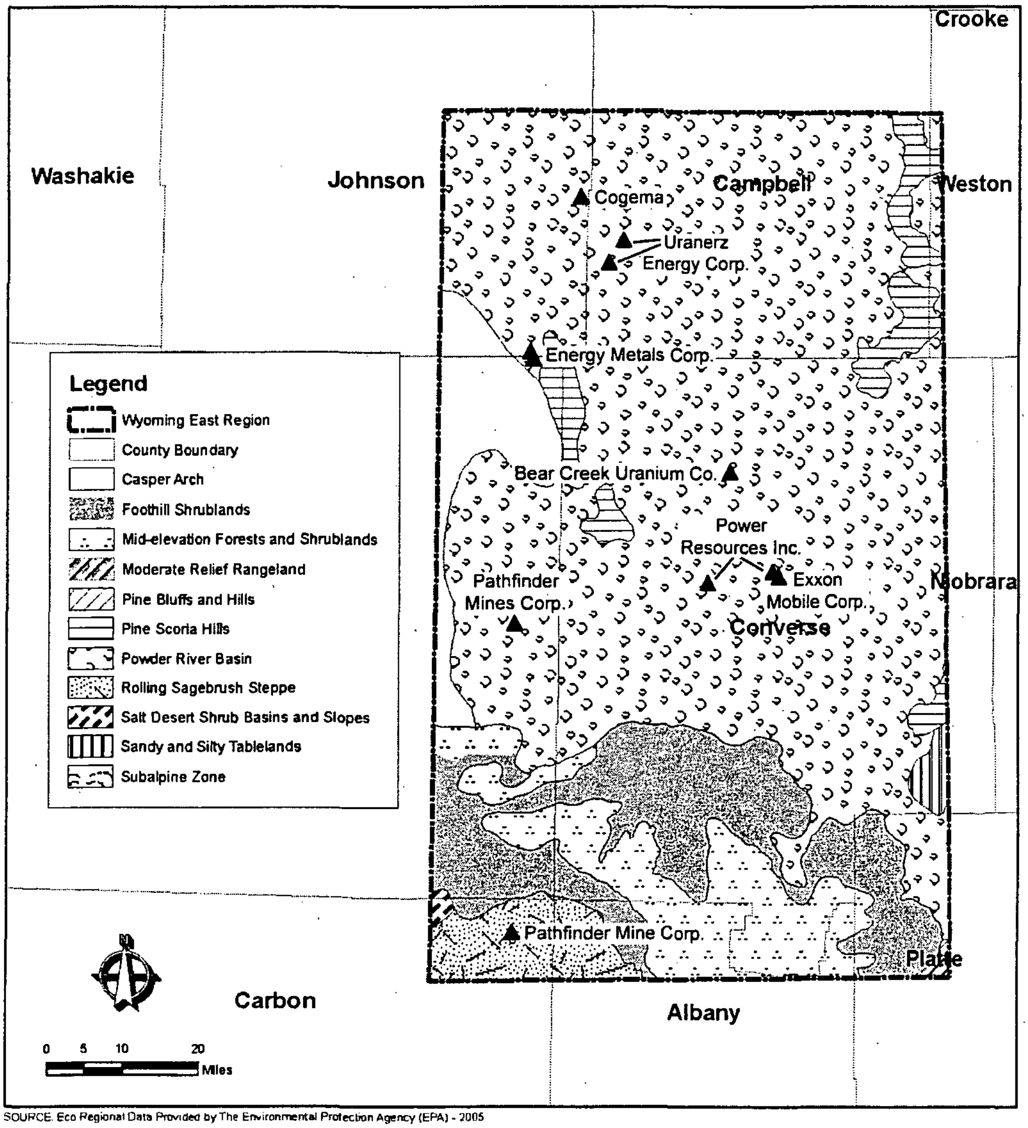



**Figure 3.3-7. Ecoregions of the Wyoming East Uranium Milling Region**

*negundo*) and wild plum in the north. Land use is mainly livestock grazing and some irrigated hayland adjacent to perennial streams (Chapman, et al., 2004).

The High Plains ecoregion consists of rolling plains and tablelands formed by uplift and the erosion of the Rocky Mountains. Due to the rainshadow of the Rocky Mountains drought resistant shortgrass and mixed-grass prairie dominate the plains vegetation. Seasonal precipitation in this region generally falls during the growing season. This region occupies the southeastern corner of Wyoming where the Southern Rockies, Wyoming Basin, and the Northwestern Great Plains ecoregions meet. The boundaries of these regions fade into one another and some characteristics of each region can be found near the borders, making the boundary of the High Plains in Wyoming a transitional area.

The Moderate Relief Rangeland ecoregion of the High Plains consists of mixed-prairie vegetation dominated by grass species such as blue grama, western winter wheatgrass, junegrass, Sandberg blue grass needle-and-thread grass, prairie junegrass, and winter fat (*Ceratoides lanata*). Other species found in the prairie include rabbitbrush, fringed sage, scattered yucca, and other various forbs. Patches of mountain mahogany (*Cercocarpus* spp.) and skunkbush sumac (*Rhus trilobata*) grow on bluffs and hilltops. The plains surface steadily increases in elevation as it rises to a subtle boundary transition with the Laramie Mountains (Chapman, et al., 2004).

The Pine Bluffs and Hills ecoregion of the High Plains is composed of escarpments, bluffs, and badlands. Ponderosa pine woodland and open grasslands alternate along the rocky outcrops. Common species found in this region include little bluestem, common juniper, and bearberry (*Arctostaphylos uva-ursi*). Areas of limber pine and silver sagebrush may also be present (Chapman, et al., 2004).

The Sandy and Silty Tablelands ecoregion of the High Plains is characterized by tablelands with areas of moderate relief. This region consists of mixed-grass prairies dominated by blue grama, western wheatgrass, june grass, needle-and-thread grass, rabbit brush, fringed sage, and various forbs. Since the 1880s the ecoregion has been mainly used for livestock grazing (Chapman, et al., 2004).

The Northwestern Great Plains encompass the Missouri Plateau section of the Great Plains. This area includes semiarid rolling plains of shale and sandstone derived soils punctuated by occasional buttes and badlands. For the most part, it has not been influenced by continental glaciation. Cattle grazing and agriculture with spring wheat and alfalfa farming are common land uses. Agriculture is affected by erratic precipitation and limited opportunities for irrigation. In Wyoming, mining for coal and coal-bed methane production is prevalent, with a large increase in the number of coal-bed methane wells drilled in recent years. Native grasslands and some woodlands persist, especially in areas of steep or broken topography (Chapman, et al., 2004).

The Pine Scoria Hills ecoregion is composed of rugged broken land and stony rough hills covered by open ponderosa pine-Rocky Mountain juniper forest or ponderosa pine savannas. Coal, sandstone, and shale bedrock underlie the region. Savannas and extensive open grassland are found in areas with less available moisture. Species found in this region include little bluestem (*Schizachyrium scoparium*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), western wheatgrass, blue grama, and Sandberg bluegrass. Skunkbush sumac and western snowberry (*Symphoricarpos occidentalis*) are common shrubs.

Land use includes woodland grazing and areas of historical small-scale coal mining (Chapman, et al., 2004).

The Casper Arch ecoregion of the Northwestern Great Plains is a transitional region between the Northern Great Plains and the Wyoming Basin. Soils are weathered from sodic Cody shale; they are generally well drained to slowly permeable, and are moderately to very shallow. Shrubland dominated by sagebrush steppe, which may include Wyoming big sagebrush, Gardner saltbush (*Atriplex gardneri*), Indian ricegrass (*Oryzopsis hymenoides*), birdfoot sagebrush (*Artemisia pedatifida*), western wheatgrass, bluebunch wheatgrass, needle-and-thread grass, blue grama, Sandberg bluegrass, junegrass, rabbitbrush, fringed sage, and other grasses, forbs, and shrubs (Chapman, et al., 2004).

The Powder River Basin ecoregion of the Northwestern Great Plains covers rolling prairie and dissected river breaks surrounding the Powder, Cheyenne, and Upper North Platte Rivers. The Powder River Basin has less precipitation and less available water than the neighboring regions. Vegetation within this region is composed of mixed-grass prairie dominated by blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbrush, fringed sage, and other forbs, shrubs and grasses (Chapman, et al., 2004).

**Wyoming East Uranium Milling Region Fauna**

The animal species that may occur in the Wyoming Basin and the Middle/Southern Rockies have been discussed previously in the Wyoming West Uranium Milling Region (see Section 3.2.5.1)

The Northwest Great Plains/Northern short grasslands region of Wyoming is home to approximately 337 different species. Many of these species are found in the adjacent Wyoming Basin Shrub Steppe (World Wildlife Fund, 2007d,e). Many of the animals in this region are associated with prairie potholes. Birds include the Ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), golden eagle, sharp tailed grouse (*Tympahuchus phasinellus*), sage-grouse, the greater prairie chicken (*Tympanuchus cupido*), numerous migratory birds such as ducks and song birds, and one of the largest breed populations of the endangered piping plover (*Charadrius melodus*). Blacktail and white tailed deer, pronghorns, bighorn sheep, American bison (*Bison bison*), bobcat (*Lynx rufus*), and cougars (*Felis concolor*) are typical large animals. This region is also known for its abundance of white-tailed prairie dog towns, which the black-footed ferret uses as a habitat (World Wildlife Fund, 2007a–e).

The Western High Plains/Western Short Grasslands is home to approximately 431 different species. Many of these spices can be found in the adjacent Northwest Great Plains region to the north. Rodents are the most numerous type of mammals of this region. These include Desert and Eastern cotton tail rabbits, gophers (*Thomonys* sp.), shrews (*Sorex* sp.), voles (*Microtus* sp.), kangaroo rats (*Dipodomys* sp.), black-tailed prairie dogs, and numerous rat and mouse species. Larger mammals include the pronghorns, elk, big horn sheep, coyote, beaver, porcupine, bobcats, and foxes. The largest diversity of animals of the region is birds. Birds include the Ferruginous hawk, Swainson's hawk, golden eagle, sharp tailed grouse, prairie chickens, wrens, kingbirds, vireos sparrows, flycatchers (*Tyrannidae* spp.), and ducks. This region contains numerous reptile and amphibians. Amphibian species include the northern cricket frog (*Acris crepitans*), leopard frog (*Rana* spp.), bull frog (*Rana catesbeiana*), Rio Grande frog (*Rana berlandieri*), narrowmouth toad (*Gastrophryne* spp.), great plains toad (*Bufo cognatus*), green toad (*Bufo debilis* spp.), tiger salamander, and Woodhouse toad. Western rattle snake ringneck snake (*Diadophis punctatus* ssp.), king snake (*Lampropeltis* spp.), hog-nose snake (*Heterodon platirhinos*), and garter snake can be found in the region. Numerous lizards and turtles are also found within the region (World Wildlife Fund, 2007 a–e).

According to the Wyoming Game and Fish Department, crucial wintering habitats are found within this region for large game mammals and nesting leks for the sage-grouse. Figures 3.3-8 to 3.3-14 show the crucial winters and yearlong ranges for large mammal found in this region. Most of the crucial areas are located either in the Thunder Basin National Grassland in the northeast portion of the region; the Medicine Bow National Forest in the Laramie Mountains, or along the North Platte River and its tributaries that traverse west-east across the lower half of the region. Within this region, the area of milling interest nearest to Casper is situated in close proximity to a crucial wintering area for antelopes. Numerous sage-grouse leks are clustered near the Pumpkin Buttes Uranium District in the northwestern part of the study region. In addition, a large concentration of leks is found in the southwestern corner of the study region in the vicinity of the Shirley Basin Uranium District.

### 3.3.5.2 Aquatic

Within the Wyoming East Uranium Milling Region, watersheds identified as aquatic habitat areas include the Lower Salt Creek Basin; the middle North Platte River Corridor, the La Bonte Creek and Horseshoe Creek Watersheds; and the North Platte River, Bolton Creek; and Bates Creek Watersheds. Additional information on watersheds in the region is provided in Section 3.3.4.1. The three uranium districts within the Wyoming West Uranium Milling Region are located in the following regional watersheds: Salt Creek, Middle North Platte-Casper, Lightning Creek, Dry Fork Cheyenne River, Antelope Creek, and Upper Powder River.

The Lower Salt Creek Basin located in the northeastern portion of the Wyoming West Uranium Milling Region (near theh Pumpkin Buttes Uranium District) is a relatively dry basin with little vegetation. This basin includes intermittent streams with few perennial streams. Many of the stream channels are degraded or actively degrading. Small reservoirs in the basin are dewatered for live stock and have diminished water storage capacity from sedimentation due to erosion. Native species like the fathead minnow, flathead chub, longnose dace, plains minnow, sand shiner, and white sucker are found in this watershed (Wyoming Game and Fish Department, 2007a,b).

The La Bonte Creek and Horseshoe Creek watersheds are located in the southeastern portion of the Wyoming West Uranium Milling Region. These watersheds are subject to short periods of high water flow that contribute to the scouring of stream channels leaving wide channels that decrease during low flow periods during the summer, winter and fall seasons thus limiting habitat. Native species found in the watersheds include the brassy minnow, fathead minnow, longnose dace, sand shiner, longnose sucker, stonecat and plains killifish. Sport fish that can be found in the systems include rainbow and brown trout (Wyoming Game and Fish Department, 2007a,b).

The middle North Platte River Corridor (near the Monument Hill Uranium District) is discussed for the Wyoming West Uranium Milling Region (Section 3.2.5.2).

The North Platte River, Bolton Creek, and Bates Creek watersheds are located in the southwestern portion of the Wyoming East Uranium Milling Region (in the vicinity of the Shirley Basin Uranium District). Soil erosion and sediment loading to these waterways have diminished the potential for fish to naturally reproduce. Sedimentation is further increased by erosive soils,

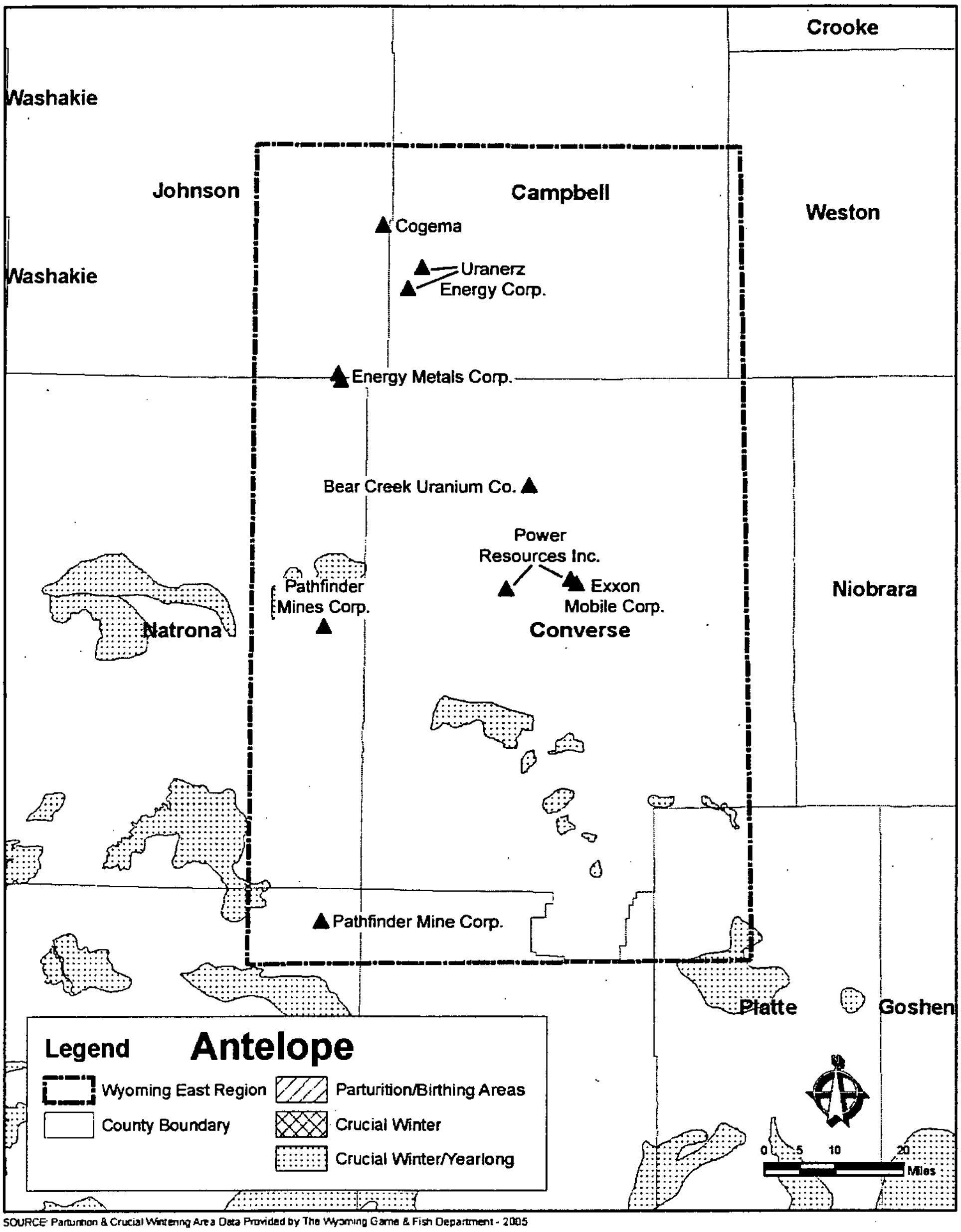
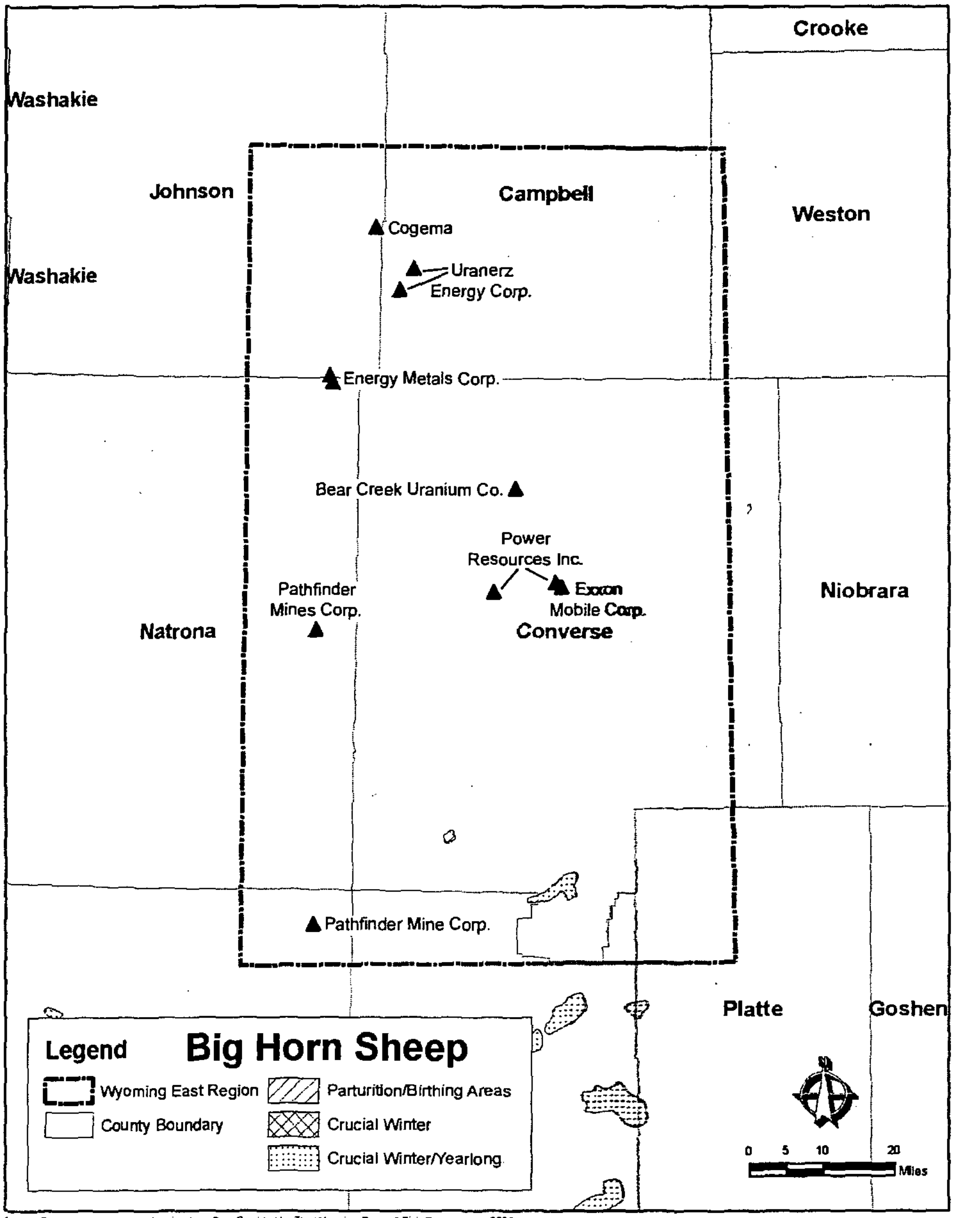
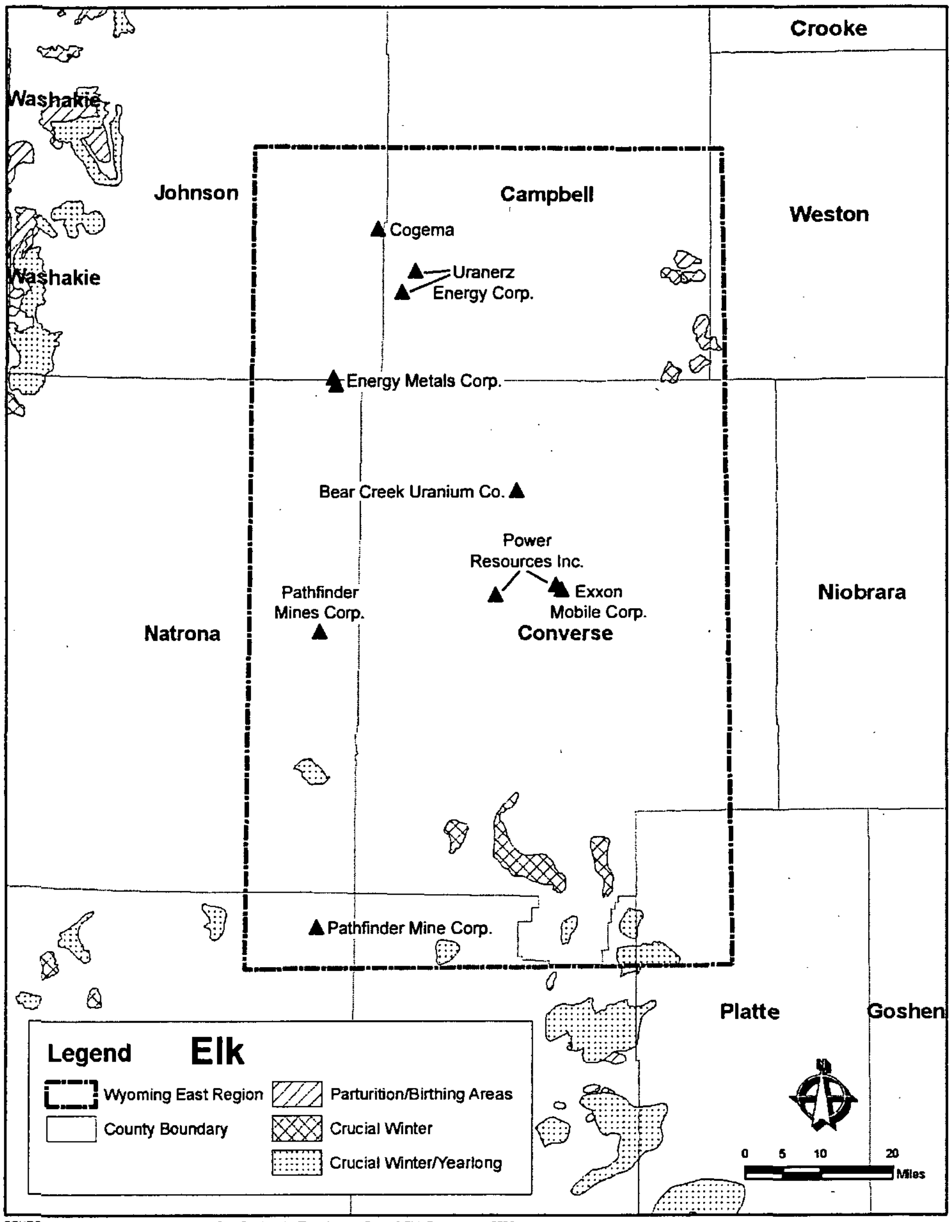



**Figure 3.3-8. Antelope Wintering Area for the Wyoming East Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.3-9. Big Horn Wintering Area for the Wyoming East Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.3-10. Elk Wintering Area for the Wyoming East Uranium Milling Region**

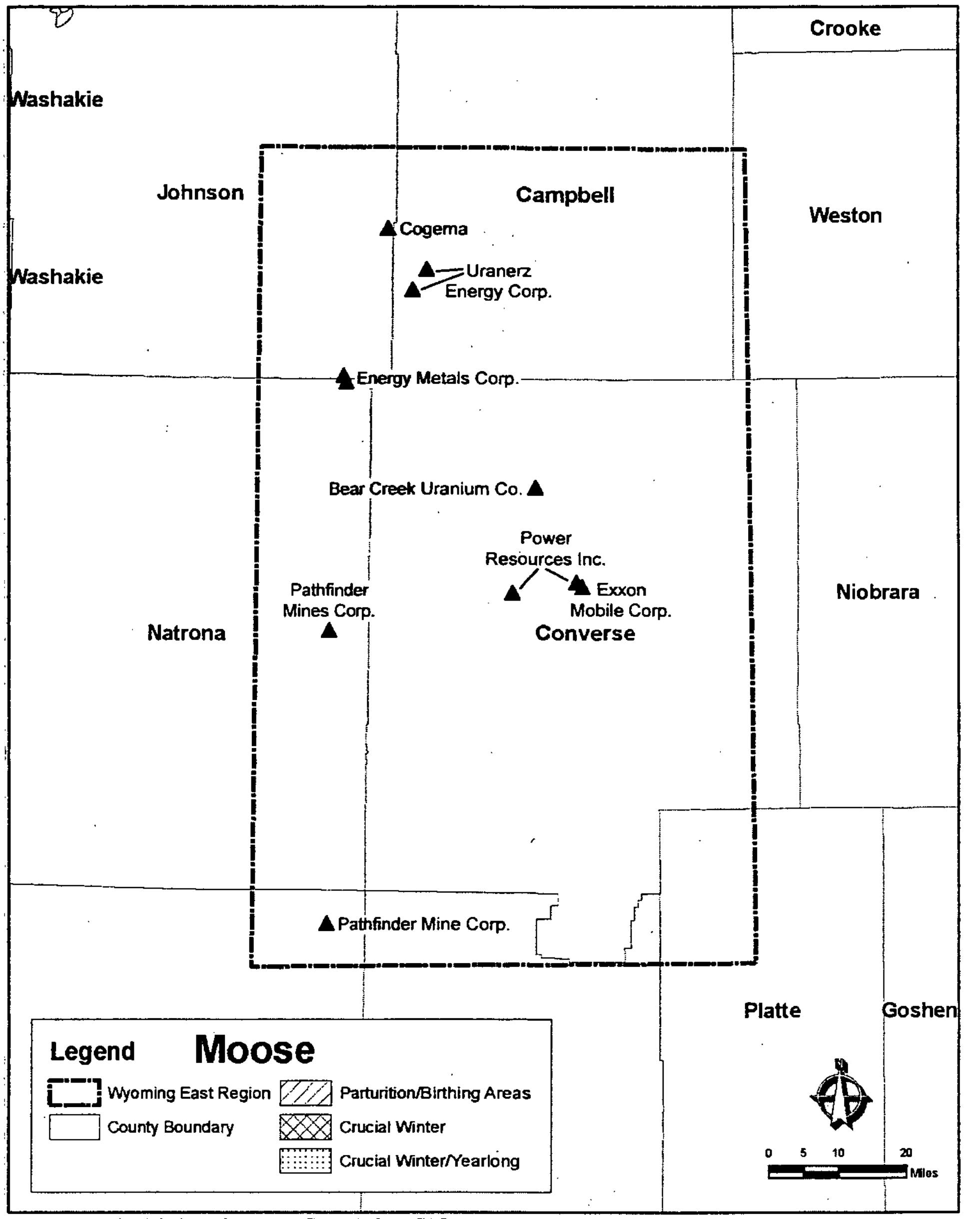
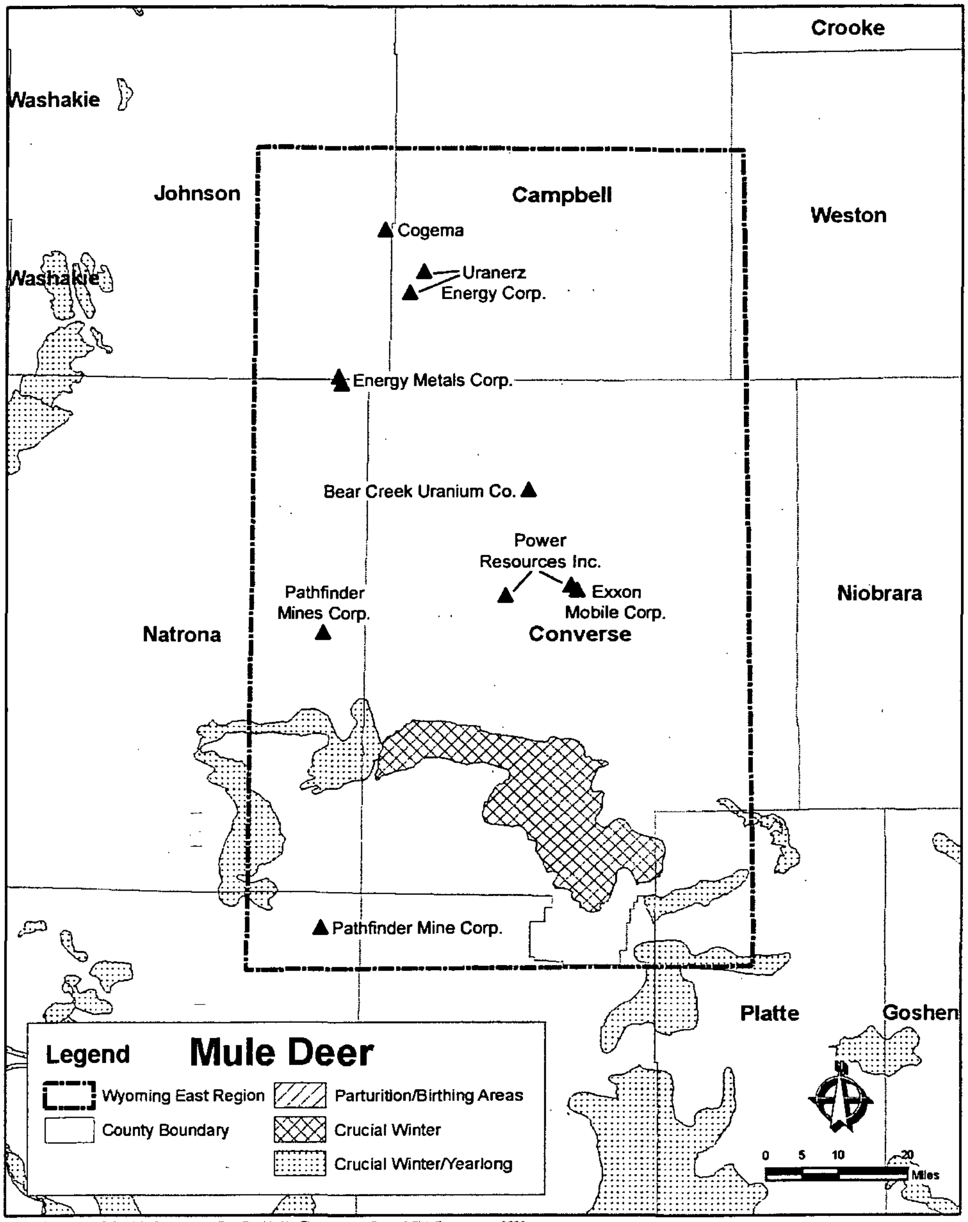



**Figure 3.3-11. Moose Wintering Area for the Wyoming East Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.3-12. Mule Deer Wintering Area for the Wyoming East Uranium Milling Region**

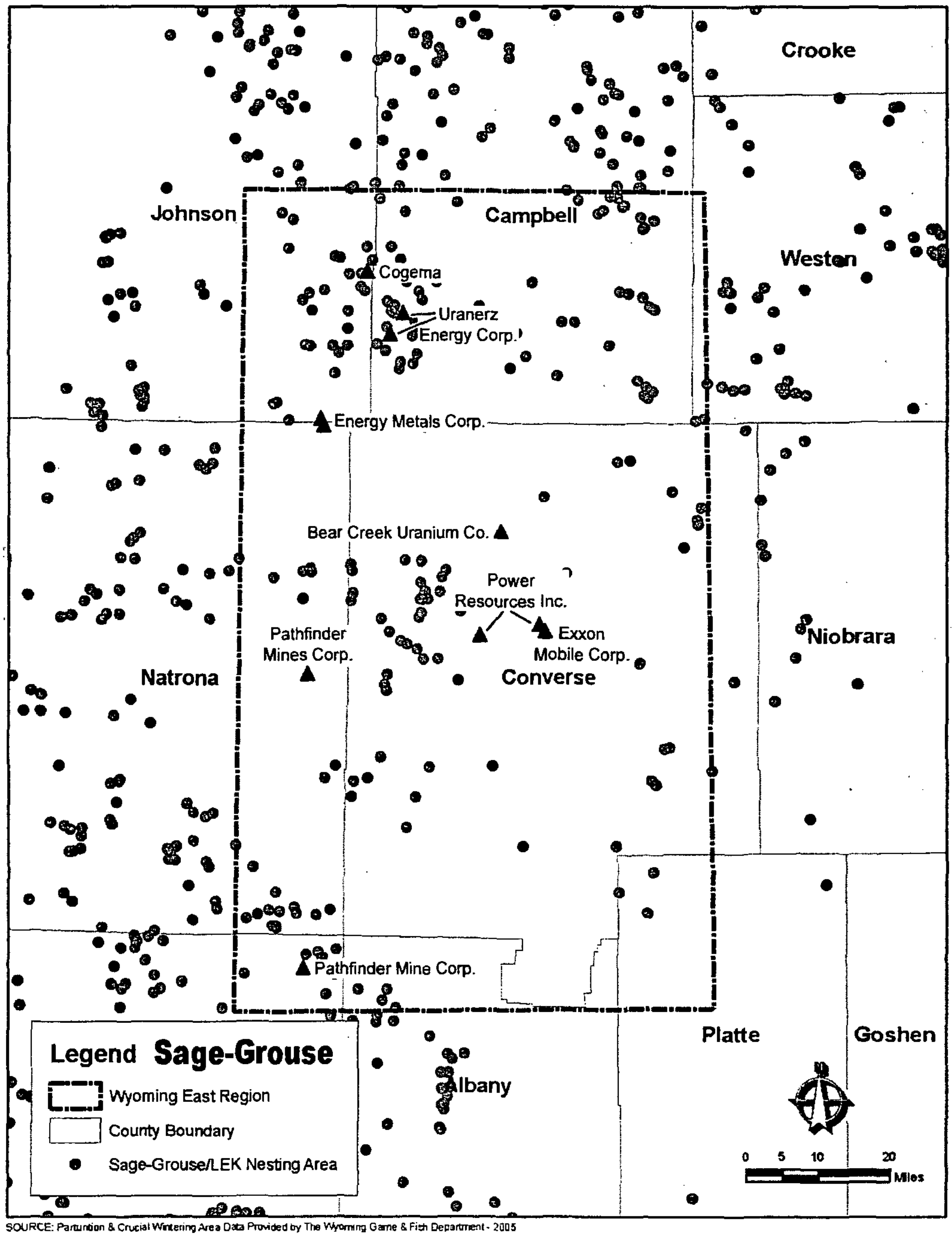
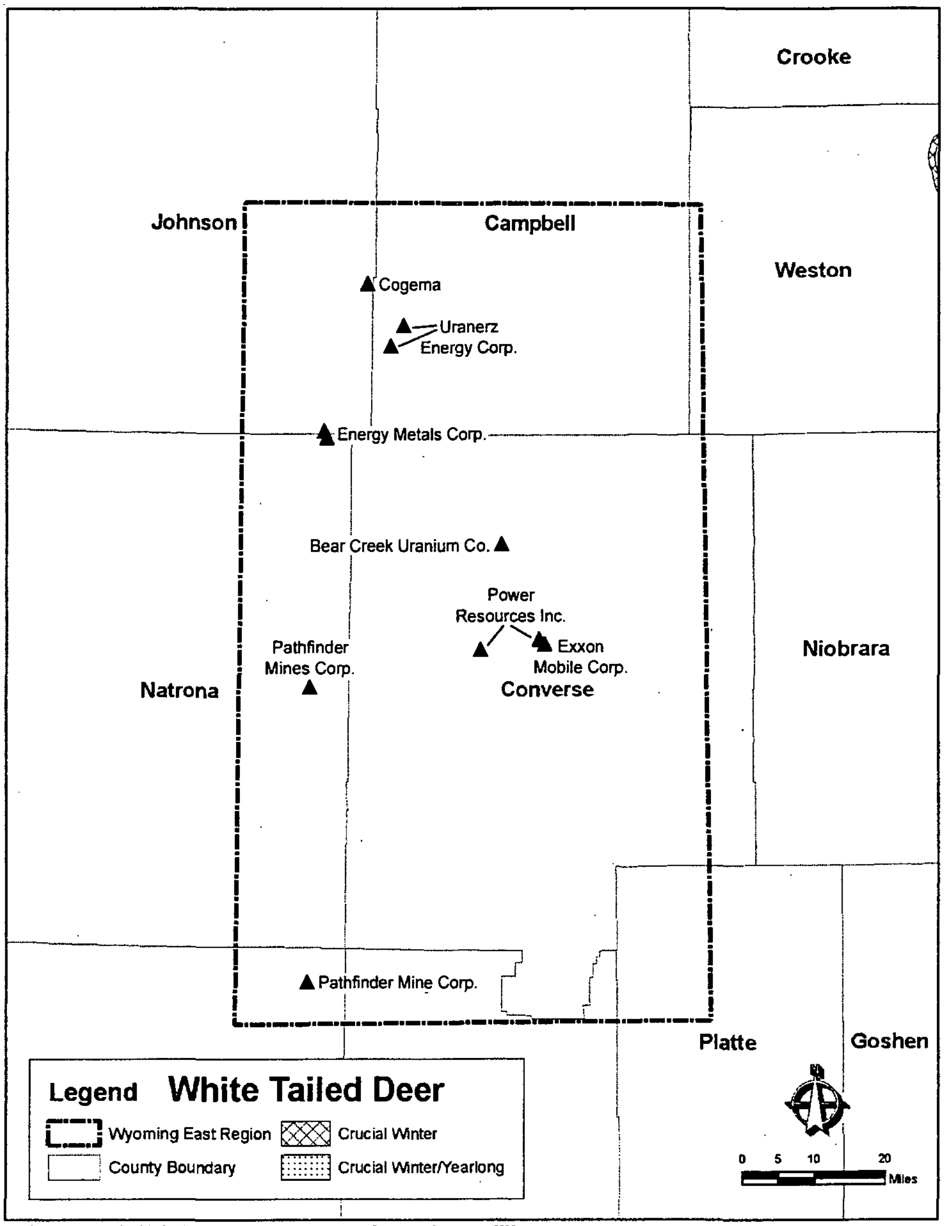



**Figure 3.3-13. Sage-Grouse/Leks Nesting Areas for the Wyoming East Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.3-14. White Tailed Deer Wintering Area for the Wyoming East Uranium Milling Region**

intense grazing, road density, and poorly engineered stream crossings. Native fish within these watersheds include the big mouth shiner, brassy minnow (*Hybognathus hankinsoni*), common shiner (*Notropis cornutus*), creek chub, fathead minnow, longnose dace, sand shiner, stoneroller, longnose sucker, white sucker, and the plains killifish. Sports fish in the watershed include rainbow trout, cutthroat trout, brook trout, and green sunfish (*Lepomis cyanellus*) (Wyoming Game and Fish Department, 2007a,b).

### 3.3.5.3 Threatened and Endangered Species

A number of federally listed threatened and endangered species that are known to exist within habitats found with in the region have been discussed previously for the Wyoming West Uranium Milling Region in Section 3.2.5.3.

- Black Footed Ferret—discussed in Section 3.2.5.3
- Blowout Penstemon—discussed in Section 3.2.5.3
- Bonytail Chub—discussed in Section 3.2.5.3
- Canada Lynx—discussed in Section 3.2.5.3
- Colorado Butterfly Plant (*Gaura neomexicana* ssp. *Coloradensis*)—The Colorado butterfly plant typically occurs on subirrigated, stream deposited soils on level floodplains and drainage bottoms. Subpopulations are often found in low depressions or along bends in wide, active, meandering stream channels just a short distance upslope of the active channel. The plant occurs on soils derived from conglomerates, sandstones and tufaceous mudstones and siltstones of the Tertiary White River, Arikaree, and Ogalalla Formations. Average annual precipitation within its range is 33–41 cm [13–16 in] primarily in the form of rainfall. The Colorado butterfly plant requires early- to mid-succession riparian habitat experiencing periodic disturbance. It commonly occurs in communities including redtop and Kentucky bluegrass (*Poa pratensis*) on wetter sites, or wild licorice (*Aralia nudicaulis*), Flodmans's thistle (*Cirsium flodmanii*), curlytop gumweed (*Grindelia squarrosa*), and smooth scouring rush (*Equisetum laevigatum*) on drier sites (U.S. Fish and Wildlife Service, 2008).
- Colorado Pikeminnow—discussed in Section 3.2.5.3.
- Humpback Chub—discussed in Section 3.2.5.3.
- Interior Least Tern—discussed in Section 3.2.5.3.
- Pallid Sturgeon—discussed in Section 3.2.5.3.
- Piping Plover—discussed in Section 3.2.5.3.
- Preble's Meadow Jumping Mouse—discussed in Section 3.2.5.3.
- Razor Sucker—discussed in Section 3.2.5.3.
- Ute Ladies's Tresses—discussed in Section 3.2.5.3.

- Western Prairie Fringed Orchid—discussed in Section 3.2.5.3.
- Whooping Crane—discussed in Section 3.2.5.3.
- Wyoming Toad (*Bufo baxteri*)—This toad is a glacial relict found only in Albany County, Wyoming. It formerly inhabited flood plains, ponds, and small seepage lakes in the shortgrass communities of the Laramie Basin. The diet of this species includes ants, beetles, and a variety of other arthropods. Adults emerge from hibernation in May or June, after daytime maximum temperatures reach 21 °C [70 °F] (U.S. Fish and Wildlife Service, 2008).
- Yellow Billed Cuckoo—(candidate) discussed in Wyoming West Uranium Milling Region

Wyoming Species of Concern are described as Wyoming Native Species Status Matrix 1 (populations are greatly restricted or declining—extirpation appears possible) and 2 (populations are declining or restricted in numbers and/or distribution–extirpation is not imminent). Wyoming state species of concern may be found in the Wyoming East Uranium Milling Region include the following:

- Kendall Warm Spring Dace (*Rhinichthys osculus thermalis*), Native Species Status 1—It resides solely in a warm spring tributary to the Green River within the Bridger-Teton National Forest. Kendall warm springs dace are found well distributed throughout all but the upper portion of the 300-m [984-ft]-long spring creek. Kendall Warm Springs has a near constant temperature of 29 °C [85 °F]. Habitat consists of moderate to fast riffles, several man-made pools less than 1 m [3 ft] deep and shallower boggy areas. Adults are seen in the main current and pools while juveniles are seen in vegetated lateral habitats (Wyoming Game and Fish Department, 2008).
- Bluehead Sucker (*Catostomus discobolus*) Native Species Status 1—Bluehead suckers are usually found in the main current of streams, although their streamlined bodies form a narrow caudal peduncle, which indicates adaptation to living in the strong currents of larger rivers. Bluehead suckers prefer turbid to muddy streams with often high alkalinity and are rarely found in clear water (Wyoming Game and Fish Department, 2008).
- Black Footed Ferret (*Mustela nigripes*), Native Species Status 1—The black-footed ferret is found almost exclusively in prairie dog colonies in basin-prairie shrublands, sagebrush-grasslands, and grasslands. It is dependent on prairiedogs for food and all essential aspects of its habitat, especially prairie dog burrows where it spends most of its life underground (Wyoming Game and Fish Department, 2008).
- Bonneville Cutthroat (*Oncorhynchus clarki utah*), Native Species Status 2—Cutthroat trout prefer gravel-bottomed creeks and small rivers as well as lakes. The Bonneville cutthroat trout is well known for its ability to survive in harsh and often degraded (by man) habitats. In Wyoming, the Bonneville cutthroat is found in the Smith Fork and Thomas Fork drainages of the Bear River system. It is also native to some drainages in Idaho, Utah and Nevada with the bulk of its historic range within Utah (Wyoming Game and Fish Department, 2008).

- Western Silvery Minnow (*Hybognathus argyritis*), Native Species Status 2—This minnow prefers large to medium sized rivers with sluggish flow and silted bottoms. It is typically found in shallow backwaters and slow pools with sand or gravel substrates. It is more abundant in clear water and show intolerance for turbidity and pollution. Western silvery minnows occur in the Belle Fourche, Little Powder, and Little Missouri Rivers. It is believed to persist in the Powder River but recent surveys did not find them. They are believed extirpated from the Big Horn River. The western silvery minnow is associated with the more common plains minnow (Wyoming Game and Fish Department, 2008).

- Swift Fox (*Vulpes velox*), Native Species Status 4—The Swift fox historically inhabited Montana and the Dakotas through the Great Plains states to northwestern Texas and eastern New Mexico. In Wyoming, it occurs primarily east of the Continental Divide and is considered common in Wyoming. Its habitat consists of shortgrass and mixed grass prairies, although it often uses highway and railroad right-of-ways, agricultural areas, and sagebrush-grasslands. Closely associated with prairie dog colonies, the swift fox uses underground dens year round. It selects habitat with low growing vegetation, relatively flat terrain, friable soils, and high den availability. Although expected to be stable, Wyoming classifies it as Native Species Status 4 because habitat is vulnerable though there is no ongoing significant loss of habitat (Wyoming Game and Fish Department, 2008).

- Plains Topminnow (*Fundulus sciadicus*), Native Species Status 2—The plains topminnow is considered to be of special concern in Minnesota, Missouri, Kansas, Nebraska, and Colorado. In Wyoming plains topminnows are considered rare and their distribution appears to be declining. The plains topminnow occupies habitats that are impacted by natural and anthropogenic dewatering. Introductions of western mosquito fish have been implicated in the current restricted distribution of plains topminnow in Nebraska (Wyoming Game and Fish Department, 2008).

- Great Basin Gopher Snake—discussed in Section 3.2.5.3.

- Canada Lynx—discussed in Section 3.2.5.3.

- Pale Milk Snake Native Species Status 2—discussed in Section 3.2.5.3.

- Smooth Green Snake—discussed in Section 3.2.5.3.

- Yellow-Billed Cuckoo—discussed in Section 3.2.5.3.

- Greater Sage-Grouse—discussed in Section 3.2.5.3.

- Bald Eagle—discussed in Section 3.2.5.3.

- Trumpeter Swan—discussed in Section 3.2.5.3.

- Fringed Myotis—discussed in Section 3.2.5.3.

- Long-Legged Myotis—discussed in Section 3.2.5.3.

- Pallid Bat—discussed in Section 3.2.5.3.
- Spotted Bat—discussed in Section 3.2.5.3.

## 3.3.6 Meteorology, Climatology, and Air Quality

### 3.3.6.1 Meteorology and Climatology

Wyoming's elevation results in relatively cool temperatures. Much of the temperature variations within the state can be attributed to elevation with average values dropping 1 to 2 °C [1.8 to 3.6 °F] per 300 m [1,000 ft] (National Climatic Data Center, 2005]. Summer nights are normally cool although daytime temperatures may be quite high. The fall, winter, and spring can experience rapid changes with frequent variations from cold to mild periods. Freezes in early fall and late spring are typical and result in long winters and a short growing season. In the mountains and high valleys, freezes can occur any time in the summer. During winter warm spells, nighttime temperatures can remain above freezing. Valleys protected from the wind by mountain ranges can provide ideal pockets for cold air to settle and temperatures in the valley can be considerably lower that on nearby mountainsides. Tables 3.3-5 and 3.3-6 provide information on two climate stations located in the Wyoming East Uranium Milling Region.

Precipitation within Wyoming varies, with spring and early summer being the wettest time for much of the state. Mountain ranges are generally oriented in a north-south direction. This is perpendicular to the prevailing westerlies. Therefore, these mountains often act as moisture barriers. Air currents for the Pacific Ocean rise and drop much of their moisture along the

**Table 3.3-5. Information on Two Climate Stations in the Wyoming East Uranium Milling Region***

| Station (Map Number) | County | State | Longitude | Latitude |
|---|---|---|---|---|
| Glenrock 5 ESE (044) | Converse | Wyoming | 105°47W | 42°50N |
| Midwest (062) | Natrona | Wyoming | 106°17W | 43°25N |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

**Table 3.3-6. Climate Data for Stations in the Wyoming East Uranium Milling Region***

| | | Glenrock 5 ESE | Midwest |
|---|---|---|---|
| Temperature (°C)† | Mean—Annual | 8.8 | 7.5 |
| | Low—Monthly Mean | −3.1 | −5.7 |
| | High—Monthly Mean | 22.4 | 21.5 |
| Precipitation (cm)‡ | Mean—Annual | 31.0 | 35.0 |
| | Low—Monthly Mean | 0.90 | 1.4 |
| | | **Glenrock 5 ESE** | **Midwest** |
| | High—Monthly Mean | 6.1 | 6.5 |
| Snowfall (cm) | Mean—Annual | 58.4 | 135 |
| | Low—Monthly Mean | 0 | 0 |
| | High—Monthly Mean | 13.5 | 22.6 |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

western slopes of the mountains. Summer showers are frequent, but typically result in rainfall amounts of a few hundredths of an inch. Usually several times a year in the state, local thunderstorms will result in 2.5 to 5 cm [1 to 2 in] of rain in a 24-hour period. On rare occasions, rainfall in a 24-hour period can reach 7.5 to 12.5 cm [3 to 5 in] (National Climatic Data Center, 2005). Heavy rains can create flash flooding in headwater streams, and this flooding intensifies if these storms coincide with snowpack melting. Table 3.3-6 contains precipitation data for two stations in the Wyoming East Uranium Milling Region. The wettest month for both stations identified in Table 3.3-6 is May, which based on the snow depth data, coincides with snowpack melting (National Climatic Data Center, 2004). One of the stations is in Converse County and the other is in Natrona County. Data from the National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the vast majority of thunderstorms in Converse and Natrona Counties occurs between June and August with the most occurring in June (National Climatic Data Center, 2007).

Hailstorms are the most destructive storm event for Wyoming. Most hailstorms pass over open rangeland with minimal impact. When a hailstorm passes over a city or farmland, the property and crop damage can be severe. Most of the severe hailstorms occur in the southeast corner of the state.

Low elevations typically experience light to moderate snowfall from November to May. Snowfall within Wyoming varies by location with the mountain ranges typically receiving the most. Significant storms of 25 to 40 cm [10 to 16 in] of snowfall are infrequent outside of the mountains. Wind often coincides or follows snowstorms and can form snow drifts several meters [feet] deep. Snow can accumulate to considerable depths in the high mountains. Blizzards that last more than 2 days are uncommon. Table 3.3-6 contains snowfall data for two stations in the Wyoming East Uranium Milling Region.

Wyoming is windy and ranks first in the United States with an annual average speed of 6 m/s [12.9 mph]. During winter, Wyoming frequently experiences periods where wind speed reaches 13 to 18 m/s [30 to 40 mph] with gusts to 22 to 27 m/s [50 or 60 mph] (National Climatic Data Center, 2005). Prevailing wind direction varies by location but usually ranges from west-southwest through west to northwest. Because the wind is normally strong and constant from those directions, trees often lean to the east or southeast.

The pan evaporation rates for the Wyoming East Uranium Milling Region range from about 102 to 127 cm [40 to 50 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data is typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

### 3.3.6.2 Air Quality

The air quality general description for the Wyoming East Uranium Milling Region is similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region.

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. Except for Indian Country, New Source

Review permits in Wyoming are regulated under the EPA-approved State Implementation Plan. For Indian Country in Wyoming, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas are in Wyoming. States may develop standards that are stricter or supplement the NAAQS. Wyoming has a more restrictive annual average standard for sulfur dioxide at 60 $\mu g/m^3$ [$1.6 \times 10^{-6}$ $oz/yd^3$] and a supplemental 50 $\mu g/m^3$ [$1.3 \times 10^{-6}$ $oz/yd^3$] $PM_{10}$ standard with an annual averaging time (WDEQ, 2006).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas, and Class I areas have the most stringent requirements.

The Wyoming East Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and PSD classifications in the region.

All of the area within the Wyoming East Uranium Milling Region is classified as attainment for NAAQS. Figure 3.3-15 identifies counties in Wyoming and surrounding areas that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). All of the area within the Wyoming East Uranium Milling Region is classified as attainment. In fact, Wyoming only has one area that is not in attainment. The city of Sheridan in Sheridan County is designated as nonattainment for $PM_{10}$. Portions of several Colorado counties along the southern Wyoming border are classified as not in attainment. However, the southern boundary of the Wyoming East Uranium Milling Region is north of the Wyoming/Colorado border.

Table 3.3-7 identifies the Prevention of Significant Deterioration Class I areas in Wyoming. These areas are shown in Figure 3.3-16. There are no Class I areas in the Wyoming East Uranium Milling Region (40 CFR Part 81).

### 3.3.7 Noise

The existing ambient noise levels in the undeveloped rural and more urban areas of the Wyoming East Uranium Milling Region would be 22 to 38 dB, similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region. The largest community is Casper, the second largest city in Wyoming, with a population near 50,000. Smaller communities include Glenrock and Douglas, with populations between 2,000 and about 6,000 (see Section 3.3.10). Ambient noise levels in these communities would be expected to be similar to other urban areas (up to 78 dB) (Washington State Department of Transportation, 2006).

As described in Section 3.3.2, major highways in the region include Interstate 25 and U.S. Highways 20, 26, 18, and 87. Sections of these highways are multilane, limited access freeways, and traffic is highest to the east (about 7,200 vehicles per day) and north (about 5,300 vehicles per day) of Casper on Interstate 25 (Wyoming Department of Transportation,

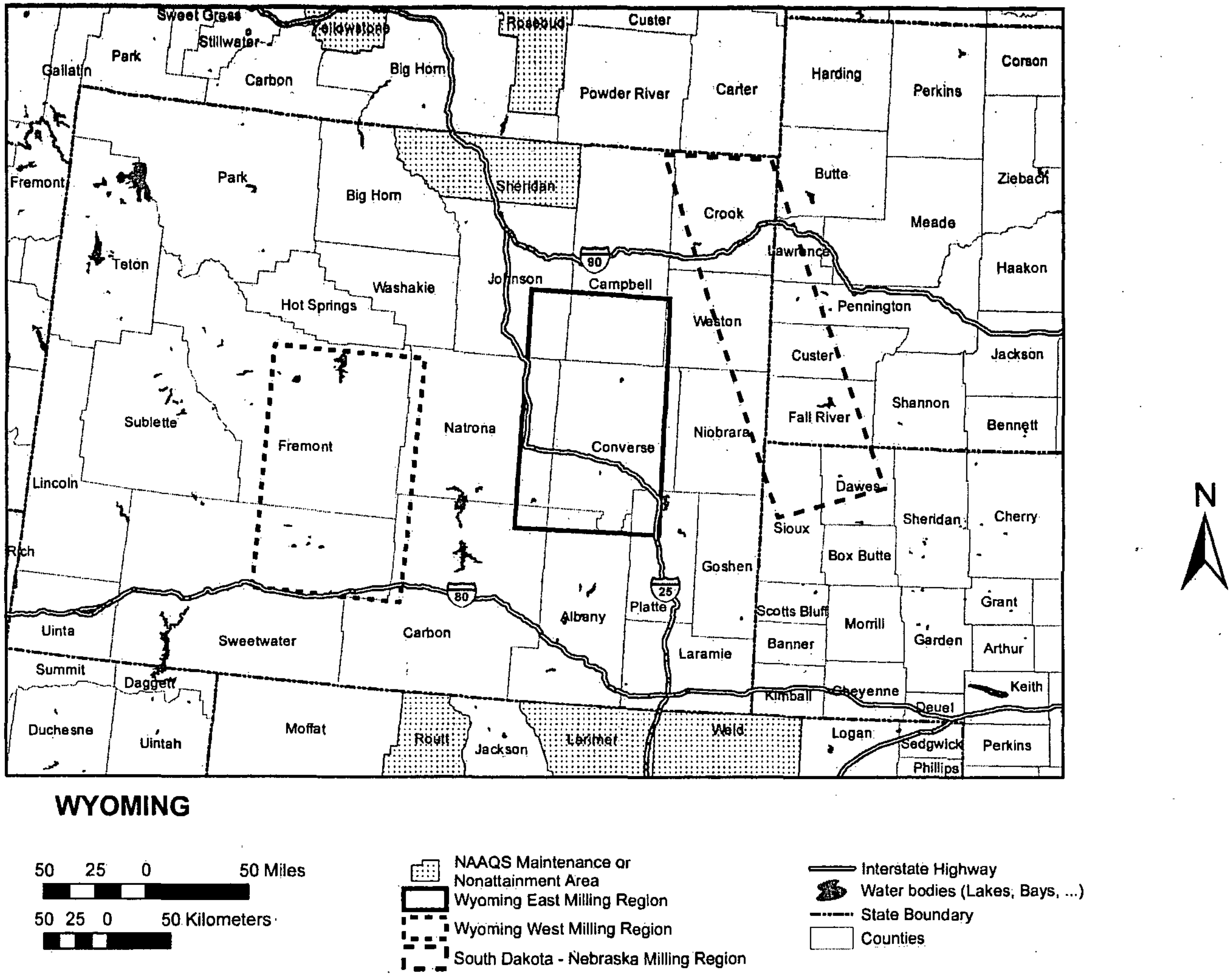



**Figure 3.3-15. Air Quality Attainment Status for Wyoming and Surrounding Areas (EPA, 2007a)**

| Table 3.3-7. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in Wyoming* |
|---|
| Bridger Wilderness |
| Fitzpatrick Wilderness |
| Grand Teton National Park |
| North Absaroka Wilderness |
| Teton Wilderness |
| Washakie Wilderness |
| Yellowstone National Park |
| *Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40, Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005. |

2005). Passenger cars make up about 75 percent of the traffic count on Interstate 25, indicating that ambient noise levels would likely be less than those measured at up to 70 dBA along Interstate 80 where traffic count and heavy truck traffic is higher (Federal Highway Administration, 2004; see also Section 3.2.7).

The current ISL uranium facilities (Smith Ranch-Highland and Reynolds Ranch) and those that are anticipated for the Wyoming East Uranium Milling Region are located at least 16 km [10 mi] from the larger communities in the region. For the three uranium districts in the Wyoming East Uranium Milling Region, most of the ambient noise levels would therefore be anticipated to be similar to rural, undeveloped areas. As in the Wyoming West Uranium Milling Region, a number of small communities are located along the highways and roads that run through the region. For example, Linch, Savageton, and Sussex are located in the Pumpkin Buttes Uranium District in the northwest corner of the region. In the central uranium district, the closest small communities include Orpha and Bill, and Shirley Basin is located in the uranium district in the southeast corner of the region. Noise levels in these areas would be anticipated to be higher than the undeveloped areas (22 to 38 dB), but less than the larger urban areas like Casper and Douglas.

## 3.3.8 Historical and Cultural Resources

### 3.3.8.1 Cultural Resources Overview

A general overview of historical and cultural resources for the Wyoming East Uranium Milling Region is provided in Section 3.2.8.1. As described in Section 3.2.8.1, the Wyoming SHPO administers and is responsible for oversight and compliance with the NRHP, compliance and review for Section 106 of the NHPA traditional cultural properties review, enforcement of NAGPRA, and compliance with other federal and state historic preservation laws, regulations, and statutes.

### 3.3.8.2 National Register of Historic Properties and State Registers

Table 3.3-8 includes a summary of the historic properties in the Wyoming East Uranium Milling Region that are listed on the Wyoming state and/or the NRHP. Many of the sites are located in Casper, Glenrock, and Douglas, at least 16 km [10 mi] from potential and existing uranium ISL facilities. Several sites near Sussex in Johnson County are located near the uranium district in the northwest corner of the Wyoming East Uranium Milling Region.

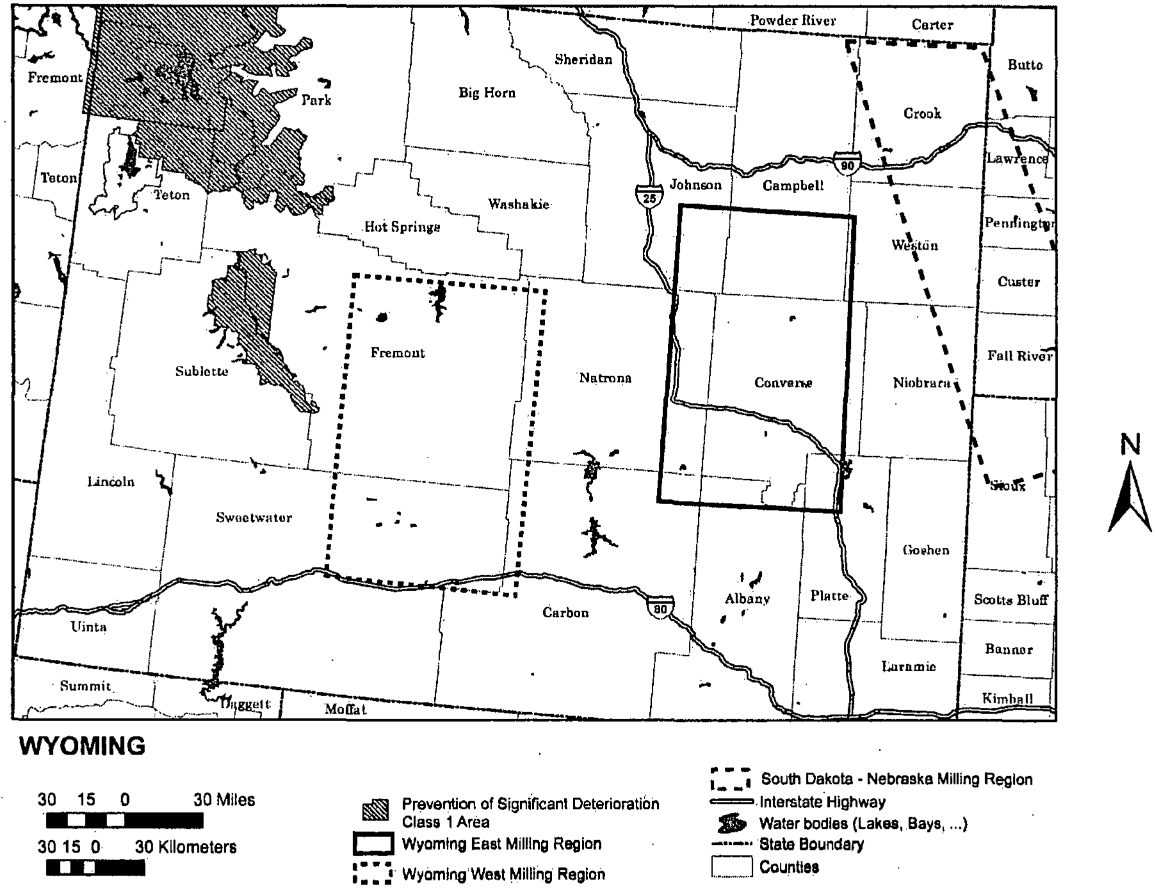



**Figure 3.3-16. Prevention of Significant Deterioration Class I Areas in the Wyoming East Uranium Milling Region and Surrounding Areas (40 CFR Part 81)**

| Table 3.3-8. National Register Listed Properties in Counties Included in the Wyoming East Uranium Milling Region | | | |
|---|---|---|---|
| **County** | **Resource Name** | **City** | **Date Listed YYYY-MM-DD** |
| Campbell | Basin Oil Field Tipi Rings (48CA1667) | Piney | 1985-12-13 |
| Campbell | Bishop Road Site (48CA1612) | Piney | 1985-12-13 |
| Campbell | Nine Mile Segment, Bozeman Trail (48CA264) | Pine Tree Junction | 1989-07-23 |
| Converse | Antelope Creek Crossing (48CO171 and 48CO165) | City Unavailable | 1989-07-23 |
| Converse | Braehead Ranch | Douglas | 1995-09-07 |
| Converse | Christ Episcopal Church and Rectory | Douglas | 1980-11-17 |
| Converse | College Inn Bar | Douglas | 1979-07-10 |
| Converse | Commerce Block | Glenrock | 2005-01-21 |
| Converse | *Douglas City Hall* | Douglas | 1994-03-17 |
| Converse | Fort Fetterman | Orpha | 1969-04-16 |
| Converse | Fremont, Elkhorn & Missouri Valley Railroad Passenger Depot | Douglas | 1994-08-03 |
| Converse | Glenrock Buffalo Jump | Glenrock | 1969-04-16 |
| Converse | Holdup Hollow Segment, Bozeman Trail (48CO165) | City Unavailable | 1989-07-23 |
| Converse | Hotel Higgins | Glenrock | 1983-11-25 |
| Converse | Jenne Block | Douglas | 1998-01-06 |
| Converse | La Prele Work Center | Douglas | 1994-04-11 |
| Converse | Morton Mansion | Douglas | 2001-01-11 |
| Converse | North Douglas Historic District | Douglas | 2002-11-25 |
| Converse | Officer's Club, Douglas Prisoner of War | Douglas | 2001-09-08 |
| Converse | Ross Flat Segment, Bozeman Trail (48C0165) | City Unavailable | 1989-07-23 |
| Converse | Sage Creek Station (48CO104) | Glenrock | 1989-07-23 |
| Converse | Stinking Water Gulch Segment, Bozeman Trail (48CO165) | City Unavailable | 1989-07-23 |
| Converse | U.S. Post Office—Douglas Main | Douglas | 1987-05-19 |
| Johnson | AJX Bridge over South Fork and Powder Rivers | Kaycee | 1985-02-22 |
| Johnson | Cantonment Reno | Sussex | 1977-07-29 |
| Johnson | Dull Knife Battlefield | Barnum | 1979-08-15 |
| Johnson | EDZ Irigaray Bridge | Sussex | 1985-02-22 |
| Johnson | Fort Reno | Sussex | 1970-04-28 |
| Johnson | Lake Desmet Segment, Bozeman Trail | City Unavailable | 1989-07-23 |
| Johnson | Powder River Station—Powder River Crossing (48JO134 and 48JO801) | Sussex | 1989-07-23 |
| Johnson | Sussex Post Office and Store | Kaycee | 1998-11-12 |
| Natrona | Archaeological Site No. 48NA83 | Arminto | 1994-05-13 |
| Natrona | Big Horn Hotel | Arminto | 1978-12-18 |
| Natrona | Bishop House | Casper | 2001-03-12 |
| Natrona | Bridger Immigrant Road—Waltman Crossing | Casper | 1975-01-17 |
| Natrona | Casper Army Air Base | Casper | 2001-08-03 |
| Natrona | Casper Buffalo Trap | Casper | 1974-06-25 |
| Natrona | Casper Federal Building | Casper | 1998-12-21 |
| Natrona | Casper Fire Department Station No. 1 | Casper | 1993-11-04 |
| Natrona | Casper Motor Company—Natrona Motor Company | Casper | 1994-02-23 |
| Natrona | Church of Saint Anthony | Casper | 1997-01-30 |
| Natrona | Consolidated Royalty Building | Casper | 1993-11-04 |
| Natrona | DUX Bessemer Bend Bridge | Bessemer Bend | 1985-02-22 |
| Natrona | Elks Lodge No. 1353 | Casper | 1997-01-30 |

| Table 3.3-8. National Register Listed Properties in Counties Included in the Wyoming East Uranium Milling Region (continued) | | | |
|---|---|---|---|
| County | Resource Name | City | Date Listed YYYY-MM-DD |
| Natrona | Fort Casper | Casper | 1971-08-12 |
| Natrona | Fort Casper (Boundary Increase) | Casper | 1976-07-19 |
| Natrona | Independence Rock | Casper | 1966-10-15 |
| Natrona | Martin's Cove | Casper | 1977-03-08 |
| Natrona | Masonic Temple | Casper | 2005-08-24 |
| Natrona | Midwest Oil Company Hotel | Casper | 1983-11-17 |
| Natrona | Natrona County High School | Casper | 1994-01-07 |
| Natrona | North Casper Clubhouse | Casper | 1994-02-18 |
| Natrona | Ohio Oil Company Building | Casper | 2001-07-25 |
| Natrona | Pathfinder Dam | Casper | 1971-08-12 |
| Natrona | Rialto Theater | Casper | 1993-02-11 |
| Natrona | Roosevelt School | Casper | 1997-01-30 |
| Natrona | South Wolcott Street Historic District | Casper | 1988-11-23 |
| Natrona | Split Rock, Twin Peaks | Muddy Gap | 1976-12-22 |
| Natrona | Stone Ranch Stage Station | Casper | 1982-11-01 |
| Natrona | Teapot Rock | Midwest | 1974-12-30 |
| Natrona | Townsend Hotel | Casper | 1983-11-25 |
| Natrona | Tribune Building | Casper | 1994-02-18 |

### 3.3.8.3 Tribal Consultation

Section 3.2.8.3 includes a discussion on Native American tribes located within or immediately adjacent to the state of Wyoming that have interests in the state, including

- Arapaho Tribe of the Wind River Reservation
- Shoshone Tribe of the Wind River Reservation
- Northern Cheyenne Tribe of Montana
- Cheyenne River Sioux
- Flandreau Santee Sioux
- Lower Brulé Sioux
- Oglala Sioux
- Rosebud Sioux
- Sisseton-Whapeton Oyate
- Standing Rock Sioux
- Yankton Sioux
- Crow Tribe of Montana

The Siouan tribes are located throughout South and North Dakota, and the Crow and Northern Cheyenne are located in Montana and have interests in Wyoming. Other Siouan-speaking tribes, as well as other tribes in North Dakota, Wyoming, Montana, and Nebraska may have traditional land use claims in the Wyoming East Uranium Milling Region.

### 3.3.8.4 Places of Cultural Significance

Section 3.2.8.4 includes a more detailed discussion of culturally significant places and traditional cultural properties in Central and Eastern Wyoming. As described in Section 3.2.8, there are no culturally significant places listed in either the NRHP or state registers in the Wyoming East

Uranium Milling Region. However, the Lakota Sioux or other Sioux bands (Cheyenne River Sioux, Lower Brulé Sioux, Oglala Sioux, Rosebud Sioux) along with the Northern Cheyenne, Crow Tribe, the Arapaho, the Kiowa, and Wind River Shoshone who once occupied or may have utilized portions of the Wyoming East Uranium Milling Region consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant. These were once used for personal rituals and the Sun Dance and are the source of origin legends among many of these tribes.

Areas of central and eastern Wyoming once used by these tribes may contain additional, hitherto undocumented or undisclosed culturally significant sites and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

Traditional cultural properties are those that refer to beliefs, customs, and practices of a living community that have been passed down over the generations. Native American traditional cultural properties are often not found on the state or national registers of historic properties or described in the extant literature or in SHPO files. There are, however, a range of cultural property types of religious or traditional use that might be identified during the tribal consultation process. These might include

- Sites of ritual and ceremonial activities and related features
- Shrines
- Marked and unmarked burial grounds
- Traditional use areas
- Plant and mineral gathering areas
- Traditional hunting areas
- Caves and rock shelters
- Springs
- Trails
- Prehistoric archaeological sites

### 3.3.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook (BLM, 2007a–c), the uranium districts in the Wyoming East Uranium Milling Region are located at the junction of the Northern and Southern Rocky Mountain, Wyoming Basin, and Great Basin physiographic provinces (Bennett, 2003). The BLM resource management plans covering this region include the Casper (BLM, 2007d), Buffalo (BLM, 2001), Rawlins (BLM, 2008b), and Newcastle (BLM, 2000) field offices (see the BLM Wyoming website at http://www.blm.gov/wy/st/en.html). The VRM classifications assigned within these resource plans are presented in Figure 3.3-17.

The bulk of the Wyoming East Uranium Milling Region is categorized as VRM Class III (along highways) and Class IV (open grassland, oil and natural gas, urban areas). The landscape has been extensively modified in urban areas and in several areas of oil, natural gas, and coal production, such as Natrona and Converse Counties near Casper and Douglas (Bennett, 2003; BLM, 2007d) and Johnson and Campbell Counties near Gillette (BLM, 2001). As a result, these areas are predominantly classified as VRM Class IV or as Class V/Rehabilitation. The BLM resource management plans do not identify any VRM Class I resources that fall within the

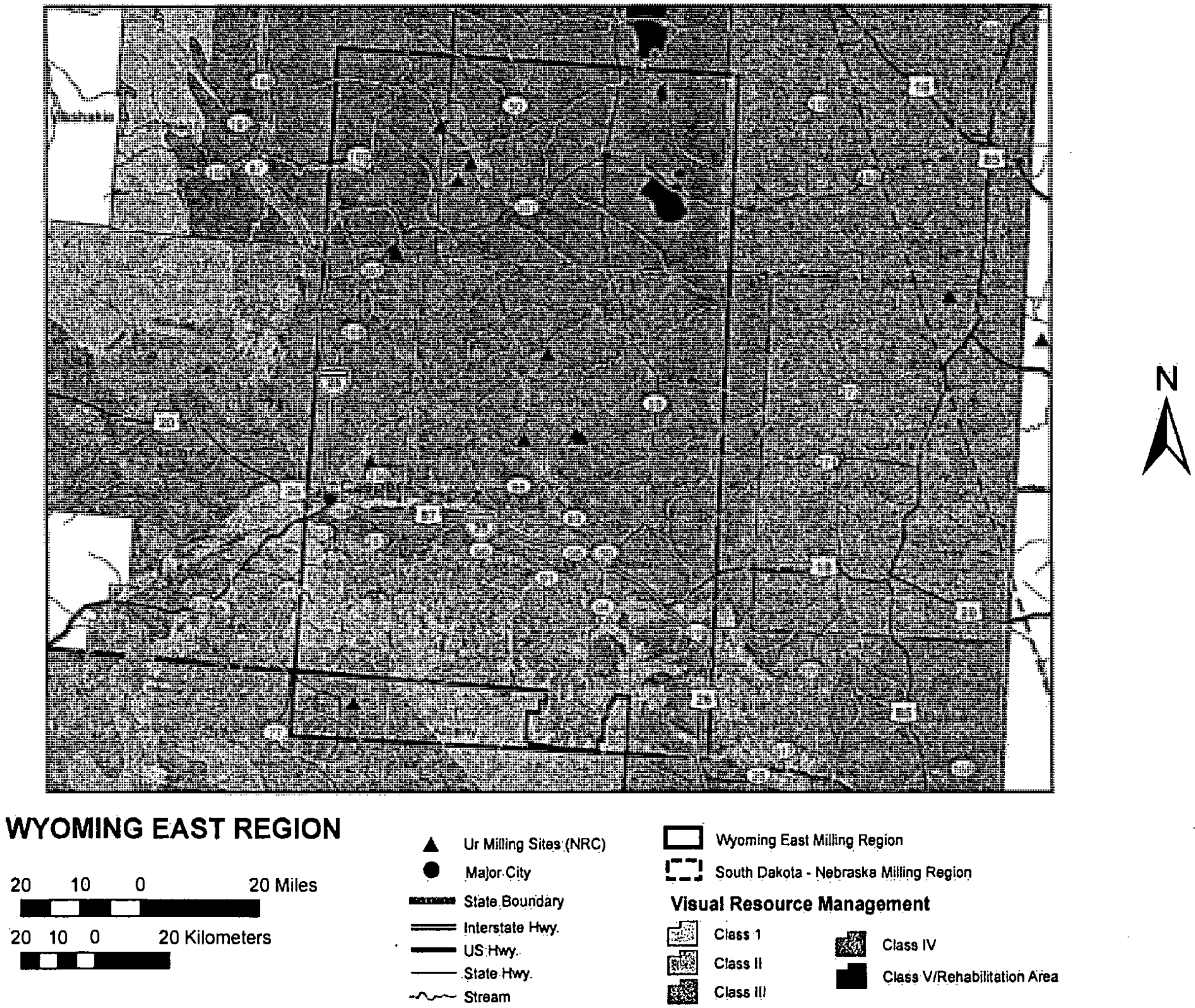



**Figure 3.3-17. BLM Visual Resource Classifications for the Wyoming East Uranium Milling Region (BLM, 2008b, 2007d, 2001, 2000)**

Wyoming East Uranium Milling Region. VRM Class II areas are generally identified south of Interstate 25 in the region, ranging from the Laramie Mountains in the southwestern portion of the region to the North Platte River and its tributaries across the southern part of the region (BLM, 2007d, 1992). Additional areas of potentially sensitive visual resources include the Bozeman, Oregon, and Bridger Historic Trails that cross the southern part of the region, traveling east to west roughly parallel to the North Platte River (Bennett, 2003; BLM, 2007d, 1992) on the north side of the Laramie Mountains. All of the current and potential ISL facilities identified in the three uranium districts in the Wyoming East Uranium Milling Region are located within Class III through Class V/Rehabilitation VRM areas (Figure 3.3-17). There are no Prevention of Significant Deterioration Class I or Wyoming Unique/Irreplaceable or Rare/Uncommon designated areas within the Wyoming East Uranium Milling Region (Girardin, 2006).

### 3.3.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Wyoming East Uranium Milling Region includes communities within the region of influence for potential ISL facilities in the three uranium districts in the region. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined in the GEIS by (1) proximity to an ISL facility {generally within 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment within the Wyoming East Uranium Milling Region consists of counties and CBSAs. A CBSAs, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000 (U.S. Census Bureau, 2008). The major political divisions of the affected environment are listed in Table 3.3-9. The following subsections describe areas most likely to have implications to socioeconomics and are listed below. In some subsections Metropolitan Areas are also discussed. A Metropolitan Area is greater than 50,000 and a town is considered less than 10,000 in population (U.S. Census

**Table 3.3-9. Summary of Affected Environment Within the Wyoming East Uranium Milling Region**

| Counties Within Wyoming East | Core-Based Statistical Areas Within Wyoming East |
|---|---|
| Albany | Casper |
| Campbell | |
| Carbon | |
| Converse | |
| Johnson | |
| Natrona | |
| Niobrara | |
| Platte | |
| Weston | |

Bureau, 2008). Smaller communities such as Bill and Linch are considered as part of the county demographics.

### 3.3.10.1 Demographics

Demographics are based on 2000 U.S. Census data population and racial characteristics of the affected environment (Table 3.3-10). (Figure 3.3-18 illustrates the populations of communities within the Wyoming East Uranium Milling Region.) Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic area of interest.

The most populated county in the Wyoming East Uranium Milling Region is Natrona County, and the most sparsely populated county is Niobrara County. The county with the largest percentage of nonminorities is Niobrara County with a white population of 98.0 percent. The largest minority based county is Carbon County with a white population of 90.1 percent or a minority-based population of 9.9 percent. The CBSAs of Casper is demographically similar to the counties within the Wyoming East Uranium Milling Region.

### 3.3.10.2 *Income*

Income information from the 2000 U.S. Census including labor force, income, and poverty levels for the affected environment is based on data collected from state and county levels. Data collected at the state level also include information on towns, CBSA, or Metropolitan Areas and considers an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if local workforce is unavailable or unspecialized). In Wyoming, the workforce frequently commutes long distances to work. For example, in the Wyoming East Uranium Milling Region, most of the affected counties experienced net inflows of workers during the fourth quarter of 2005. Net inflows ranged from about 160 for Johnson County to about 7,500 for Campbell County. These inflows were predominately for jobs related to the energy industry in the Powder River Basin (Wyoming Workforce Development Council, 2007). Converse (-1,063) and Platte (-228) Counties experienced net outflows during the same period. Data collected at the county level are generally the same as for the affected environment presented in Table 3.3-9. State-level information for the surrounding region is provided in Table 3.3-11, and county data are listed in Table 3.3-12.

For the surrounding region, the state with both the largest labor force population and families and individuals living below poverty level is Colorado. The largest labor force population is Billings, Montana {128 km [80 mi] from the nearest potential ISL facility in the region}, and the smallest labor force population is Laramie, Wyoming {96 km [60 mi] from the nearest potential ISL facility}. The population with the highest per capita income is Fort Collins, Colorado {240 km [150 mi] from the nearest potential ISL facility}, and the lowest per capita income population is Laramie, Wyoming. The population with the highest percentage of individuals and families below poverty levels is Laramie, Wyoming (Table 3.3-11).

The county with the largest labor force is Natrona County, and the smallest labor force is located in Niobrara County. The county with the highest per capita income is Campbell County, and the smallest per capita income at the county level is Niobrara County. The county with the highest percentage of individuals and families living below the poverty level is Albany County (Table 3.3-12).

**Table 3.3-10. 2000 U.S. Bureau of Census Population and Race Categories of the Wyoming East Uranium Milling Region***

| Affected Environment | Total Population | White | African American | Native American | Some Other Race | Two or More Races | Asian | Hispanic Origin† | Native Hawaiian and Other Pacific Islander |
|---|---|---|---|---|---|---|---|---|---|
| Wyoming | 493,782 | 454,670 | 3,722 | 11,133 | 12,301 | 8,883 | 2,771 | 31,669 | 302 |
| *Percent of total* | | 92.1% | 0.8% | 2.3% | 2.5% | 1.8% | 0.6% | 6.4% | 0.1% |
| Albany County | 32,014 | 29,235 | 354 | 18 | 847 | 710 | 545 | 2,397 | 18 |
| *Percent of total* | | 91.3% | 1.1% | 0.1% | 2.6% | 2.2% | 1.7% | 7.5% | 0.1% |
| Campbell County | 33,698 | 32,369 | 51 | 313 | 378 | 450 | 108 | 1,191 | 29 |
| *Percent of total* | | 96.1% | 0.2% | 0.9% | 1.1% | 1.3% | 0.3% | 3.5% | 0.1% |
| Carbon County | 15,639 | 14,092 | 105 | 9 | 808 | 321 | 105 | 2,163 | 9 |
| *Percent of total* | | 90.1% | 0.7% | 0.1% | 5.2% | 2.1% | 0.7% | 13.8% | 0.1% |
| Converse County | 12,052 | 11,416 | 18 | 110 | 296 | 177 | 32 | 660 | 3 |
| *Percent of total* | | 94.7% | 0.1% | 0.9% | 2.5% | 1.5% | 0.3% | 5.5% | 0.0% |
| Johnson County | 7,075 | 6,865 | 6 | 45 | 39 | 112 | 8 | 148 | 0 |
| *Percent of total* | | 97.0% | 0.1% | 0.6% | 0.6% | 1.6% | 0.1% | 2.1% | 0.0% |
| Natrona County | 66,533 | 62,644 | 505 | 686 | 1,275 | 1,121 | 277 | 3,257 | 25 |
| *Percent of total* | | 94.2% | 0.8% | 1.0% | 1.9% | 1.7% | 0.4% | 4.9% | 0.0% |
| Niobrara County | 2,407 | 2,360 | 3 | 12 | 12 | 17 | 3 | 36 | 0 |
| *Percent of total* | | 98.0% | 0.1% | 0.5% | 0.5% | 0.7% | 0.1% | 1.5% | 0.0% |
| Platte County | 8,807 | 8,471 | 14 | 44 | 149 | 112 | 15 | 465 | 2 |
| *Percent of total* | | 96.2% | 0.2% | 0.5% | 1.7% | 1.3% | 0.2% | 5.3% | 0.0% |
| Weston County | 6,644 | 6,374 | 8 | 84 | 62 | 102 | 13 | 137 | 1 |
| *Percent of total* | | 95.9% | 0.1% | 1.3% | 0.9% | 1.5% | 0.2% | 2.1% | 0.0% |
| Casper | 49,644 | 46,680 | 428 | 495 | 1,011 | 775 | 245 | 2,656 | 10 |
| *Percent of total* | | 94.0% | 0.9% | 1.0% | 2.0% | 1.6% | 0.5% | 5.4% | 0.0% |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100 percent).

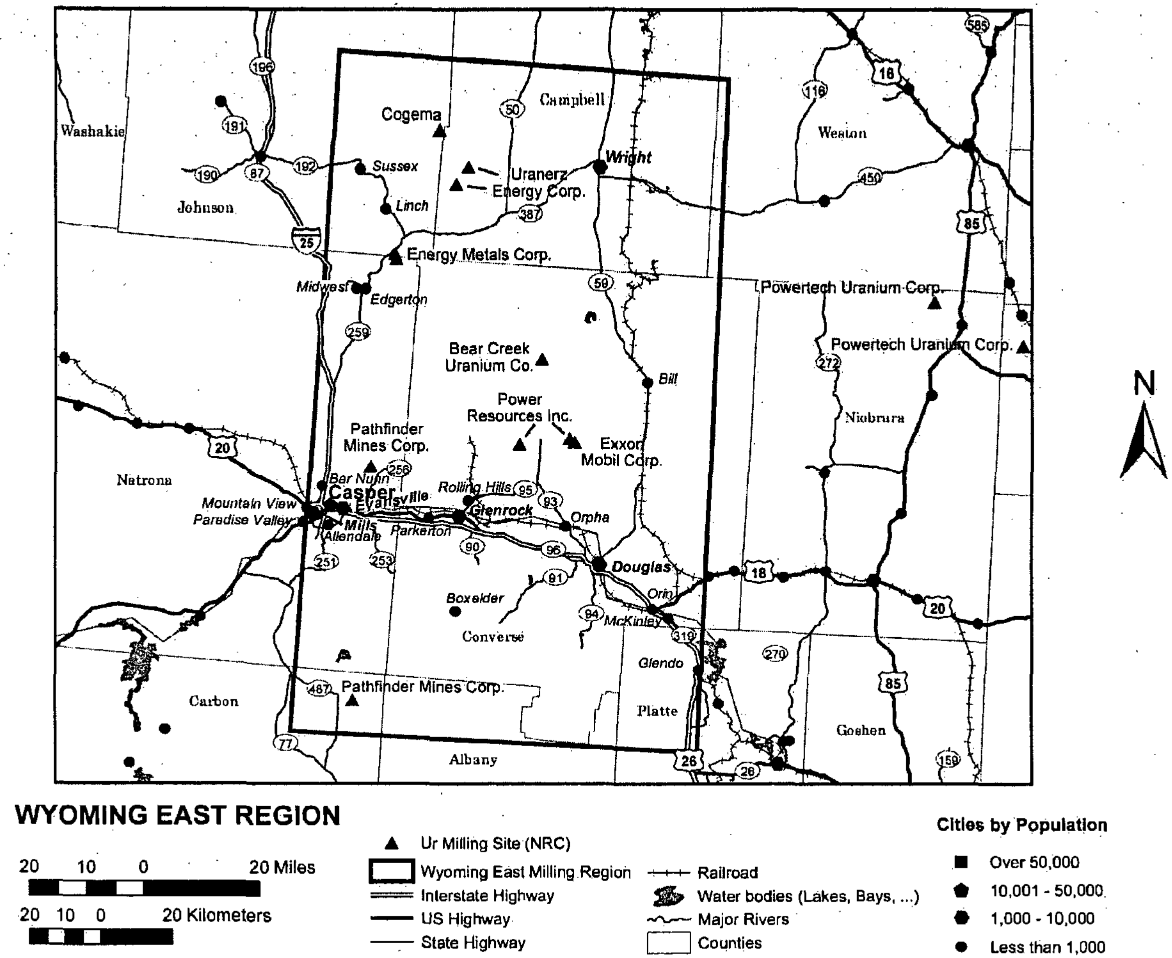



Figure 3.3-18. Wyoming East Uranium Milling Region With Population

| Table 3.3-11. U.S. Bureau of Census State Income Information for Wyoming East Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 years and over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Colorado | 2,331,898 | $47,203 | $55,883 | $24,049 | 67,614 | 388,952 |
| South Dakota | 394,945 | $35,282 | $42,237 | $17,562 | 18,172 | 95,900 |
| Wyoming | 257,808 | $37,892 | $45,685 | $19,134 | 10,585 | 54,777 |
| Casper | 26,343 | $36,567 | $46,267 | $19,409 | 1,122 | 5,546 |
| *Percent of total†* | 68.4% | NA‡ | NA‡ | NA‡ | 8.5% | 11.4% |
| Cheyenne, Wyoming | 27,647 | $38,856 | $46,771 | $19,809 | 891 | 4,541 |
| *Percent of total†* | 66.7% | NA‡ | NA‡ | NA‡ | 6.3% | 8.8% |
| Ft. Collins, Colorado | 69,424 | $44,459 | $59,332 | $22,133 | 1,417 | 15,835 |
| *Percent of total†* | 72.4% | NA‡ | NA‡ | NA‡ | 5.5% | 14.0% |
| Laramie, Wyoming | 15,504 | $27,319 | $43,395 | $16,036 | 633 | 5,618 |
| *Percent of total†* | 67.2% | NA‡ | NA‡ | NA‡ | 11.1% | 22.6% |
| Rapid City, South Dakota | 31,948 | $35,978 | $44,818 | $19,445 | 1,441 | 7,328 |
| *Percent of total†* | 68.8% | NA‡ | NA‡ | NA‡ | 9.4% | 12.7% |

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 15 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA—Not applicable.

### 3.3.10.3 Housing

Housing information based on 2000 U.S. Census data is provided in Table 3.3-13.

The availability of housing within the immediate vicinity of potential ISL facilities in the Wyoming East Uranium Milling Region is limited. The majority of housing is available in larger populated areas such as the towns of Casper {48 km [30 mi] to the nearest potential ISL facility} and

| Table 3.3-12. U.S. Bureau of Census County Income Information for Wyoming East Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 years and over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Albany County, Wyoming | 18,182 | $28,790 | $44,334 | $16,706 | 763 | 6,228 |
| *Percent of total†* | 67.7% | NA‡ | NA‡ | NA‡ | 10.8% | 21.0% |
| Campbell County, Wyoming | 18,805 | $49,536 | $53,92 | $20,063 | 507 | 2,544 |
| *Percent of total†* | 76.6% | NA‡ | NA‡ | NA‡ | 5.6% | 7.6% |
| Carbon County, Wyoming | 7,744 | $36,060 | $41,991 | $18,375 | 411 | 1,879 |
| *Percent of total†* | 62.5% | NA‡ | NA‡ | NA‡ | 9.8% | 12.9% |
| Converse County, Wyoming | 6,244 | $39,603 | $45,905 | $18,744 | 319 | 1,379 |
| *Percent of total†* | 68.6% | NA‡ | NA‡ | NA‡ | 9.2% | 11.6% |
| Johnson County, Wyoming | 3,472 | $34,012 | $42,299 | $19,030 | 147 | 712 |
| *Percent of total†* | 61.7% | NA‡ | NA‡ | NA‡ | 7.2% | 10.1% |
| Natrona County, Wyoming | 35,081 | $36,619 | $45,575 | $18,913 | 1,548 | 7,695 |
| *Percent of total†* | 68.3% | NA‡ | NA‡ | NA‡ | 8.7% | 11.8% |
| Niobrara County, Wyoming | 1,193 | $29,701 | $33,714 | $15,757 | 74 | 309 |
| *Percent of total†* | 61.5% | NA‡ | NA‡ | NA‡ | 10.7% | 13.4% |
| Platte County, Wyoming | 4,540 | $33,866 | $41,449 | $17,530 | 216 | 1,021 |
| *Percent of total†* | 66.1% | NA‡ | NA‡ | NA‡ | 8.5% | 11.7% |
| Weston County | 3,183 | $32,348 | $40,472 | $17,366 | 119 | 628 |
| *Percent of total†* | 60.0% | NA‡ | NA‡ | NA‡ | 6.3% | 9.9% |

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Percent of total based on a population of 16 years and over.
‡NA—Not applicable.

**Table 3.3-13. U.S. Bureau of Census Housing Information for the Wyoming East Uranium Milling Region***

| Affected Environment | Single Family Owner-Occupied Homes | Median Value in Dollars | Median Monthly Costs With a Mortgage | Median Monthly Costs Without a Mortgage | Occupied Housing Units | Renter-Occupied Units |
|---|---|---|---|---|---|---|
| Wyoming | 95,591 | $96,600 | $825 | $229 | 193,608 | 55,793 |
| Albany County | 4,987 | $118,600 | $916 | $225 | 13,269 | 6,345 |
| Campbell County | 5,344 | $102,900 | $879 | $247 | 12,207 | 3,174 |
| Carbon County | 7,744 | $76,500 | $685 | $196 | 6,129 | 1,708 |
| Converse County | 2,290 | $84,900 | $714 | $206 | 4,694 | 1,142 |
| Johnson County | 1,414 | $115,500 | $849 | $227 | 2,959 | 677 |
| Natrona County | 15,250 | $84,600 | $746 | $218 | 26,819 | 7,993 |
| Niobrara County | 480 | $60,300 | $562 | $200 | 1,011 | 222 |
| Platte County | 1,659 | $84,100 | $698 | $205 | 3,625 | 800 |
| Weston County | 1,174 | $66,700 | $664 | $199 | 2,624 | 549 |
| Casper | 12,642 | $84,500 | $744 | $220 | 20,437 | 6,645 |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).

Riverton {193 km [120 mi]} to the nearest potential ISL facility}. Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the proposed ISL facilities is not as limited. There are 17 apartment complexes available in larger populated areas such as the CBSAs or towns of Casper, Douglas, Lusk, and Orpha (MapQuest, 2008). There are also 15 hotels/motels along major highways or towns near the uranium districts located within the Wyoming East Uranium Milling Regions. In addition to apartments and lodging, there are more than 25 trailer camps situated along major roads or near towns (MapQuest, 2008).

### 3.3.10.4 Employment Structure

Employment structure from the 2000 U.S. Census, including employment rate and type, is based on data collected at the state and county levels. Data collected from the state level also includes information on towns, CBSAs, or Metropolitan Areas and considers an outside workforce. An outside workforce may include workers willing to commute long distances {greater than 48 km [30 mi]} for employment opportunities or external labor necessary to fulfill specialized positions (if local workforce is unavailable or unspecialized). Data collected at the county level are generally the same as the affected environment presented in Table 3.3-9.

Based on review of regional state-level information, Colorado has the highest percentage of employment.

At the county level, the county in the Wyoming East Uranium Milling Region with the highest percentage of employment is Campbell County and the county with the highest unemployment rate is Albany County.

3.3.10.4.1 State Data

3.3.10.4.1.1 Colorado

The State of Colorado has an employment rate of 66.3 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 37.4 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Ft. Collins

Ft. Collins has an employment rate of 68.5 percent and unemployment higher than the state at 3.8 percent. The largest sector of employment is management, professional, and related occupations at 42.9 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.1.2 South Dakota

The state of South Dakota has an employment rate of 64.9 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 32.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Rapid City

Laramie has an employment rate of 63.7 percent and unemployment higher than the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 32.8 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.1.3 Wyoming

The State of Wyoming has an employment rate of 63.1 percent and unemployment rate of 3.5 percent. The largest sector of employment is sales and office occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Casper

Casper has an employment rate of 64.9 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is sales and office occupations at 30.6 percent followed by management, professional, and related occupations at 29.7 percent. The largest type of industry is educational, health, and social services at 22.1 percent. The largest class of worker is private wage and salary workers at 76.6 percent (U.S. Census Bureau, 2008).

Cheyenne

Cheyenne has an employment rate of 59.2 percent and unemployment less than the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 33.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Laramie

Laramie has an employment rate of 63.4 percent and unemployment less than the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 40.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.3.10.4.2 County Data

Albany County, Wyoming

Albany County has an employment rate of 63.9 percent and an unemployment rate higher than that of the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 40.4 percent. The largest type of industry is educational, health, and social services at 37.1 percent. The largest class of worker is private wage and salary workers at 61.9 percent (U.S. Census Bureau, 2008).

Campbell County, Wyoming

Campbell County has an employment rate of 73.2 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is management, professional, and related occupations at 23.9 percent followed by construction, extraction, and maintenance occupations at 23.7 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 23.3 percent followed by educational, health, and social services at 16.7 percent. The largest class of worker is private wage and salary workers at 78.4 percent (U.S. Census Bureau, 2008).

Carbon County, Wyoming

Carbon County has an employment rate of 59.2 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 23.4 percent followed by sales and office occupations at 21.9 percent. The largest type of industry is educational, health, and social services at 17.1 percent. The largest class of worker is private wage and salary workers at 65.6 percent (U.S. Census Bureau, 2008).

Converse County, Wyoming

Converse County has an employment rate of 65.4 percent and an unemployment rate lower than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 23.2 percent followed by sales and office occupations at 21.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 20.1 percent followed by educational, health, and social services at 18.5 percent. The largest class of worker is private wage and salary workers at 71.1 percent (U.S. Census Bureau, 2008).

Johnson County, Wyoming

Johnson County has an employment rate of 57.6 percent and an unemployment rate slightly higher than that of the state at 3.7 percent. The largest sector of employment is management, professional, and related occupations at 37.5 percent followed by sales and office occupations at 20.3 percent. The largest type of industry is educational, health, and social services at 20.5 percent followed by agriculture, forestry, fishing and hunting, and mining at 19.5 percent. The largest class of worker is private wage and salary workers at 61.1 percent (U.S. Census Bureau, 2008).

Natrona County, Wyoming

Natrona County has an employment rate of 64.6 percent and an unemployment rate similar to that of the state at 3.5 percent. The largest sector of employment is sales and office occupations at 29.9 percent followed by management, professional, and related occupations at 28.5 percent. The largest type of industry is educational, health, and social services at 21.2 percent. The largest class of worker is private wage and salary workers at 76.2 percent (U.S. Census Bureau, 2008).

Niobrara County, Wyoming

Niobrara County has an employment rate of 59.4 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 34.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 62.6 percent (U.S. Census Bureau, 2008).

Platte County, Wyoming

Platte County has an employment rate of 63.1 percent and an unemployment rate lower than that of the state at 2.9 percent. The largest sector of employment is management, professional, and related occupations at 30.3 percent. The largest type of industry is educational, health, and social services at 21.4 percent. The largest class of worker is private wage and salary workers at 64.4 percent (U.S. Census Bureau, 2008).

Weston County, Wyoming

Weston County has an employment rate of 56.6 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 24.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 22.4 percent. The largest class of worker is private wage and salary workers at 68.9 percent (U.S. Census Bureau, 2008).

### 3.3.10.5 Local Finance

Local finance such as revenue and tax distribution information for the affected counties is presented in Table 3.3-14.

Wyoming

The State of Wyoming does not have an income tax nor does it assess tax on retirement income received from another state. Wyoming has a 4 percent state sales tax, 2 percent to 4 percent county lodging tax, and 4 percent use tax. Counties have the option of collecting an additional 1 percent tax for general revenue and 2 percent tax for specific purposes. Wyoming also imposes "ad valorem taxes" on mineral extraction properties. Taxes levied for uranium production were 10.0 percent in 2007 (6.0 percent "ad valorem" and 4 percent severance) totaling $1.7 million dollars (Wyoming Department of Revenue, 2007). For 2007, in the Wyoming East Uranium Milling Region all of this uranium tax revenue was generated in Converse County. Annual sales and use tax distribution information for the affected counties (including cities and towns) in the Wyoming East Uranium Milling Region are presented in Table 3.3-14.

Casper

Sources of revenue for Casper, the largest city in the Wyoming East Uranium Milling Region, include sales, use, lodging, and property taxes as well as mill levies. The sales and use tax rate is 5 percent and lodging is 3 percent. The largest distribution of property tax is school district tax at a rate of 32.5 percent (Casper Chamber of Commerce, 2007).

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Carbon County

Carbon County has two school districts, Carbon County School District No. 1 and No. 2, with a combined total of approximately 2,647 students. There are a total of nine elementary schools, two middle schools, two high schools, and two private schools. The majority of schools within each school district provides bus services (Carbon County School District No.1, 2008; Carbon County District No. 2, 2008).

**Table 3.3-14. 2007 State and Local Annual Sales and Use Tax Distribution of Affected Counties Within the Wyoming East Uranium Milling Region***

| Affected Counties | Use Tax | | Sales Tax | | Gross Revenue |
|---|---|---|---|---|---|
| | State | Local | State | Local | |
| Albany County | $2,712,413 | $3,152,059 | $12,083,171 | $14,042,820 | $32,812,196 |
| Campbell County | $9,104,434 | $8,130,984 | $72,443,855 | $64,724,530 | $155,316,435 |
| Carbon County | $3,778,037 | $4,328,728 | $15,087,797 | $16,953,793 | $40,812,784 |
| Converse County | $1,042,601 | $837,455 | $8,316,835 | $6,682,328 | $17,225,640 |
| Johnson County | $795,512 | $639,174 | $8,502,430 | $6,831,523 | $17,012,155 |
| Natrona County | $4,135,490 | $3,322,747 | $51,551,636 | $41,420,622 | $102,046,519 |
| Niobrara County | $156,916 | $182,363 | $1,091,293 | $1,268,288 | $2,745,320 |
| Platte County | $1,100,272 | $884,041 | $3,040,039 | $2,442,613 | $7,523,115 |
| Weston County | $630,016 | $506,201 | $2,572,484 | $2,066,940 | $5,886,521 |

* Wyoming Department of Revenue. "State of Wyoming Department of Revenue 2007 Annual Report." 2007. <http://revenue.state.wy.us/PortalVBVS/uploads/2007%20DOR%20Annual%20Report.pdf> (7 April 2009).

Converse County

Converse County has two school districts, Converse County School Districts No. 1 and No. 2, with a total of approximately 2,455 students. There are a total of nine elementary schools, four middle/intermediate schools, and two high schools. The majority of schools within each school district provides bus services (Schoolbug.org, 2007b).

Johnson County

Johnson County has one school district with two elementary schools, one middle school, two high schools, and one learning center. There are a total of approximately 1,257 students. The majority of schools provides bus services (Johnson County School District No. 1, 2007).

Natrona County

Natrona County has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 30 public and private elementary and secondary schools. The majority of schools provides bus services (Natrona County School District No. 1, 2007).

Niobrara County

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

Platte County

Platte County has the Platte County School District No. 1, with a total of approximately 1,571 students. There are two elementary schools, one middle school, one high school, and two private or parochial schools. Information as to whether these schools provide bus services is not available (Platte County School District No.1, 2008).

Weston County

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

### 3.3.10.6 Education

Information on education for the affected communities within the region of influence is presented next.

Based on review of the affected environment, the county with the largest number of schools is Natrona County and the county with the smallest number of schools is Niobrara County. The CBSA of Casper was average to the county level when compared to the aforementioned schools.

Casper

Casper has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 25 public and private elementary, middle, and high schools. The majority of schools provides bus services (Schoolbug.org, 2007a).

Albany County

Albany County has one school district, Albany County School District No. 1, with a total of approximately 3,790 students. There are 13 elementary schools, 6 middle schools, and 3 high schools. The majority of schools provides bus services (Greatschools.com, 2008).

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Carbon County

Carbon County has two school districts, Carbon County School Districts No. 1 and No. 2, with a combined total of approximately 2,647 students. There are a total of nine elementary schools, two middle schools, two high schools, and two private schools. The majority of schools within each school district provide bus services (Carbon County School District No.1, 2008; Carbon County School District No. 2, 2008).

Converse County

Converse County has two school districts, Converse County School Districts No. 1 and No. 2, with a total of approximately 2,455 students. There are a total of nine elementary schools, four middle/intermediate schools, and two high schools. The majority of schools within each school district provides bus services (Schoolbug.org, 2007b).

Johnson County

Johnson County has one school district with two elementary schools, one middle school, two high schools, and one learning center. There are a total of approximately 1,257 students. The majority of schools provides bus services (Johnson County School District No. 1, 2007).

Natrona County

Natrona County has one school district, Natrona County School District No. 1, with a total of approximately 11,500 students. There are more than 30 public and private elementary and secondary schools. The majority of schools provides bus services (Natrona County School District No. 1, 2007).

Niobrara County

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

Platte County

Platte County has the Platte County School District No. 1, with a total of approximately 1,571 students. There are two elementary schools, one middle school, one high school, and two private or parochial schools. Information as to whether these schools provide bus services is not available (Platte County School District No.1, 2008).

Weston County

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

### 3.3.10.7 Health and Social Services

Health Care

The majority of the health care facilities that provide service in the vicinity of the Wyoming East Uranium Milling Region is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the ISL facilities are located in Riverton, Lander, Casper, Douglas, Wheatland, Cheyenne, and Laramie and have a total of 15 facilities

(MapQuest, 2008). These consist of hospitals, clinics, emergency centers, and medical services. The following hospitals are located proximate to the Wyoming East Milling Region: Riverton (1), Cheyenne (1), Laramie (1), and Wheatland (1).

Local Emergency

Local police within the Wyoming East Uranium Milling Region are under the jurisdiction of each county. There are 28 police, sheriff, or marshals offices within the region: Albany County (2), Campbell County (2), Carbon County (6), Converse County (3), Johnson County (3), Natrona County (4), Niobrara County (2), Platte County (3), and Weston County (3) (USACops, 2008).

Fire departments within the Wyoming East Uranium Milling Region are comprised at the county, town, CBSA, or city level. There are seven fire departments within the milling region: Campbell County (one), Casper (one), Douglas (two), Lusk (one), Natrona County (one), and Wheatland (one) (50states, 2008).

## 3.3.11 Public and Occupational Health

### 3.3.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council of Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels than those with other types of soils/bedrock (EPA, 2006).

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

For the Wyoming East Uranum Milling Region, the average background radiation dose for the state of Wyoming is used, which is 3.16 mSv/yr [316 mrem/yr] (EPA, 2006). This value includes natural and man-made sources. This dose is slightly lower than the U.S. average primarily because the radon dose is lower {U.S. average of 2 mSv/yr [200 mrem/yr] versus Wyoming average of 1.33 mSv/yr [133 mrem/yr]}. The cosmic dose is slightly higher than the U.S. average: 0.515 mSv/yr [51.5 mrem/yr] versus 0.27 mSv/yr [27 mrem/yr]. The remaining contributions from terrestrial, internal, and manmade radiation combined are the same as the U.S. average of 1.318 mSv/yr [131.8 mrem/yr].

#### 3.3.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. See Section 3.2.11.2 for further discussion of these standards.

#### 3.3.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. See Section 3.2.11.3 for further discussion of these standards.

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## 3.4 Nebraska-South Dakota-Wyoming Uranium Milling Region

### 3.4.1 Land Use

The Nebraska-South Dakota-Wyoming Uranium Milling Region defined in this GEIS is represented by a south-southeast–north-northwest swath of land encompassing parts of Sioux and Dawes Counties in Nebraska; Fall River, Custer, Pennington, and Lawrence Counties in South Dakota; and Niobrara, Weston and Crook Counties in Wyoming (Figure 3.4-1).

This region lies within portions of the Missouri Plateau, the Black Hills and the High Plains sections of the Great Plains province (U.S. Geological Survey, 2004). The locations of past, current, and potential uranium milling operations are found in the Crow Butte Uranium District located in Dawes County, Nebraska; in the Southern Black Hills Uranium District in Fall River County, South Dakota, and Niobrara County, Wyoming; and in the Northern Black Hills Uranium District in Crook County, Wyoming (Figure 3.4-2). Details on the geology and soils of these three districts are provided in Section 3.4.3.

The general land ownership and use statistics for the Nebraska-South Dakota-Wyoming Uranium Milling Region shown next were calculated using the Geographic Information System used to construct the map shown in Figure 3.4-1. Private (surface ownership) lands (59 percent) and national forest and national grassland (38 percent combined) account for 97 percent of this region (Table 3.4-1). As described for the Wyoming West Uranium Milling Region in Section 3.1.1, there are also in this region privately owned surface rights and publicly owned subsurface mineral rights resulting in split estate situations (BLM, 2000a) (Section 3.1.2.2).

In the areas of interest in Dawes and Sioux Counties in Nebraska, the predominant land cover consists of a mix of western shortgrass prairie and western wheatgrass prairie, followed by agricultural fields and ponderosa pine forests and woodlands (Henebry, et al., 2005). A large portion of Dawes and Sioux Counties is occupied by the Oglala National Grassland to the north and west and by the Nebraska National Forest in the center, which are both administered by the USFS (Figure 3.4-1). These federal lands offer general recreational activities, including camping, fishing, and hunting (USFS, 2008b). Chadron, a 394-ha [972-acre] state park in the heart of the Nebraska National Forest, and Fort Robinson, a 8,900-ha [22,000-acre] state park of Pine Ridge scenery west of Crawford, also offer general recreational activities to the public. (Nebraska Game and Parks Commission, 2008). Similar to nearby Niobrara County in Wyoming to the west and Fall River County in South Dakota to the north, the dominant land use in these two northwestern Nebraska counties is cattle grazing on both public and private rangeland and associated livestock feed production. Cultivated lands mixed with the rangeland are used primarily to produce winter wheat and hay, which is both grazed and harvested.

Approximately half of Fall River County in the southwest corner of South Dakota is occupied by the Buffalo Gap National Grassland to the south and by the Black Hills National Forest to the north, which are both managed by the USFS. Higher elevation areas to the north into the Black Hills National Forest create favorable growing conditions for ponderosa pine. The lower elevation areas surrounding the Black Hills to the south are primarily used as rangeland for livestock grazing and as agricultural land. Hay and winter wheat farming are the principal agricultural uses in dry land areas, and alfalfa, corn, and vegetables are typically grown in wetter valley areas and on irrigated land (South Dakota State University, 2001). A large part of

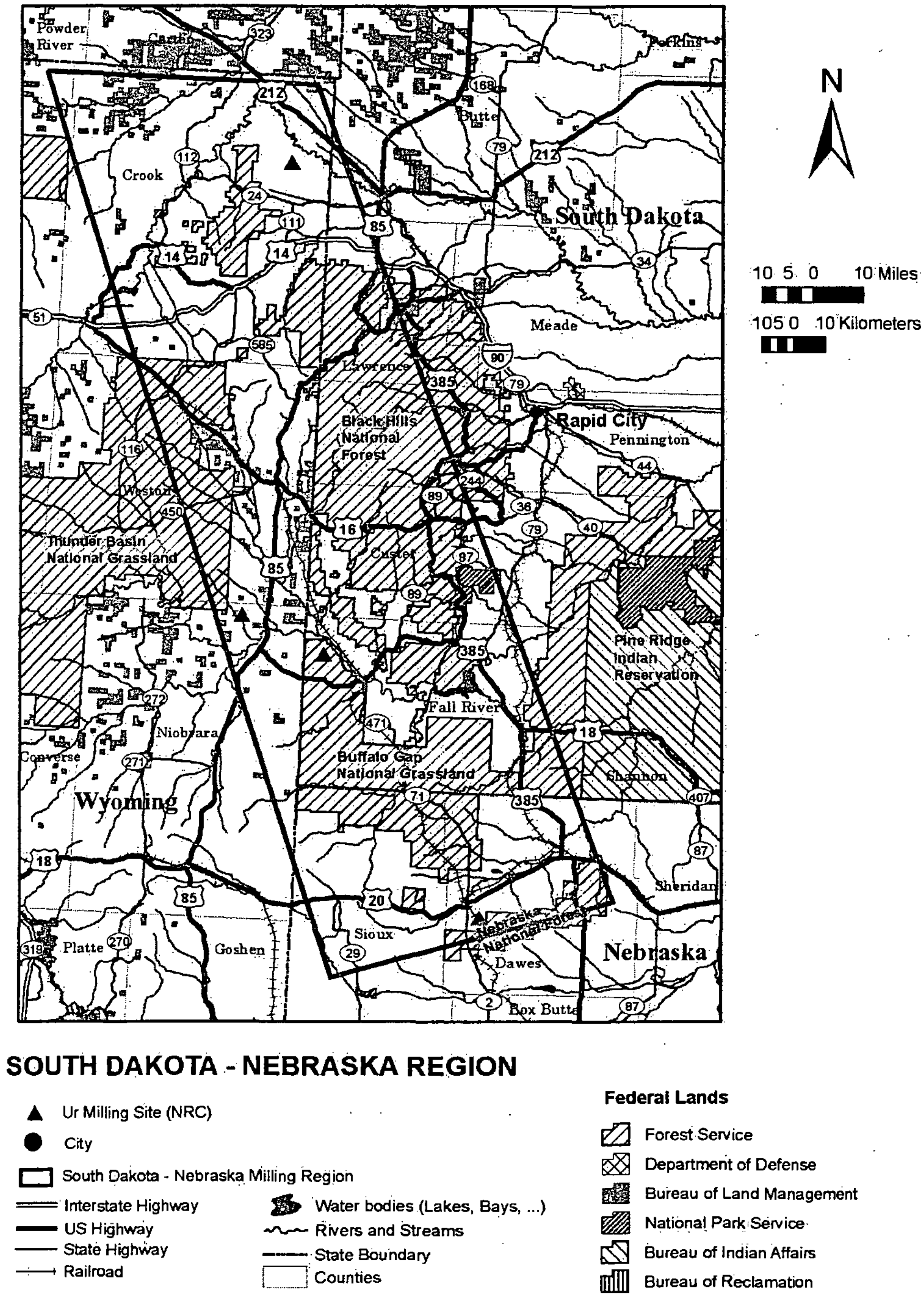



**Figure 3.4-1. Nebraska-South Dakota-Wyoming Uranium Milling Region General Map With Current (Crow Butte, Nebraska) and Potential Future Uranium Milling Site Locations**

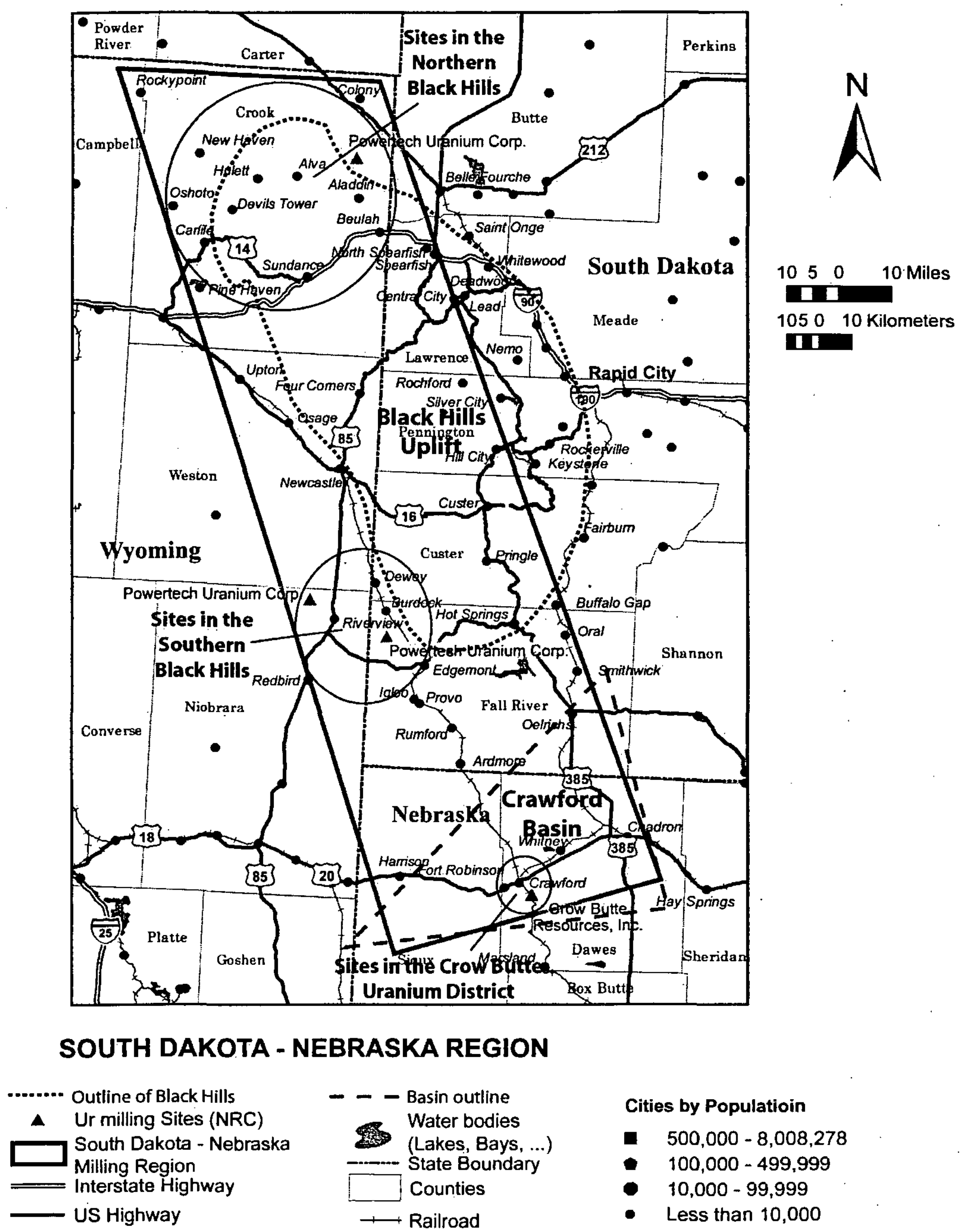



**Figure 3.4-2. Map Showing the Nebraska-South Dakota-Wyoming Uranium Milling Region and Uranium Milling Sites in the Black Hills Uranium Districts in South Dakota and Wyoming and in the Crow Butte Uranium District in Nebraska**

| Table 3.4-1. Land Surface Ownership and General Use in the Nebraska-South Dakota-Wyoming Uranium Milling Region | | | |
|---|---|---|---|
| Land Surface Ownership and General Use | Area (mi$^2$) | Area (km$^2$) | Percent |
| State and Private Lands | 5,379 | 13,932 | 58.6 |
| U.S. Forest Service (USFS), National Forest | 1,979 | 5,125 | 21.5 |
| USFS, National Grassland | 1,553 | 4,022 | 16.9 |
| U.S. Bureau of Land Management, Public Domain Land | 185 | 480 | 2 |
| National Park Service, National Park | 41 | 107 | 0.5 |
| Bureau of Reclamation | 16 | 42 | 0.2 |
| USFS, Wilderness | 22 | 56 | 0.2 |
| USFS, National Recreation Area | 4 | 11 | 0.05 |
| National Park Service, National Monument | 4 | 11 | 0.05 |
| **Totals** | 9,185 | 23,788 | 100 |

Shannon County, South Dakota, which abuts Fall River County to the east, is occupied entirely by the Pine Ridge Indian Reservation (Figure 3.4-1).

More than half of Custer, Pennington, and Lawrence Counties in South Dakota is also occupied by the Black Hills National Forest (Figure 3.4-1). In these counties, the majority of the land cover consists of ponderosa pine forest associated with short to tall grasslands and agricultural fields (South Dakota State University, 2001).

Historically, the Black Hills have been prospected and mined for many minerals, metals, and materials. Recreational activities provided in the Buffalo Gap National Grassland and in the Black Hills National Forest are similar to those described for USFS lands in Nebraska and in the Wyoming East Uranium Milling Region (USFS, 2008a,b).

In the eastern and northeastern Wyoming Counties of Niobrara and Crook, land ownership is predominantly private as it is in the Wyoming East Uranium Milling Region. BLM-administered lands, which are scattered and mixed with state and private lands, represent less than 10 percent of the land. In Weston County, located between Niobrara and Crook Counties, land ownership is dominated by the USFS Thunder Basin National Grassland. In its eastern half, a large portion of Crook County is occupied by the Black Hills National Forest. To the west of the forest on Route 24, Devils Tower National Monument, administered by the National Park Service, provides additional recreational activities in Crook County (Figure 3.4-1).

The characteristics of open rangeland in these three eastern Wyoming counties are similar to those of the Wyoming East Uranium Milling Region described in Section 3.3.1. Cattle and sheep grazing represent the primary land use on private and federal lands. Recreational activities available on federal lands are also similar to those described previously for parts of Nebraska, South Dakota and the Wyoming East Uranium Milling Region (Section 3.3.1).

### 3.4.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of goods and personnel (Section 2.8). As shown in Figure 3.4-3, the

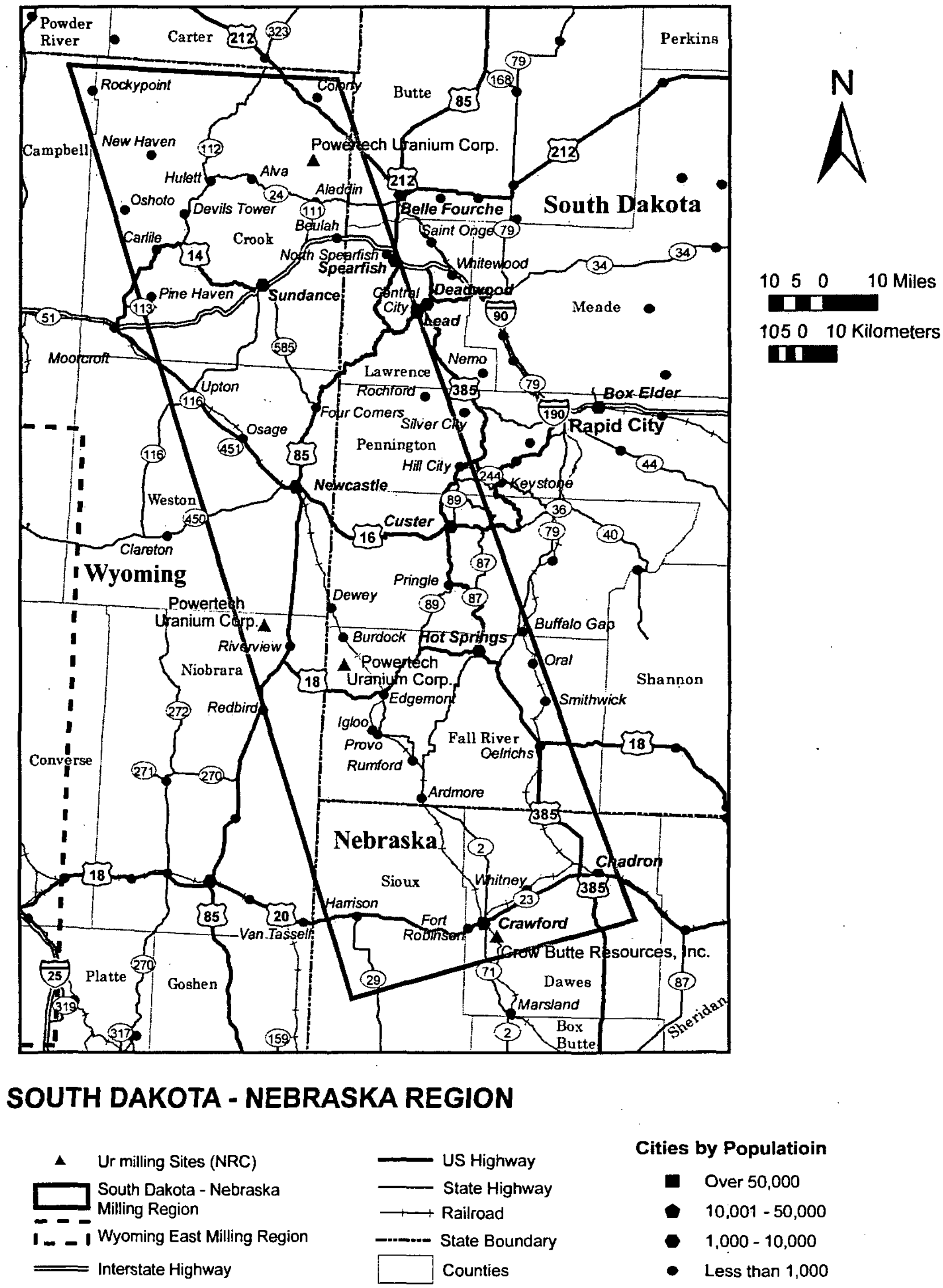



**Figure 3.4-3. Nebraska-South Dakota-Wyoming Uranium Milling Region Transportation Corridor**

Nebraska-South Dakota-Wyoming Uranium Milling Region is accessible by a variety of highways. In the northern part of the region, Interstate 90 connects Gillette, Wyoming, and Rapid City, South Dakota. U.S. Highway 212 enters the region from Montana to the north intersecting U.S. Highway 85 and then crossing Interstate 90 to the south and traversing the region southbound to intersect U.S. Highway 20. U.S. Highway 20 traverses the south portion of the region and connects with Interstate 25 to the west. A rail line serves the central portion of the South Dakota/Nebraska region along U.S. Highway 16 from the west to the intersection with U.S. Highway 85 at Newcastle and then south to Crawford at the southern boundary of the region.

Areas of past, present, or future uranium milling interest in the region are shown in Figure 3.4-3. These areas are located in three subregions when considering site access by local roads. The area of milling interest in the northeastern part of the region (north of Aladdin, Wyoming) is accessible by local access roads to U.S. Highway 212 southeast to U.S. Highway 85 south, which intersects Interstate 90. Traveling west from Aladdin, State Route 24 connects to U.S. Highway 14 and Interstate 90 continuing west to Gillette. Milling sites farther to the southwest of the region (near Burdock, South Dakota) are served by local access roads and U.S. Highway 18 west to connect with U.S. Highway 85 southbound that exits the region from the southwest. At Lusk, Wyoming, U.S. Highway 20 west provides access to Interstate 25. Areas of milling interest near the southern border of the region (near Crawford, Nebraska) are served by local access roads to U.S. Highway 20, which exits the region to the west to intersect Interstate 25.

Table 3.4-2 provides available traffic count data for roads that support areas of past or future milling interest in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Counts are variable with the minimum all-vehicle count at 333 vehicles per day on U.S. Highway 16 west of Custer (westbound) and the maximum on Interstate 90 east of Spearfish (between Spearfish and Whitewood) at 9,491 vehicles per day. Most of the vehicle counts in the Nebraska-South Dakota-Wyoming Uranium Milling Region are above 400 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.4-3 describes representative routes and distances for shipments of yellowcake from locations of Uranium milling interest in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

### 3.4.3 Geology and Soils

Sandstone-hosted uranium ore deposits have been identified in western South Dakota, northeastern Wyoming, and in northwestern Nebraska (Figure 3.4-2). In the Nebraska-South

**Table 3.4-2. Average Annual Daily Traffic Counts for Roads in the Nebraska-South Dakota-Wyoming Uranium Milling Region***

| Road Segment | County, State | All Vehicles |
|---|---|---|
| State Route 24 at Devils Tower Junction (intersection with U.S. Highway 14) | Crook, Wyoming | 982–1,236 |
| State Route 14 at Devils Tower Junction (west intersection with State Route 24) | Crook, Wyoming | 610–675 |
| Interstate 90 at County Border East (near Beulah, Wyoming) | Crook, Wyoming | 4,048–5,272 |
| U.S. Highway 85 North of Belle Fourche (southbound in direction of U.S. Highway 212) | Butte, South Dakota | 468–905† |
| Interstate 90 East of Spearfish (between Spearfish and Whitewood) | Lawrence, South Dakota | 5,201–9,491† |
| U.S. Highway 16 West of Custer (westbound) | Custer, South Dakota | 333–1,231† |
| U.S. Highway 385 North of Hot Springs (near north county line) | Fall River, South Dakota | 425–1,243† |
| U.S. Highway 18 at Mule Creek Junction (intersection with U.S. Highway 85) | Niobrara, Wyoming | 817–1,192 |
| U.S. Highway 85 at Mule Creek Junction (south of intersection with U.S. Highway 18) | Niobrara, Wyoming | 1,327–2,037 |
| U.S. Highway 20 at Van Tassell (at east county line) | Niobrara, Wyoming | 415–552 |
| U.S. Highway 20 at Manville South (intersection with State Route 270) | Niobrara, Wyoming | 1,418–1,891 |

*Wyoming Department of Transportation. "Wyoming Department of Transportation Traffic Analysis." 2005. <http://dot.state.wy.us/Default.jsp?sCode=hwyta> (27 December 2005).
South Dakota Department of Transportation. "Automatic Traffic Recorder Data." 2008. <http://gis.sd.gov/dot%5Fctysys/> (January 2008).
†Data for South Dakota are monthly averages of daily counts; Wyoming data are the arithmetic mean of average annual daily counts for each day of the week.

**Table 3.4-3. Representative Transportation Routes for Yellowcake Shipments From the Nebraska-South Dakota-Wyoming Uranium Milling Region***

| Origin | Destination | Major Links | Distance* (mi) |
|---|---|---|---|
| North of Aladdin, Wyoming | Metropolis, Illinois | Local access road northeast to U.S. Highway 212<br>U.S. Highway 212 southeast to U.S. Highway 85<br>U.S. Highway 85 south to Interstate 90<br>Interstate 90 east to Sioux Falls, South Dakota<br>Interstate 29 south to Kansas City, Missouri<br>Interstate 70 east to St. Louis, Missouri<br>Interstate 64 east to Interstate 57<br>Interstate 57 south to Interstate 24<br>Interstate 24 south to U.S. Highway 45<br>U.S. Highway 45 west to Metropolis, Illinois | 1,230 |

| Table 3.4-3. Representative Transportation Routes for Yellowcake Shipments From the Nebraska-South Dakota-Wyoming Uranium Milling Region* (continued) | | | |
|---|---|---|---|
| Origin | Destination | Major Links | Distance* (mi) |
| Edgemont, South Dakota | Metropolis, Illinois | Local access road south to U.S. Highway 18<br>U.S. Highway 18 west to U.S. Highway 85<br>U.S. Highway 85 south to U.S. Highway 20<br>U.S. Highway 20 west to Interstate 25<br>Interstate 25 south to Denver, Colorado<br>Interstate 70 east to St. Louis, Missouri<br>Interstate 64 east to Interstate 57<br>Interstate 57 south to Interstate 24<br>Interstate 24 south to U.S. Highway 45<br>U.S. Highway 45 west to Metropolis, Illinois | 1,410 |
| Crawford, Wyoming | Metropolis, Illinois | Local access roads north to U.S. Highway 20<br>U.S. Highway 20 west to Interstate 25<br>Interstate 25 south to Denver, Colorado<br>Denver, Colorado, to Metropolis, Illinois (as above) | 1,360 |
| *American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006. | | | |

Dakota-Wyoming Uranium Milling Region, uranium mineralization is found in fluvial sandstones in two major areas: the Black Hills of western South Dakota and northeastern Wyoming and the Crawford Basin of northwestern Nebraska. Uranium mineralization in the sandstone-hosted uranium deposits in these two areas is in a geologic setting amenable to recovery by ISL milling.

#### 3.4.3.1 The Black Hills (Western South Dakota-Northeastern Wyoming)

The Black Hills are an asymmetrical domal uplift elongated in a northwest direction (Figure 3.4-4). Economically significant uranium discoveries in the Black Hills are contained within strata of the Inyan Kara Group (Chenoweth, 1988). Prior to 1968, the Black Hills produced approximately 1,800 metric tons [2,000 tons] of $U_3O_8$ (Hart, 1968). The bulk of this production came from the Hulett Creek and Carlile districts of the northern Black Hills and the Edgemont district of the southem Black Hills (Figure 3.4-4).

Stratigraphic units present in the Black Hills area are shown in Figure 3.4-5. Jurassic (144 to 206 million year old) and Cretaceous (65 to 144 million year old) rocks crop out low on the flanks of the Black Hills and form the eroded surface upon which younger rocks were deposited (Harshman, 1968). Sedimentary rocks of Tertiary (1.8 to 65 million year old) age are virtually absent from the Black Hills. However, remnants of Miocene (5.3 to 23.8 million year old) and/or Pliocene (1.8 to 5.3 million year old) age rocks on the flanks of the Black Hills indicate that at one time rocks of middle and late Tertiary age may have extended across the area and at least partially buried the Black Hills uplift. The Tertiary rocks are tuffaceous (i.e., they contain materials made from volcanic rock and mineral fragments in a volcanic ash matrix) and clastic (i.e., they contain fragments or grains of older rocks) and are of fluvial (river), lacustrine (lake), and paludal (marsh) origin.

The Inyan Kara Group is Lower Cretaceous (99 to 144-million-years-old) in age and consists of subequal amounts of complexly interbedded sandstone and claystone (Renfro, 1969). The

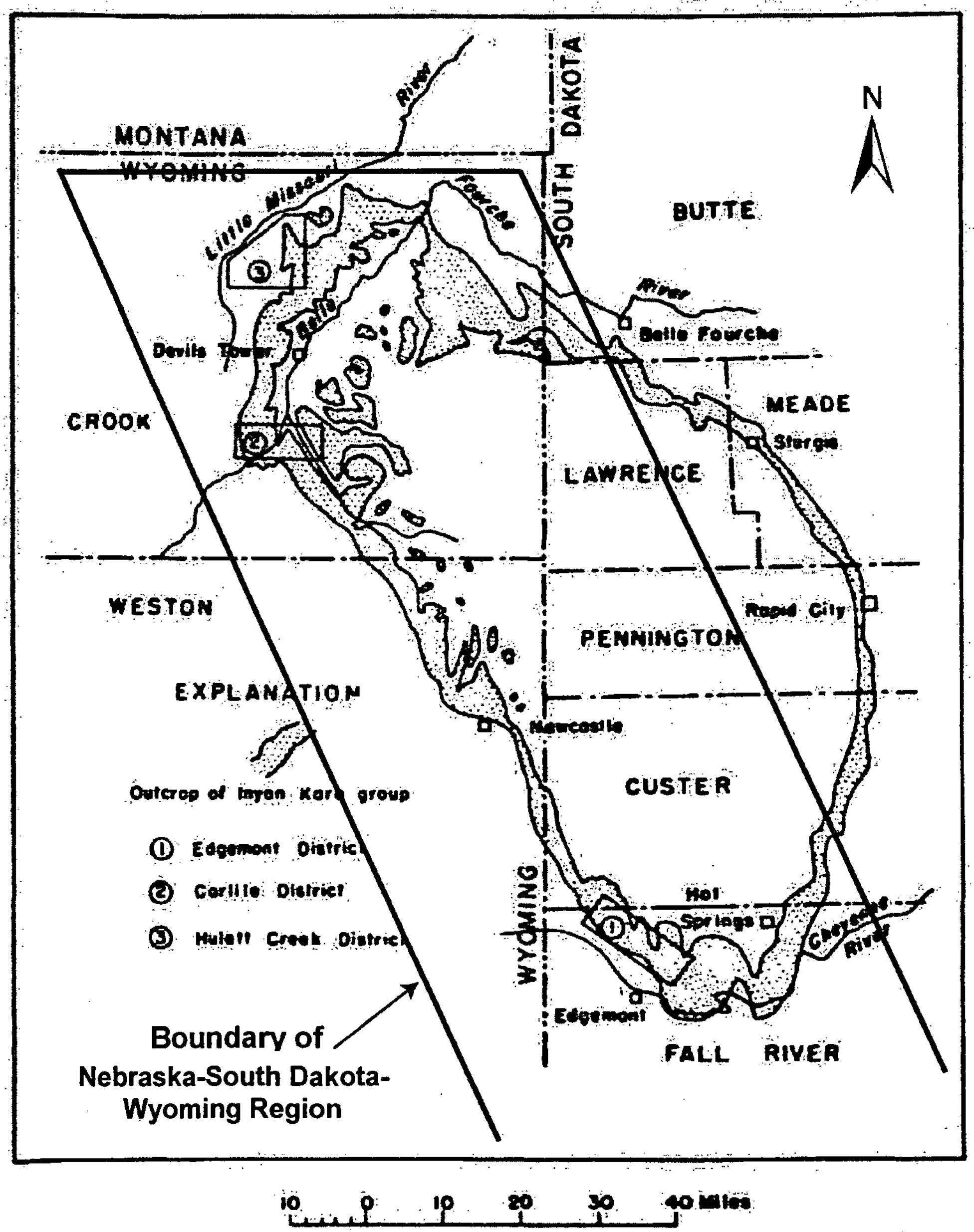



**Figure 3.4-4. Outcrop Map of the Inyan Kara Group in the Black Hills of Western South Dakota and Northeastern Wyoming Showing the Locations of Principal Uranium Mining Districts (From Hart, 1968)**

<table>
<tr><th colspan="4">Black Hills Area</th></tr>
<tr><th>System</th><th>Series</th><th colspan="2">Formation</th></tr>
<tr><td rowspan="5">Tertiary</td><td>Pliocene</td><td colspan="2">Ogallala Formation</td></tr>
<tr><td>Miocene</td><td colspan="2">Arikaree Formation</td></tr>
<tr><td>Oligocene</td><td colspan="2">White River Formation</td></tr>
<tr><td>Eocene</td><td colspan="2">(Absent)</td></tr>
<tr><td>Paleocene</td><td colspan="2">Fort Union Formation</td></tr>
<tr><td rowspan="8">Cretaceous</td><td rowspan="5">Upper</td><td colspan="2">Hell Creek Formation</td></tr>
<tr><td colspan="2">Fox Hills Sandstone</td></tr>
<tr><td colspan="2">Pierre Shale</td></tr>
<tr><td colspan="2">Niobrara Formation</td></tr>
<tr><td colspan="2">Carlile Shale, Greenhorn Formation, and Belle Fourche Shale</td></tr>
<tr><td rowspan="3">Lower</td><td colspan="2">Mowry Shale</td></tr>
<tr><td colspan="2">Newcastle Sandstone and Skull Creek Shale</td></tr>
<tr><td>Fall River and Lakota Formations</td><td>Inyan Kara Group</td></tr>
<tr><td colspan="2" rowspan="3">Jurassic</td><td colspan="2">Morrison Formation</td></tr>
<tr><td colspan="2">Sundance Formation</td></tr>
<tr><td colspan="2">Gypsum Spring Formation</td></tr>
</table>

**Figure 3.4-5. Principal Stratigraphic Units in the Black Hills Area of Western South Dakota and Northeastern Wyoming**

Inyan Kara is bounded below by continental Jurassic sediments of the Morrison Formation and is overlain by marine sediments of the Lower Cretaceous Skull Creek Shale. Resistant Inyan Kara sediments form the outermost ring of hogback ridges that crop out in a roughly oval pattern around the flanks of the Black Hills. Major uranium deposits occur from 2 to 8 km [1 to 5 mi] downdip from the main Inyan Kara escarpment at depths ranging from 30 to 180 m [100 to 600 ft].

The Inyan Kara Group is formally subdivided into the Lakota Formation and the Fall River Formation, which are generally accepted to be respectively continental and marginal marine in origin (Robinson, et al., 1964). The source of sediment for the Lakota and Fall River is considered to include all pre-Cretaceous sediments that were exposed to the south and east of the Black Hills (Renfro, 1969).

The Lakota is a sequence of coastal-plain deposits of fine-grained, poorly sorted sandstone and mudstone; channel-fill deposits of cross-bedded sandstone; natural levee and overbank deposits of lenticular (i.e., deposits with a lens-shaped cross section), fine-grained, carbonaceous sandstone and siltstone; and floodplain deposits of bedded siltstone, mudstone, and claystone (Maxwell, 1974). The Lakota Formation is from 15 to 90 m [50 to 300 ft] thick and thickens regionally from northwest to southeast (Chenoweth, 1988).

The oldest Lakota strata are thin, discontinuous dark gray to olive black, humic sandstone and claystone containing sparse subbituminous coal seams (Renfro, 1969). These strata appear to conform with the underlying Morrison Formation. The lowermost Lakota grades upward to a sequence of dark gray, medium- to coarse-grained, cherty and quartzose sandstone containing abundant disseminated carbon and pore-filling, massive pyrite. The uppermost Lakota consists of lenticular greenish gray to dark gray, fine- to medium-grained, quartzose sandstone and varicolored claystone.

Dondanville (1963) divided the Fall River Formation into deltaic and marine facies. The deltaic facies forms approximately 50 percent of the formation and consists of channel sandstone, interchannel sandstone and mudstone, and blanket sandstone formed during erosion of abandoned deltas. The marine and marginal-marine rocks consist of offshore and lagoonal mudstone and shale, and bar and spit sandstone. The Fall River is from 30 to 45 m [100 to 150 ft] thick and thickens regionally from southeast to northwest at the expense of the underlying Lakota Formation.

Renfro (1969) describes the Fall River as a light to dark gray, fine- to medium-grained quartzose sandstone containing traces of glauconite and abundant disseminated carbon, pyrite, and detrital chert. Thin beds of claystone and siltstone are common. The Fall River is in conformable contact and regionally intertongues with the overlying Skull Creek Shale.

Uranium deposits in the Inyan Kara Group are typified by roll-front accumulations (see Section 3.1.1). The geometric complexity of individual roll fronts is governed by the stratigraphic complexity of the Inyan Kara host sediments. Most roll fronts are within tabular sandstones of the Fall River Formation or widespread cherty sandstone facies of the Lakota Formation and have simple C-shaped cross sections that extend laterally for tens of kilometers [tens of miles] (Figure 3.4-6). Roll-front deposits in the more complex sandstone and claystone facies of the upper Lakota Formation are very erratic and generally contain relatively weak mineralization. Mineralization in the roll limbs seldom extends more than 90 to 120 m [300 or 400 ft] up-plunge from the roll fronts. Although roll fronts in the Inyan Kara are common, ore grade

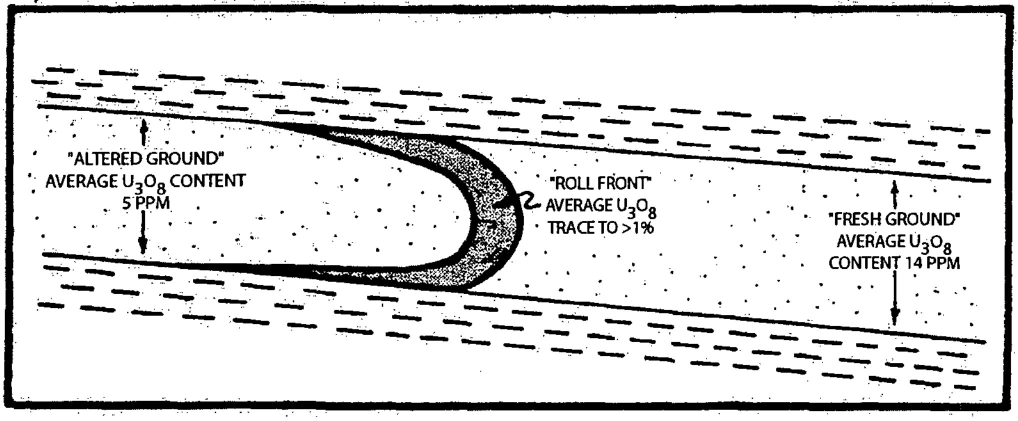



**Figure 3.4-6. Schematic Cross Section Through a Typical Inyan Kara Roll-Front Deposit Showing Differences in $U_3O_8$ Concentration Between "Fresh" (i.e., Unoxidized) and "Altered" Ground (Modified From Renfro, 1969)**

mineralization is restricted vertically and laterally. Ore most often occurs in terminal lobes of the roll-front trends. Within Inyan Kara ore bodies, uranium minerals coat sand grains, fill interstices between grains, and are finely disseminated in organic matter (Renfro, 1969). In oxidized deposits, the uranium vanadates, carnotite, tyuyamunite, and meta-tyuyamunite are the principal ore minerals. Uraninite and coffinite are the main minerals in unoxidized ore. Pyrite, marcasite, and calcite are present as gangue minerals (i.e., low-value minerals intermixed with ore minerals).

Tongues of hematite-stained pinkish-red sandstone are present at most of the deposits. This alteration is due to the oxidation of pyrite in the sandstone by migrating groundwater.

The source of uranium in the Inyan Kara deposits is unknown, but two main theories have been proposed. Renfro (1969) proposed that the uranium and other metals indigenous to the Lakota and Fall River sediments were mobilized by oxidizing groundwater and transported downdip, where they were precipitated along an oxidation-reduction boundary. Hart (1968) proposed that uranium was leached by groundwater from tuffaceous beds of the White River Group that were unconformably deposited across the eroded Black Hills uplift. Migrating groundwater carried the uranium into the permeable host rocks where it traveled downdip into reducing environments. Later groundwater movements remobilized and redeposited some of the ore bodies.

The surface of the Black Hills range is still largely mantled by sedimentary rocks that form an outer ring of hogback ridges that crop out in a roughly oval pattern around the flanks of the range. Soils in low lying areas adjacent to the Black Hills of western South Dakota and northeastern Wyoming consist of the weathering products of these sedimentary rocks. The topographic position and texture of typical soils in the Black Hills were obtained from Munn and Arneson (1998). This map was designed primarily for a statewide study of groundwater's vulnerability to contamination and would not be expected to be used for site-specific soil interpretations at proposed ISL milling facilities. For site-specific evaluations, detailed soils information would be expected to be obtained from published county soil surveys or NRCS.

Soils within the Black Hills area of western South Dakota and northeastern Wyoming are mostly fine textured (fine or fine-loamy soils). Shallow fine and fine-loamy soils with little or no subsoil development are found on ridges and steep slopes on the flanks of Black Hills. On gently sloping to moderately steep slopes adjacent to ridges, moderately deep fine and fine-loamy soils with moderate- to well-developed soil horizons are found. These soils are generally light colored and depleted in moisture. On low gradient surfaces, such as terraces and floodplains, deep fine and fine-loamy soils with well-developed subsoil horizons are found. Dark-colored, base-rich soils formed under grass are generally associated with floodplains along streams with permanent high water tables.

### 3.4.3.2 The Crawford Basin (Northwestern Nebraska)

Uranium deposits in northwestern Nebraska are located in Dawes and Sioux Counties in what has been named the Crawford Basin (Figure 3.4-2) (DeGraw, 1969). In 1979, an area west of the city of Crawford in Sioux County and an area north of Crawford in Dawes County were identified as having considerable weak uranium mineralization associated with vague oxidation-reduction boundaries (Collings and Knode, 1984). In 1981 and 1982, the Crow Butte mineralized trend was discovered southeast of Crawford in Dawes County. The Crow Butte mineralized trend is about 10 km [6 mi] long and up to 900 m [3,000 ft] wide with ore reserves calculated to be over 13,600 metric tons [15,000 tons] of $U_3O_8$ having an average grade exceeding 0.25 percent $U_3O_8$ (Collings and Knode, 1984). Uranium mineralization in the Crow Butte area occurs exclusively within the Chadron Sandstone.

The Crawford Basin is a triangular, asymmetrical basin bounded by the Black Hills Uplift on the northwest, the Chadron Arch to the west, and the Cochran Arch to the south (Figure 3.4-7). As a result of the Black Hills Uplift, formations underlying the uranium milling areas in the Crawford Basin dip gently to the south. The single most prominent structural feature within the Crawford Basin is the White River Fault. It is located north of Crawford and strikes northeast to southwest with the upthrown side to the south. The total vertical displacement is 60 to 120 m [200 to 400 ft].

A generalized stratigraphic section of sedimentary strata in the Crow Butte mining area of northwestern Nebraska is shown in Figure 3.4-8. Stratigraphic descriptions presented here are limited to formations that may be involved in potential milling operations or formations that may have environmental significance, such as important aquifers or confining units above and below potential milling zones.

The Upper Cretaceous (65- to 99-million-year-old) Pierre Shale is a widespread, compositionally uniform, dark gray to black marine shale, which outcrops extensively in Dawes County north of the Crow Butte mining area (Collings and Knode, 1984). In Dawes County, the Pierre Shale is 365 to 460 m [1,200 to 1,500 ft] thick and is essentially impermeable. Due to aerial exposure and subsequent erosion, the top of the present-day Pierre Shale contact marks a major unconformity and exhibits a paleotopography with considerable relief (DeGraw, 1969). As a result of the extended exposure to atmospheric weathering, an ancient soil horizon, or paleosol, from 0 to 10 m [0 to 33 ft] thick, was formed on the surface of the Pierre Shale.

The Oligocene (23.8- to 33.7-million-year-old) White River Group lies unconformably on top of the Pierre Shale. The White River Group consists of the Chadron and Brule Formations. The Chadron comprises three distinct units: the Basal Chadron Sandstone Member, Middle Chadron Member, and Upper Chadron Member.

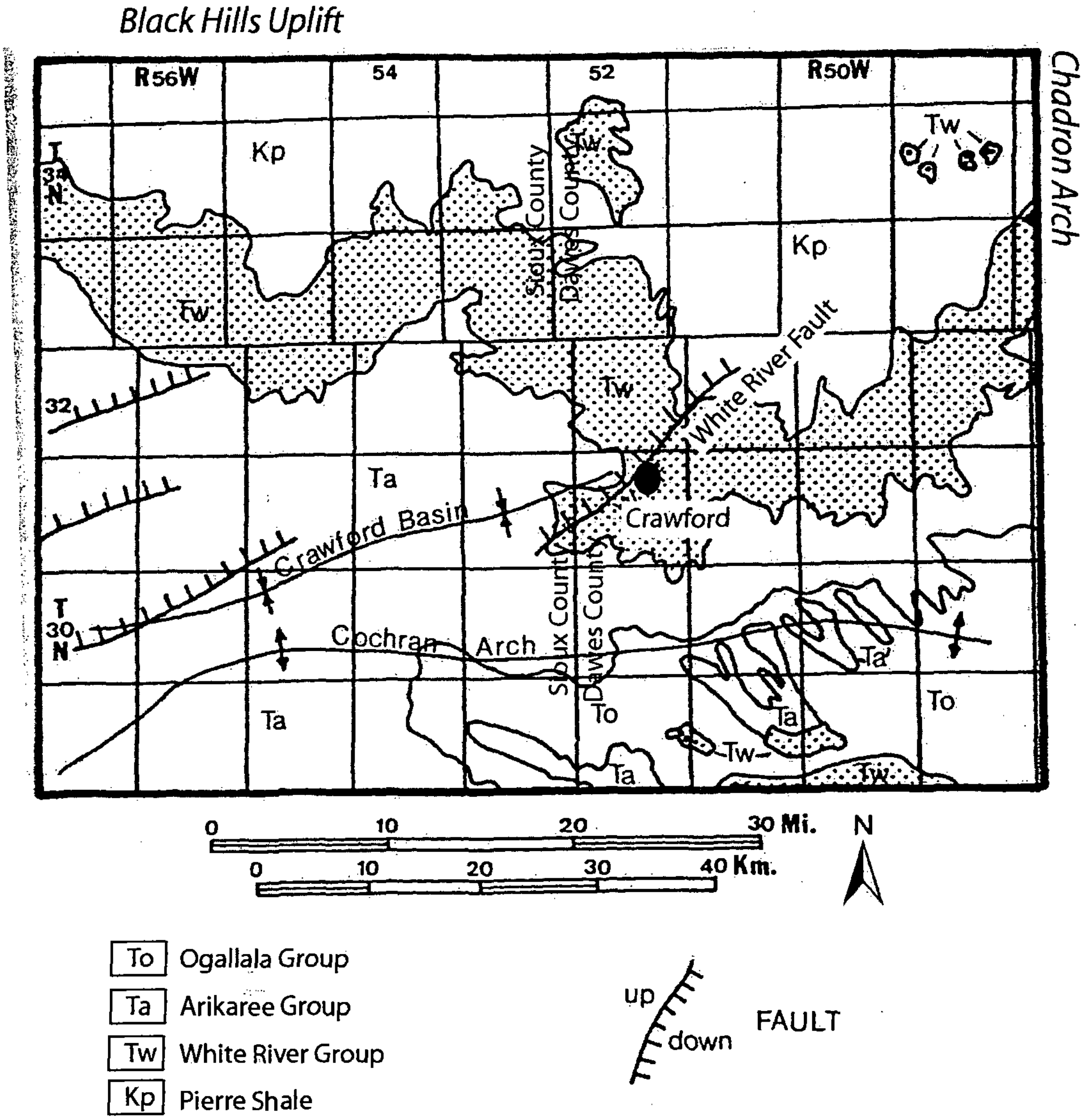



**Figure 3.4-7. Bedrock Geology and Major Structural Features of the Crawford Basin (Modified From Gjelsteen and Collings, 1988)**

Uranium mineralization in the Crow Butte mineralized trend occurs exclusively within the Basal Chadron Sandstone. The Basal Chadron Sandstone Member consists of coarse-grained arkosic sandstone (i.e., sandstone containing a significant fraction of feldspar) with frequent interbedded thin clay beds. Occasionally, the lower portion of the Basal Member is a very coarse, poorly sorted conglomerate. The Basal Sandstone is the depositional product of a large, braided stream system and ranges from 0 to 105 m [0 to 350 ft] thick.

The Middle Chadron Member overlies the Basal Sandstone Member. The lower part of the Middle Member is impermeable brick-red clay with occasional interbedded gray-green clay. The brick-red clay grades upward to a light green-gray sandy claystone. The upper part of the Middle Member is light gray bentonitic clay. The Middle Member ranges from 12 to 30 m [40 to

| Northwestern Nebraska | | | |
|---|---|---|---|
| **Age** | **Group** | **Formation** | **Member** |
| Miocene | Arikaree | Monroe Creek | |
| Oligocene | | Gering | |
| | White River | Brule | Whitney |
| | | | Orella |
| | | Chadron | Upper |
| | | | Middle |
| | | | Basal |
| Eocene ? | | Paleosol | |
| Cretaceous | | Pierre Shale | |

**Figure 3.4-8. Generalized Stratigraphic Units in the Crow Butte Area of Northwestern Nebraska (Modified From Collings and Knode, 1984)**

100 ft] thick. The Upper Chadron Member consists of massive claystones and siltstones, generally considered to be fluvial in origin (Vondra, 1958). The Upper Chadron Member averages 30 m [100 ft] thick throughout the Crow Butte mining area.

The Brule Formation lies conformably on top of the Chadron Formation and consists almost entirely of siltstones with minor sand channels. The Brule is subdivided into two members: the Orella and the Whitney. The Orella lies directly on the Chadron and is composed of buff to brown siltstones. The Whitney comprises massive buff to brown siltstones and contains several volcanic ash horizons.

Uranium deposits in the Basal Chadron Sandstone are associated with oxidation-reduction boundaries or roll fronts (see Section 3.1.1) adjacent to the White River Fault (Figure 3.4-9). Within the Crow Butte uranium ore trend, the Basal Chadron is about 12 m [40 ft] thick (Collings and Knode, 1984). Depth to mineralization varies from 85 to 250 m [275 to 820 ft]. Uranium is present in the matrix and as a coating on grains as coffinite and uraninite, and occurs locally in concentrations as high as 3.0 percent (Gjelsteen and Collings, 1988). The volcaniclastic sediments contained in and overlying the Chadron sandstone are considered to be the most likely source of the uranium of the roll-front deposits in the Crawford Basin because of their abundance, close proximity, and susceptibility to dissolution (Gjelsteen and Collings, 1988).

The distribution and occurrence of soils in Nebraska-South Dakota-Wyoming Uranium Milling Region vary regionally with respect to landform development (e.g., ridges, floodplains, hills) and

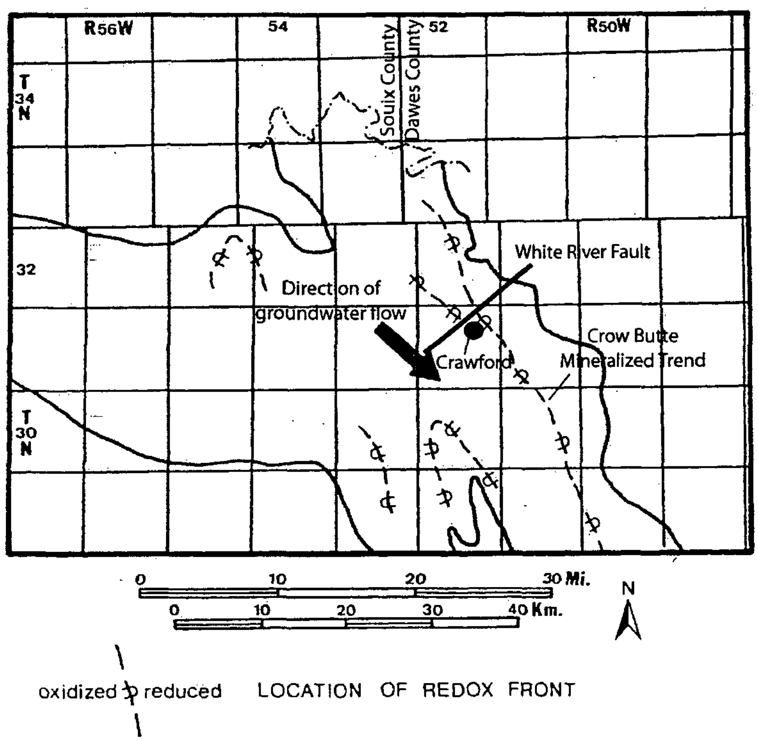



**Figure 3.4-9. Location of Oxidation-Reduction Fronts Detected During Exploration Drilling Within the Chadron Sandstone in Northwestern Nebraska. Arrow Shows Direction of Groundwater Flow at the Time of Mineralization as Indicated by Roll-Front Geometry (Modified From Gjelsteen and Collings, 1988).**

locally with changes in slope, geology, vegetation, climate, and time. The general characteristics of soils associated with landforms in Dawes County were obtained from the U.S. Department of Agriculture (NRCS, 2007). For site-specific evaluations at proposed ISL milling facilities, more detailed soils information can be obtained from published county soil surveys or the NRCS.

In Dawes County, silt loam and silty clay loam soils having little to moderate horizon development are found on ridges. These shallow to moderately shallow soils occur on steep slopes where erosion activity is greatest. Soils on hillslopes vary from soils having little or moderate horizon development to soils that have well-developed horizons (deep soils). Silty clay and silty clay loam soils having little to moderate horizon development are found on the steeper parts of hillslopes where erosional activity is greatest. Silty clay loam and loamy, very fine sand soils having well-developed horizons are found on gently sloping parts of hillslopes. On plains, which are nearly level or gently sloping, silt loam soils with well-developed clay horizons are found. Soils found on stream terraces and floodplains are generally very deep, with soil textures that are highly variable, depending on the local geology. Silty clay, silty clay loam, silt loam, and loam soils are found on stream terraces. Clay, loamy very fine sand, and sandy loam soils are found on floodplains.

## 3.4.4 Water Resources

### 3.4.4.1 Surface Waters

The Nebraska-South Dakota-Wyoming Uranium Milling Region includes portions of northwestern Nebraska, eastern Wyoming, and southwest South Dakota. Average annual surface runoff, in terms of average annual flow per unit area of a watershed in the Nebraska-South Dakota-Wyoming Uranium Milling Region, ranges from approximately 5 cm/yr [2 in/yr] in the higher elevations of the Black Hills to less than 1.3 cm/yr [0.5 in/yr] on the plains surrounding the Black Hills. Watersheds in the Nebraska-South Dakota-Wyoming Uranium Milling Region are shown in Figure 3.4-10. The watersheds within the Nebraska-South Dakota-Wyoming Uranium Milling Region are listed in Table 3.4-4 along with the generic designated uses of surface water bodies in these watersheds. The designated uses of water bodies in these watersheds differ slightly from state to state. Thus, the designated uses for water bodies in watersheds that cross state boundaries may be different. To simplify the discussion of the water quality characteristics of water bodies in each watershed, the designated uses in Table 3.4-4 have been grouped into the following generic categories: fisheries, fish and wildlife propagation, recreation, drinking water supply, agriculture, industrial, and aesthetic. Water bodies with the generic use as a fishery may support either warm-water or cold-water species. More detailed descriptions of the designated uses in each state can be found in the following references

- Wyoming—WDEQ (2001; 2008)
- Nebraska—Nebraska Department of Environmental Quality (2008)
- South Dakota—South Dakota Department of Environmental and Natural Resources (2008)

Not all water bodies within a watershed may have all of the designated uses listed in Table 3.4-4. For example, a watershed may contain perennial streams, intermittent streams that flow only during portions of the year, and ephemeral streams that flow only due to surface runoff from local precipitation events. The perennial streams and possibly portions of

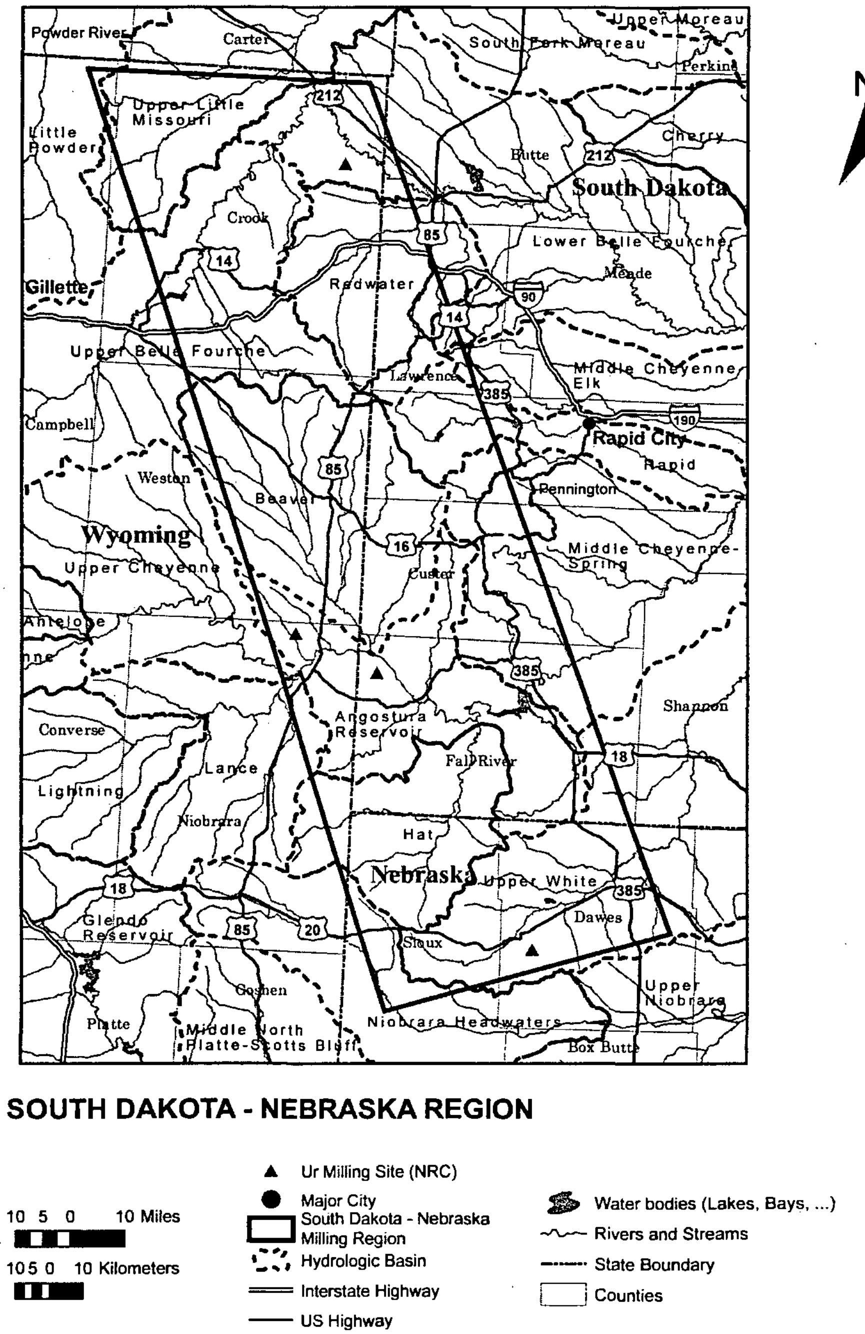



**Figure 3.4-10. Watersheds Within the Nebraska-South Dakota-Wyoming Uranium Milling Region**

**Table 3.4-4. Primary Watersheds in the Nebraska-South Dakota-Wyoming Uranium District and Range of Generic Designated Uses of Water Bodies Within Each Watershed**

| Watershed | Generic State Designated Uses of Water Bodies in the Watershed | |
|---|---|---|
| Upper White River | Nebraska | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Aesthetics |
| Hat Creek | Nebraska | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Aesthetics |
| | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Aesthetics |
| Angostura Reservoir | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Aesthetics |
| Cheyenne River Above Angostura Reservoir | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Recreation<br>Agriculture<br>Aesthetics |
| | Wyoming | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Industrial<br>Aesthetics |

| Table 3.4-4. Primary Watersheds in the Nebraska-South Dakota-Wyoming Uranium District and Range of Generic Designated Uses of Water Bodies Within Each Watershed (continued) | | |
|---|---|---|
| **Watershed** | **Generic State Designated Uses of Water Bodies in the Watershed** | |
| Beaver Creek | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Recreation<br>Agriculture<br>Aesthetics |
| | Wyoming | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Industrial<br>Aesthetics |
| Upper Belle Fourche River and Tributaries | Wyoming | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Industrial<br>Aesthetics |
| Lower Belle Fourche River and Tributaries | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Recreation<br>Agriculture<br>Aesthetics |
| | Wyoming | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Industrial<br>Aesthetics |
| Redwater River and Tributaries | South Dakota | Fisheries<br>Fish and Wildlife Propagation<br>Recreation<br>Agriculture<br>Aesthetics |
| | Wyoming | Fisheries<br>Fish and Wildlife Propagation<br>Drinking Water<br>Recreation<br>Agriculture<br>Industrial<br>Aesthetics |

intermittent streams may be designated as "fisheries," whereas ephemeral streams are unlikely to be designated as fisheries. The descriptions of the water bodies and their classifications in this section focus on perennial streams that generally have higher designated uses than the intermittent and ephemeral streams.

Surface water features in specific areas of uranium mineralization within the Nebraska-South Dakota-Wyoming Uranium Milling Region are discussed next.

**Nebraska**

The area of known uranium mineralization in Nebraska is located in Dawes County within the Upper White River Watershed (Figure 3.4-10). The average annual flow of the White River at the Nebraska-South Dakota state line, near the northern limit of known uranium deposits, was approximately 1.1 $m^3/s$ [40 $ft^3/s$] for water years 1988 through 2007 (U.S. Geological Survey, 2008a). The state-designated uses for the White River above Chadron, Nebraska, are drinking water supply, aquatic life (cold water), agriculture, and aesthetics (Nebraska Department of Environmental Quality, 2008).

The immediate area of uranium mineralization is drained by White Clay Creek, Squaw Creek, and English Creek, with headwaters in the Nebraska National Forest along Pine Ridge. Small surface impoundments are present along these creeks and are used for stock watering. The state-designated uses for these perennial creeks are aquatic life (cold water), fish consumption, agriculture, and aesthetics (Nebraska Department of Environmental Quality, 2008). These streams are not identified as having impaired water quality.

The Nebraska-South Dakota-Wyoming Uranium Milling Region also includes a portion of Sioux County and the Hat Creek Watershed. Hat Creek is a tributary to the Cheyenne River above Angostura Reservoir in South Dakota. The average flow of Hat Creek at the gauging station near Edgemont, South Dakota, is 0.45 $m^3/s$ [16 $ft^3/s$] (U.S. Geological Survey, 2008a). The only impaired water body reported in the Hat Creek Watershed is Meng Lake, which has high conductivity and impaired pH (Nebraska Department of Environmental Quality, 2008).

**South Dakota and Wyoming**

The uranium deposits in the Nebraska-South Dakota-Wyoming Uranium Milling Region of South Dakota and Wyoming occur around the western and northern flanks of the Black Hills. The principal uranium deposits are in Fall River County, South Dakota, within the Angostura Reservoir Watershed and in Niobrara, Weston, and Crook Counties in Wyoming (Hart, 1968) within the Angostura Reservoir and Lower Belle Fourche River Watersheds. Although Custer, Pennington, and Lawrence Counties in South Dakota are included within the Nebraska-South Dakota-Wyoming Uranium Milling Region, uranium deposits are not known to exist in these counties. The primary watersheds in South Dakota and Wyoming that may contain uranium deposits within the Nebraska-South Dakota-Wyoming Uranium Milling Region are listed in Table 3.4-4 along with their generic state-designated uses and any known impairments to these uses. Although the Nebraska-South Dakota-Wyoming Uranium Milling Region shown in Figure 3.4-10 includes small portions of additional watersheds on its periphery, these secondary watersheds are not in areas of anticipated uranium milling activities.

The uranium deposits in South Dakota occur within the watersheds of the Cheyenne River upstream of Angostura Reservoir, Beaver Creek, Redwater River, and Lower Belle Fourche River (Figure 3.4-10). Within South Dakota, the Cheyenne River has generic designated uses of fisheries, fish and wildlife propagation, recreation, irrigation, and aesthetics. According to South Dakota Department of Environment and Natural Resources (2008), the Cheyenne River above Angostura Reservoir is impaired due to high salinity from natural salts. The average flow of the Cheyenne River at Edgemont, South Dakota, is 2.1 $m^3/s$ [75 $ft^3/s$] (U.S. Geological Survey, 2008a). The upland portions of the uranium district are primarily drained by ephemeral and intermittent streams with the exception of the lower reach of Red Canyon Creek, which is perennial and fed by springs on the flanks of the Black Hills.

The Beaver Creek Watershed includes portions of Custer and Pennington counties in South Dakota and Weston County in Wyoming. The generic designated uses of Beaver Creek and its tributaries are listed in Table 3.4-4. Portions of Beaver Creek and its tributaries within South Dakota are impaired due to elevated temperature, salinity, and turbidity (South Dakota Department of Environment and Natural Resources, 2008). The average flow of Beaver Creek at Mallo Camp, Wyoming, is 0.05 $m^3/s$ [1.8 $ft^3/s$] for water years 1992 and 2008.

The Upper Belle Fourche Watershed is located in Wyoming northwest of the Beaver Creek Watershed in Weston and Crook Counties. The generic designated uses of the Upper Belle Fourche River and its tributaries are listed in Table 3.4-4. A number of perennial streams flowing from the flanks of the Black Hills, such as Inyan Kara Creek, are also present in this watershed. These streams are fed by springs on the flanks of the Black Hills. Streams in portions of the Upper Belle Fourche Watershed are impacted by elevated fecal coliform from unidentified sources (WDEQ, 2008).

The Lower Belle Fourche Watershed extends from northeastern Crook County in Wyoming (downstream of the Upper Belle Fourche Watershed) into Butte, Meade, and Lawrence Counties in South Dakota. The designated uses of the Lower Belle Fourche Watershed and some of its tributaries are impacted by elevated temperature, salinity, turbidity, and fecal coliform (South Dakota Department of Environment and Natural Resources, 2008). The elevated salinity, turbidity, and fecal coliform are from agricultural livestock grazing activities. Some of the tributaries to the Belle Fourche River drain historical mining districts and are impacted by metals and acidity due to mine drainage. The average flow of the Belle Fourche River at the Wyoming-South Dakota state line is 2.4 $m^3/s$ [85 $ft^3/s$] for water years 1959 through 2007 (U.S. Geological Survey, 2008a).

The Redwater River watershed straddles the Wyoming-South Dakota state line between the Upper and Lower Belle Fourche Watersheds (Figure 3.4-10) The generic designated uses of the Redwater River and its tributaries are listed in Table 3.4-4. The average flow of the Redwater River at the gauging station above Belle Fourche, South Dakota, is 3.9 $m^3/s$ [139 $ft^3/s$] for water years 1946 through 2007 (U.S. Geological Survey, 2008a). Water bodies in this watershed are not listed as impaired.

#### 3.4.4.2 Wetlands and Waters of the United States

Wetland areas found in this region are consistent with those found in the Wyoming East Uranium Milling Region (Section 3.3.4.2). Waters of the United States and special aquatic sites that include wetlands would be expected to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be obtained from the local USACE district. Section 401 state water quality certification is required for work in Waters of the United States. Within Wyoming, the State of Wyoming regulates isolated wetlands and waters. Cumulative total project impacts greater than 0.4 ha [1 acre] require a general permit for wetland mitigation by WDEQ. Within Nebraska, waters of the state are under the authority of the Nebraska Department of Environmental Quality. Isolated wetlands are included in Title 117, Nebraska Surface Water Quality Standards. No permitting mechanism is in place to authorize projects in isolated waters; however, state water quality standards apply.

### 3.4.4.3 Groundwater

Groundwater resources in the Nebraska-South Dakota-Wyoming Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of Nebraska, South Dakota, and Wyoming. Uranium-bearing aquifers exist within these regional aquifer systems in the Nebraska-South Dakota-Wyoming Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in the Nebraska-South Dakota-Wyoming Uranium Milling Region, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

#### 3.4.4.3.1 Regional Aquifer Systems

Major regional aquifers in the Nebraska-South Dakota-Wyoming Uranium Milling Region include the Northern Great Plains aquifer system (Whitehead, 1996) and the High Plains aquifer system (Miller and Appel, 1997).

**Northern Great Plains Aquifer System (underlying South Dakota):** The Northern Great Plains aquifer system underlies most of the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region (Whitehead, 1996). The Upper Cretaceous aquifers (important for uranium mineralization and water supplies) and the Paleozoic aquifers (important only for water supplies) of the Northern Great Plains aquifer system are the most extensive aquifers in the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region.

Groundwater in the upper Cretaceous aquifers (including minor aquifers in the region) contains less than 3,000 mg/L [3,000 ppm] dissolved solids except for small areas in South Dakota where concentrations are as large as 10,000 mg/L [10,000 ppm]. Water with dissolved-solids concentrations of less than 1,000 mg/L [1,000 ppm] is near the Black Hills Uplift (in west South Dakota) and in smaller areas near the boundaries of the aquifers. Groundwater from the upper Cretaceous aquifers provides domestic- and livestock-watering supplies as well as water for several small communities in northwestern South Dakota.

The lower Cretaceous aquifers are composed of several sandstones. The principal water-yielding units are the Newcastle Sandstone (equivalent to the Dakota Sandstone) and the Inyan Kara Group in the Williston Basin. The Newcastle Sandstone is only a few tens of kilometers [tens of feet] thick where it crops out on the flanks of the Black Hills Uplift, but its subsurface equivalent, the Dakota Sandstone, is more than 122 m [400 ft] thick in southeastern South Dakota. In many places, the Newcastle Sandstone is separated from the underlying Inyan Kara Group through the Skull Creek Shale. The Inyan Kara Group merges eastward into the lower part of the Dakota Sandstone in South Dakota.

The Lower Cretaceous aquifers are confined except at outcrop areas that encircle structural uplifts, such as the Black Hills Uplift and the Bighorn Mountains. In South Dakota, the lower Cretaceous aquifers are overlain by poorly permeable till and glacial-lake deposits, and the aquifers behave like a confined to semiconfined aquifer. The regional groundwater flow direction is northeastward from aquifer recharge areas at high altitudes to discharge areas. Although the groundwater in the lower Cretaceous aquifers is slightly saline in most of South Dakota, the aquifers are the principal source of water for livestock watering and domestic use. The water is very saline or a brine in the deep parts of the Williston Basin.

The upper Paleozoic aquifers consist primarily of the Madison Limestone, which is called the Madison Group in the Williston Basin. The Tensleep Sandstone in the western parts of the Powder River Basin and sandstone beds of the Minnelusa Formation in the Williston Basin and the eastern part of the Powder River Basin are treated as separated aquifers at the regional scale. The Pennsylvanian sandstones are not usually considered to be a principal aquifer. The Madison Limestone exhibits karst features in outcrop areas of the Madison in western South Dakota where large springs originate from solution conduits. In the upper Paleozoic aquifers, the regional groundwater flow direction is northeastward from recharge areas near structural uplifts close to the southern and western limits of the aquifer system. Withdrawal of the oil and gas from the hydrocarbon reservoir have resulted in water leaking downward from the upper Paleozoic aquifers through confining units into deeper permeable zones. Groundwater in the upper Paleozoic aquifers is fresh only in small zones near recharge areas, including the area of freshwater encircling the Black Hills Uplift in western South Dakota. The water becomes slightly saline to saline away from the recharge areas into the Williston Basin. Due to the upward leakage of the mineralized water from the upper Paleozoic aquifers into upper Cretaceous aquifers in central South Dakota, the groundwater becomes saline in shallower aquifers.

Lower Paleozoic aquifers are deeply buried for the most part. They consist of sandstone and carbonate rocks. There are great uncertainties in water yield characteristics of these aquifers at the regional scale. The regional groundwater flow direction is northeastward. Lower Paleozoic aquifers contain fresh water only in a small area near the Black Hills Uplift, but contain slightly saline to moderately saline groundwater throughout the southern one-half of their extent. In a large area in central South Dakota, some of the slightly saline water in the Lower Paleozoic aquifers leaks upward into shallower aquifers.

**High Plains Aquifer System (underlying Nebraska):** The High Plains aquifer underlies the southernmost part of Nebraska-South Dakota-Wyoming Uranium Milling Region. The High Plains aquifer is the principal source of groundwater for the High Plains region. The High Plains aquifer is unconfined for the most part. The water table is usually less than 61 m [200 ft] below the land surface in western Nebraska. However, the water table is between 61 and 91 m [200 and 300 ft] below the land surface in parts of western Nebraska. The regional groundwater flow direction is from west to east at an average velocity of 0.3 m/day [1 ft/day]. The saturated thickness of the High Plains aquifer ranged from 0 to approximately 305 m [0 to 1,000 ft] in 1980 with an average saturated thickness of 104 m [340 ft]. The average specific yield for entire aquifer is 15 percent. Recharge to the aquifer includes precipitation infiltrating through dune sands in western Nebraska, infiltration locally from streams and canals, and infiltration by a small quantity of water moving upward from the underlying bedrock. The rates of recharge are highly variable and range from about 0.3 to 20 percent of the average annual precipitation. Discharge from the aquifer includes water losses to springs, seeps, and streams; evapotranspiration; minor water losses to bedrocks and withdrawals mostly for irrigation.

The High Plains aquifer consists of all or parts of several geologic units of Quaternary and Tertiary age. Clay- to gravel-sized unconsolidated deposits of Quaternary age overlie the Ogallala Formation. These unconsolidated deposits are considered to be part of the High Plains aquifer, if they are saturated as in southeastern Nebraska. The High Plains aquifer is locally confined above by thick loess that consists mostly of silt and clay-sized materials. Highly porous dune sands of Quaternary age, where they are saturated, are also considered to be part of the aquifer (e.g., in west-central Nebraska) and recharge the High Plains aquifers.
The Ogallala Formation is underlain by the Arikaree Group. The Arikaree Group, which is composed of massive sandstone, overlies the Brule Formation. The maximum thickness of the Arikaree Group is about 305 m [1,000 ft] in western Nebraska. The Oligocene-aged Brule Formation of Oligocene, which is the upper unit of the White River Group, underlies much of western Nebraska. It is predominantly composed of massive siltstone and sandstone and is considered to be an aquifer only where it is fractured or it contains solution openings.

In large parts of Nebraska, the High Plains aquifer is underlain by upper Cretaceous rocks that primarily consist of shale, chalk, limestone, and sandstone. Only the chalk, where it is fractured or contains solution openings, yields enough water for irrigation. The Chadron Formation, part of the White River Group, directly underlies the High Plains aquifer in most of western Nebraska. It is predominantly composed of clay and silt units with minimal permeability.

In parts of western Nebraska, the High Plains aquifer is underlain by Jurassic- and Triassic-age rocks that primarily consist of shale and sandstone. The Jurassic and Triassic age rocks generally have low permeability, but some sandstone beds are locally permeable enough to yield water. In other areas, the High Plains aquifer is underlain by Tertiary and Permian rocks that predominantly consist of red shale, siltstone, sandstone, gypsum, anhydrite, and dolomite and locally include limestone and halite (rock salt) as beds or disseminated grains.

During 1990, about 17 million L/day [4.6 million gal/day] of groundwater was pumped from the High Plains aquifer, mostly (97 percent) for agricultural purposes. The potential water yield from wells in most of Nebraska is typically greater than 4.1 million L/day [1.1 million gal/day], although the water yield varies with the geologic formation tapped. For example, water yields from the Brule Formation are typically less than 1.6 million L/day [430,000 million gal/day]. Water yields from the Arikaree Group are not usually large, but locally in Western Nebraska are as large as 1.9 million L/day [500,000 million gal/day]. The water yields from the Brule Formation and the Arikaree Group are relatively larger where these rocks have secondary fractures. Water yields from the Ogallala Formation are 5.5 million L/day [1.4 million gal/day] in many parts of Nebraska.

In most of Nebraska, dissolved-solids concentrations in the High Plains aquifer are less than 500 mg/L [500 ppm], but locally exceed 1,000 mg/L [1,000 ppm] {the limit of dissolved solids recommended by the EPA for drinking water is 500 mg/L [500 ppm]}. Sodium concentrations in the High Plains aquifer are less than 25 mg/L [25 ppm] in most of Nebraska. However, excessive fluoride concentrations are a widespread problem in the High Plains aquifer. High fluoride concentrations in the range of 2–8 mg/L [2–8 ppm] are reported for the High Plains aquifer where the aquifer contains volcanic ash deposits or it is underlain by rocks of Cretaceous age.

The unconfined nature of the High Plains aquifer system along with the shallow water table makes the aquifer vulnerable to contamination by fertilizers and organic pesticides. Elevated concentrations of sodium, alkalinity, nitrate, and triazine (a herbicide) have been found in the aquifer in Nebraska. For example, during 1984–1985, nearly 33 percent of well samples in Nebraska showed measurable concentrations {greater than 0.04 µg/L [0.04 ppb]} of the herbicide atrazine (Whitehead, 1996).

3.4.4.3.2 Aquifer Systems in the Vicinity of Uranium Milling Sites

An underlying hydrogeological system in past and current areas of uranium milling interest in the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of a thick sequence of primarily sandstone and also limestone aquifers typically separated by shale aquitards. Uranium-bearing sandstone aquifers in the Inyan Kara Group at the potential ISL sites are used for local irrigation water supplies.

Areas of uranium milling interest in the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region are underlain by water-bearing layers including, from shallowest to deepest, the alluvial aquifers, the Newcastle sandstone (equivalent to the Muddy Sandstone), the sandstone aquifers in the Inyan Kara Group, the Morrison Formation, the Sundance Formation, the Spearfish Formation, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation. Among these aquifers, the Inyan Kara Group, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation contain important aquifers for water supplies. The rest of the water-bearing units in the region are pumped for limited local water uses (Williamson and Carter, 2001).

An underlying hydrogeological system in past and current areas of uranium milling interest in the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of a thick sequence of primarily sandstone and also limestone aquifers typically separated by shale aquitards.

At the Crow Butte ISL sites in Nebraska, only the Basal Chadron sandstone is considered to be an aquifer (NRC, 1998). The Arikaree and Brule Formations are not considered to be important aquifers for water supplies in this region (Miller and Appel, 1997; NRC, 1998).

3.4.4.3.3 Uranium-Bearing Aquifers

In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the sandstone aquifers in the Inyan Kara Group are important aquifers for uranium mineralization (Driscoll, et al., 2002). In this region, uranium may have been introduced into the Inyan Kara Group through upward leakage of uranium-rich water from the Minnelusa aquifer (Gott, et al., 1974). In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the Basal Chadron sandstone aquifer (in the Chadron Formation) hosts uranium mineralization (NRC, 1998).

For ISL operations to begin, portions of the uranium-bearing sandstone aquifers in the Inyan Kara Group and the Basal Chadron Sandstone of the Nebraska-South Dakota-Wyoming Uranium Milling Region would need to be exempted by the appropriate EPA- or state-administered underground injection program (Section 1.7.2.1).

**Hydrogeological characteristics:** In the South Dakota section of the Nebraska-South Dakota-Wyoming Uranium Milling Region, the Inyan Kara sandstone aquifers are typically confined except at outcrop areas. Transmissivity of the Inyan Kara aquifer ranges from

0.08–560 $m^2$/day [0.8–6,000 $ft^2$/day]. For ISL operations to be practical, the hydraulic conductivity of the production aquifer must be large enough to allow reasonable water flow from injection to production wells. Hence, the portions of the Inyan Kara aquifer with low hydraulic conductivities may not be readily amenable to uranium recovery using ISL techniques. The storage coefficient is in the range of $2.5 \times 10^{-5}$–$1.0 \times 10^{-4}$ (Driscoll, et al., 2002), indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from $10^{-5}$–$10^{-3}$) (Driscoll, 1986, p. 68).

In the Nebraska section of the Nebraska-South Dakota-Wyoming Uranium Milling region, the Basal Chadron Sandstone aquifer is confined by a thick sequence of aquitards. Transmissivity of the Basal Chadron Sandstone aquifer ranges from 30 to 45 $m^2$/day [350 to 480 $ft^2$/day] and the average aquifer storage coefficient is in the range of $1.3 \times 10^{-5}$–$8.4 \times 10^{-4}$ (NRC, 1998), indicating the confined nature of the production aquifer (typical storage coefficients for confined aquifers range from $10^{-5}$–$10^{-3}$ (Driscoll, 1986; p. 68).

**Level of confinement:** The production aquifer is typically confined in the Nebraska-South Dakota-Wyoming Uranium Milling Region. The thickness of the confinement varies spatially.

In South Dakota, the Inyan Kara Group is generally confined by several thick shale layers, except in the outcrop area around structural uplifts, such as the Black Hills. The Inyan Kara Group is confined above by the Skull Creek Shale with a thickness of 46–80 m m [150–270 ft]. The Skull Creek Shale is confined above by the regionally continuous Pierre Shale unit with a thickness of 1,220 m [4,000 ft] in the Black Hills area. The Inyan Kara Group is hydraulically separated from the underlying Minnekahta limestone by low permeability units including, from shallowest to deepest, the Morrison Formation, the Sundance Formation, and the Spearfish Formation. The total thickness of these low permeability layer varies from 190 to 450 m [625 to 1,470 ft] at the Black Hills. Thus, except at the outcrop areas, the sandstone aquifers in the Inyan Kara Group are confined above and below by thick confining units in the Nebraska-South Dakota-Wyoming Uranium Milling Region. A vertical hydraulic conductivity of $0.4 \times 10^{-6}$ m/day [$1.3 \times 10^{-6}$ ft/day] for the Skull Creek Shale and $1.5 \times 10^{-8}$–$1.5 \times 10^{-4}$ m/day [$5 \times 10^{-8}$–$5 \times 10^{-4}$ ft/day] for the Pierre Shale is estimated in South Dakota (Kansas Geological Survey, 1991).

In Nebraska, the ore-bearing aquifer is confined below by the Pierre Shale with an average thickness of 365 m [1,200 ft] and a vertical hydraulic conductivity of $3.4 \times 10^{-11}$ to $3.6 \times 10^{-12}$ m/s [$11.2 \times 10^{-11}$ to $11.8 \times 10^{-12}$ ft/s]. The upper confinement unit is composed of a red clay bed up to 3–8 m [10–25 ft] thick with a vertical hydraulic conductivity of $3 \times 0^{-8}$ to $2 \times 0^{-7}$ m/day [$1 \times 10^{-7}$ to $7 \times 10^{-7}$ ft/day]. The red clay bed is overlain by another thick confining layer (the Middle Chadron) with an average thickness of 95–100 m [315–325 ft]. The thickness of the upper confining unit is about 60–90 m [200–300 ft] in the permit area. Aquifer testing indicates that movement of lixiviant would be vertically contained by the confining units and horizontally captured in the production zone in the Crow Butte region (NRC, 1998).

**Groundwater quality:** Water from the Inyan Kara aquifer in South Dakota is locally fresh to slightly saline. However, generally high concentrations of dissolved solids, iron, sulfate, and manganese may hamper the use of water from the Inyan Kara aquifer. Hard water from wells located on or near the outcrop may require special treatment. Suitability for irrigation may be affected by high specific conductance and sodium adsorption ratio [the ratio of the sodium (detrimental element) concentration to the combined concentration of calcium and magnesium (beneficial elements)]. Almost 18 percent of samples collected from the Inyan Kara aquifer exceed the maximum concentration level for combined radium-226 and radium-228. About 4 percent of these samples exceed the maximum concentration level for uranium. The uranium and radium-226 concentrations ranged from 0.1 to 109 ppm and $7.4 \times 10^{-3}$–1.59 Bq/L [0.2–43 pCi/L] in the Inyan Kara aquifer, respectively. In the southern Black Hills, radium-226 and uranium concentrations may preclude use of untreated water from Inyan Kara aquifer for drinking (Williamson and Carter, 2001).

Based on baseline (preoperational) water quality data, the Basal Chadron Sandstone is generally of good quality (with the total uranium less than $3.7 \times 10^{-4}$–$8.9 \times 10^{-2}$ Bq/L [0.01–2.40 pCi/L] and the total conductivity in the range of 1,500–2,500 mhos. The State of Nebraska Department of Environmental Quality defines the Basal Chadron sandstone as an underground source of drinking water (NRC, 1998). However, in the vicinity of the mineralized zone, uranium and radium concentrations are elevated. Radium-226 levels range from $3.7 \times 10^{-3}$ – 22.9 Bq/L [0.1–619 pCi/L], which exceeds the 5 pCi/L EPA primary drinking water standard. As a result, water drawn from Chadron sandstone is not considered potable near the mineralization zone (NRC, 1998).

**Current groundwater uses:** Groundwater from Inyan Kara aquifer is typically pumped for local irrigation. Groundwater from the Basal Chadron Sandstone is pumped for agricultural and domestic uses.

3.4.4.3.4 Other Important Surrounding Aquifers for Water Supply

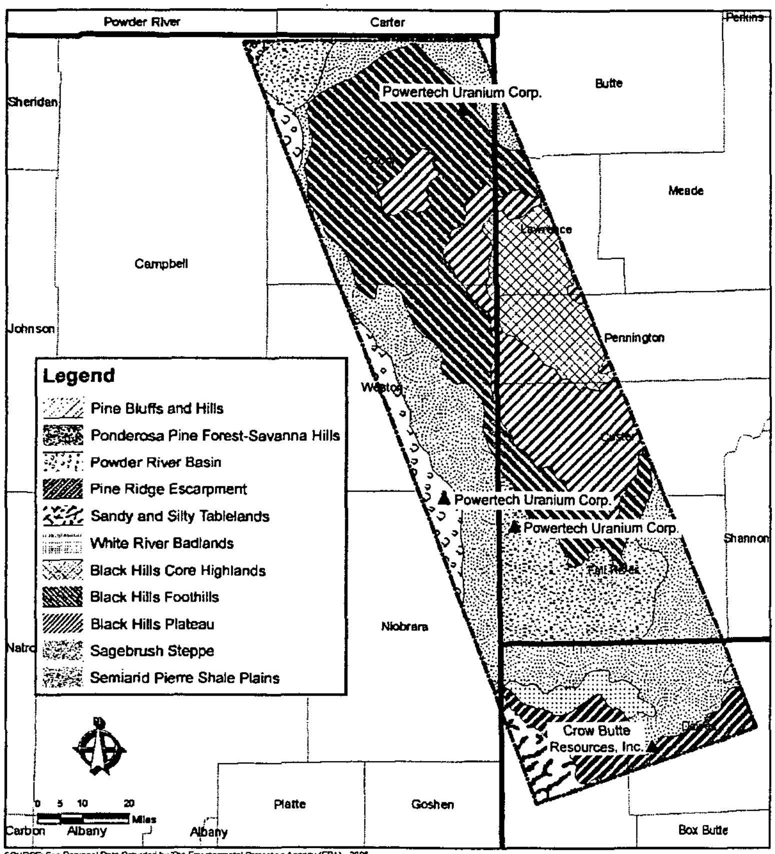
The major aquifers in the hydrologic setting of the Black Hills area all underlie the Inyan Kara Group. The major aquifers include, from shallowest to deepest, the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation. These aquifers are separated by relatively impermeable layers, but they are (including the Inyan Kara Group) collectively confined by the underlying Precambrian basement rocks and the overlying the Skull Creek and the Pierre Shales. These aquifers are used extensively for water supplies in the region (Williamson and Carter, 2001). The average saturated thicknesses of the Minnekahta Limestone, the Minnelusa Formation, the Madison Formation, and the Deadwood Formation are 15, 224, 159, and 152 m [50, 736, 521, and 500 ft], respectively. The aquifer transmissivity for the Minnelusa Formation, the Madison Formation, and the Deadwood Formation are estimated to be 2.8–28 $m^2$/day [30–300 $ft^2$/day], $9.2 \times 10^{-4}$–5,000 $m^2$/day [0.01–54,000 $ft^2$/day], and 23–93 $m^2$/day [250–1,000 $ft^2$/day], respectively. The storage coefficient for the Minnelusa Formation and the Madison Formation are estimated to be $6.6 \times 10^{-5}$ through $2.0 \times 10^{-4}$ and $1.12 \times 10^{-6}$ through 0.002 (Driscoll, et al., 2002). At the Crow Butte ISL sites in Nebraska, only the Basal Chadron sandstone is considered to be an aquifer (NRC, 1998).

## 3.4.5 Ecology

### 3.4.5.1 Terrestrial

#### Nebraska-South Dakota-Wyoming Uranium Milling Region Flora

According to the EPA, the identified ecoregions in the Nebraska-South Dakota-Wyoming Uranium Milling Region primarily consist of Middle Rockies, Northwestern Great Plains, Western High Plains, and the Nebraska Sand Hills ecoregions (Figure 3.4-11). Uranium districts are located in ecoregions including the Black Hills Foothills, Sagebrush Steppe, the Pine Ridge Escarpment, and the Powder River Basin. The Middle Rockies ecoregion is discussed in the Wyoming West region (Section 3.2.5).




SOURCE: Eco Regional Data Provided by The Environmental Protection Agency (EPA) - 2005

**Figure 3.4-11. Ecoregions for the Nebraska-South Dakota-Wyoming Uranium Milling Region**

The Black Hills Foothills ecoregion is composed of the Hogback Ridge and the Red Valley. The Hogback Ridge forms a ring of foot hills surrounding the Black Hills. The Red Valley encircles most of the Black Hills dome and acts as a buffer between the Hogback Ridge. Natural vegetation within this region includes ponderosa pine woodlands and open savannas with an understory of western wheat grass, needle-and-thread grass, little bluestem (*Schizachyrium scoparium*), blue grama, buffalo grass (*Hierochloe odorata*), and leadplant (*Amorpha canescens*). In addition, some burr oak (*Quercus macrocarpa*) is found in the north and Rocky Mountain juniper (*Juniperus scopulorum*) occurs in the south (Chapman, et al., 2004).

The Black Hills Plateau ecoregion is a relatively flat, elevated expanse, with broad ridges and entrenched canyons, covering the mid-elevation slopes of the Black Hills. The Black Hills, a mountainous outlier in the Great Plains, has a highly diverse vegetative cover, with an overlap of eastern, boreal, and Rocky Mountain species. The dominant tree spies found in the region is the ponderosa pine; however, it blends with eastern boxelder (*Acer negundo* ssp.), burr oak, and boreal paper birch (*Betula papyrifera*). White spruce and sedges can be found in moist areas. The understory includes grasses like little bluestem and timber oatgrass (*Danthonia intermedia*) and shrubs such as juniper, snowberry, bearberry, and buffaloberry (*Shepherdia argentea*) (Chapman, et al., 2004).

The Black Hills Core Highlands ecoregion includes the higher portions of the limestone plateau above 1,500 m [5,000 ft] and the granitic intrusions that form the major peaks to elevations greater than 2,130 m [7,000 ft]. Due to the high elevation, temperature, and high rainfall boreal species such as white spruce, quaking aspen, and paper birch can be found on the northern slopes and moist canyons. Ponderosa pine forests interspersed with high meadows are predominant in the region. Understory species include sedges in moist areas, bearded wheatgrass, oatgrass, brome grass (*Bromus* spp.), common juniper, snowberry, Oregon bent grass (*Agrostis oregonensis*), bearberry, and iris (*Iris* spp.) (Chapman, et al., 2004)

The Northwestern Great Plains is discussed in Section 3.3.5.1.

The Montana Central Grassland ecoregion is found mostly in Montana with only a small area continuing into northern Wyoming. The dominant vegetation within this region is a mixed grass prairie composed of blue grama, western wheatgrass, junegrass, Sandberg bluegrass, needle-and-thread grass, rabbitbush, fringed sage, and grama-needlegrass-wheatgrass. The shrub or woodland component found in other ecoregions (Sagebrush Steppe) is absent (Chapman, et al., 2004).

The Sagebrush Steppe ecoregion is found in Montana and in the Dakotas with only a small area extending into Wyoming. Vegetation types in this region consist of big sagebrush, Nuttall saltbush (*Atriplex nuttallii*), and short grass prairie. The sparse sagebrush communities consist of dusky gray sagebrush (*Artemisia arbuscula* ssp. *Arbuscula)*, dwarf sage (*Artemisia columbiensis*), and big sagebrush. Prairie vegetation that can be found include western wheatgrass, green needlegrass, blue grama, Sandberg bluegrass, junegrass, rabbit brush, fringed sage, and buffalograss. The shrub vegetation of this ecoregion is transitional between the grasslands of the Montana Central Grassland and the woodland of the Pine Scoria Hills (Bryce, et al., 1996)

The Semiarid Pierre Shale Plains are relatively treeless consisting of rolling hills and grasslands. This is an arid region with rainfall between 38 and 43 cm [15 and 17 in] annually (Bryce, et al., 1996). The natural mixed-grass prairies of the region include shortgrass species such as buffalograss, western wheatgrass, bluebunch wheatgrass, needle-and-thread grass, blue grama, and Sandberg bluegrass. In this ecoregion the sagebrush component found is the neighboring Sagebrush Steppe (Chapman, et al., 2004).

The Powder River Basin and Pine Scoria Hills ecoregions are discussed in Section 3.3.5.1.

The White River Badlands in Nebraska border the northern edges of the Pine Ridge Escarpment and are southern outliers of a more extensive area in South Dakota. The landscape is broken by grass-covered, perched "sod tables" that may be grazed or tilled typical native vegetation found in this region consists of silver sagebrush, western wheatgrass saltbush, and rabbitbrush (Chapman, et al., 2001).

**Western High Plains**

The Pine Ridge Escarpment forms the boundary between the Missouri Plateau to the north and the High Plains to the south. This escarpment consists of a ponderosa pine woodland composed of Rocky Mountain juniper, western soapberry (*Sapindus drummondii*), skunkbush sumac, choke cherry (*Prunus virginiana*), and Arkansas rose (*Rosa arkansana).* The vegetation found in the mixed-grass prairies of the region consist of little bluestem, western wheatgrass, reed grass (*Phalaris* spp.), needle-and-thread grass, blue grama, and threadleaf sedges (*Carex filifolia*) in moist areas (Chapman, et al., 2001).

The Pine Bluffs and Hills ecoregion is discussed in Section 3.3.5.1.

The Sandy and Silty Tablelands ecoregion is discussed in Section 3.3.5.1.

The Flat to Rolling Cropland ecoregion has extensive drylands farming, irrigated crops, and rangelands throughout this region. Winter wheat, grain sorgum, corn, and alfalfa are the main cash crops, with smaller acreages in forage crops consisting of grain (Chapman, et al., 2001).

The Dense Clay Prairie differs from the surrounding ecoregions in its relative lack of vegetative cover. The grassland in this ecoregion is missing its short- and midlevel layers; however, it does include tall grasses composed mostly of western wheatgrass. Little to no woodlands are found along waterways (Bryce, et al., 1996).

**Nebraska Sand Hills Ecoregions**

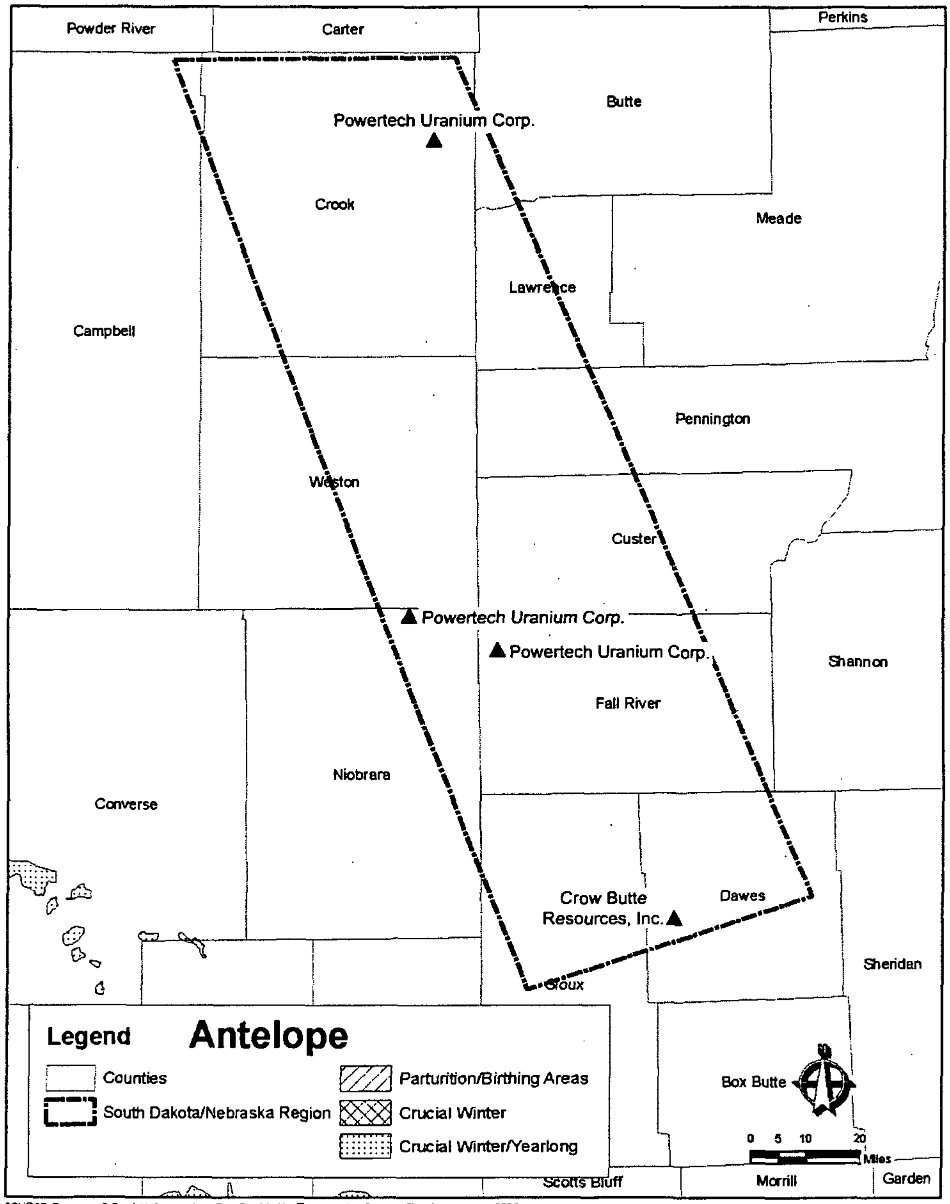
The Nebraska Sand Hills consist of one of the most distinct and homogeneous ecoregions in North America. With one of the largest areas of grass-stabilized sand dunes in the world, this region is generally devoid of cropland agriculture, and except for some riparian areas in the north and east, the region is treeless. Numerous lakes and wetlands dot the region, and parts of the region are without streams (Chapman, et al., 2001).

The Sand Hills include grass stabilized sand dunes and open sand areas. Dune size, pattern, and alignment generally follow a west-to-east trending axis, with the larger dune hills in the west having local relief as great as about 120 m [400 ft]. Grasses found in the area consist of prairie sandreed (*Calamovilfa longifolia*), little bluestem, sand bluestem (*Andropogon hallii*), switchgrass (*Panicum virgatum*), sand love grass (*Eragrostis trichodes*), needle-and-thread grass, blue grama, and hairy grama (*Bouteloua hirsuta*) (Chapman, et al., 2001).

The Alkaline Lakes Area is dominated by sand dunes and many scattered alkaline lakes. These lakes are located in what is commonly referred to as the "closed basin area." This area is generally devoid of streams. The high alkalinity around lakes restricts wetland vegetation growth with the exception of alkaline tolerant species such as certain alkaline bulrush (*Schoenoplectus maritimus)*, alkali sacaton (*Sporobolus airoides*), and inland saltgrass (*Distichlis stricta*). Grass species found in the region are similar to those found in the Sand Hills region and consist of prairie sandreed, little bluestem, sand bluestem, switchgrass, sand love grass, needle-and-thread grass, blue grama, and hairy grama (Chapman, et al., 2001).

**Nebraska-South Dakota-Wyoming Uranium Milling Region Fauna**

Animal species that may occur in the Middle/Southern Rockies which include the Black Hills, the Northwest Great Plains/Northern short grasslands, and Western High Plains/Western Short Grasslands have been discussed in the Wyoming East Uranium Milling Region (Section 3.3.5.1). According to the Wyoming Game and Fish Department, crucial wintering habitats are found with this region for large game animals and nesting leks for the sage-grouse. Figures 3.4-12 to 3.4-18 depict the crucial winters, yearlong areas ranges for large game found in this region. Within this region the Northern Black Hills Uranium District, located in the northeastern portion of the region, is near the crucial winter/yearlong area for white-tailed deer.




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.4-12. Antelope Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**

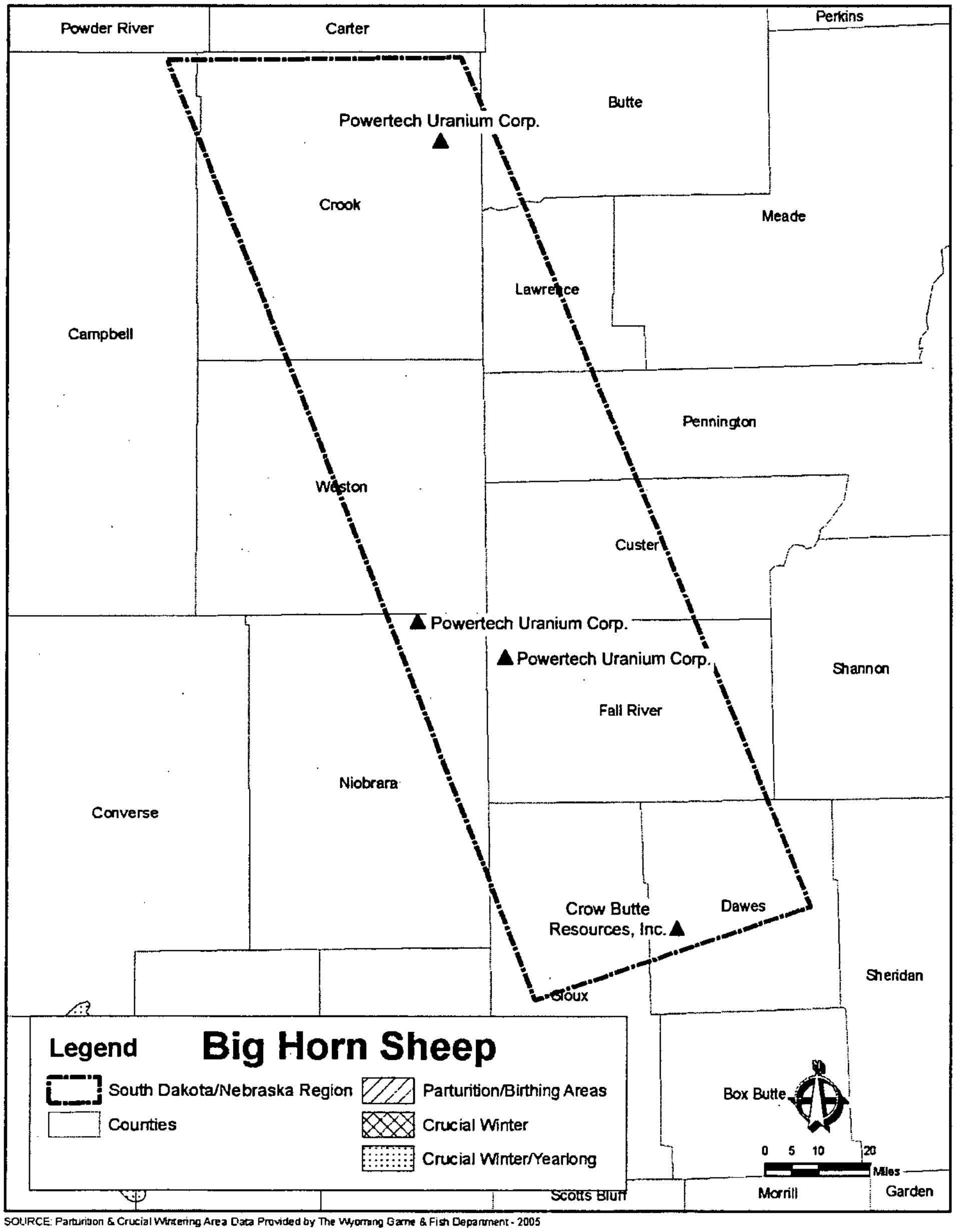



**Figure 3.4-13. Big Horn Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**

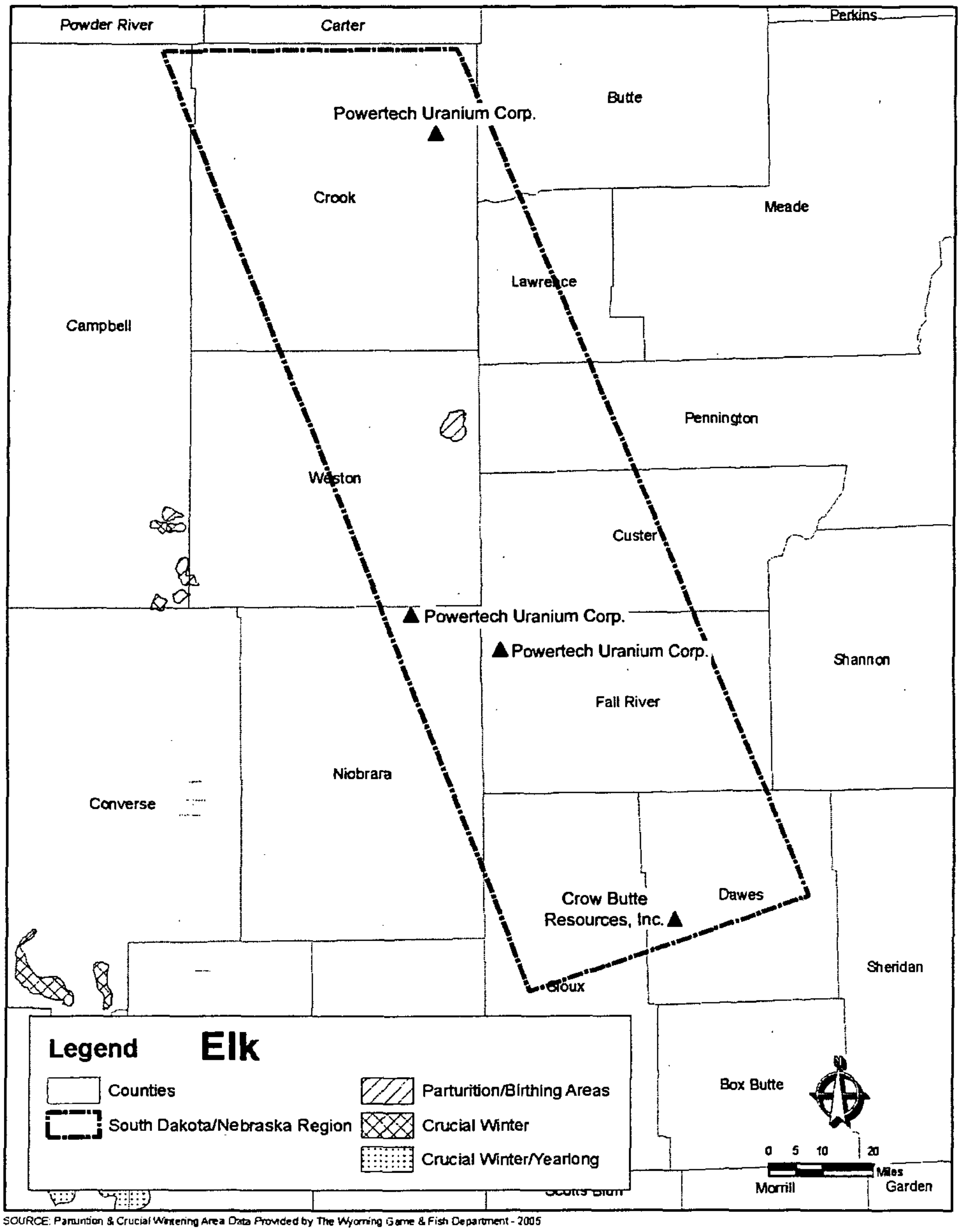
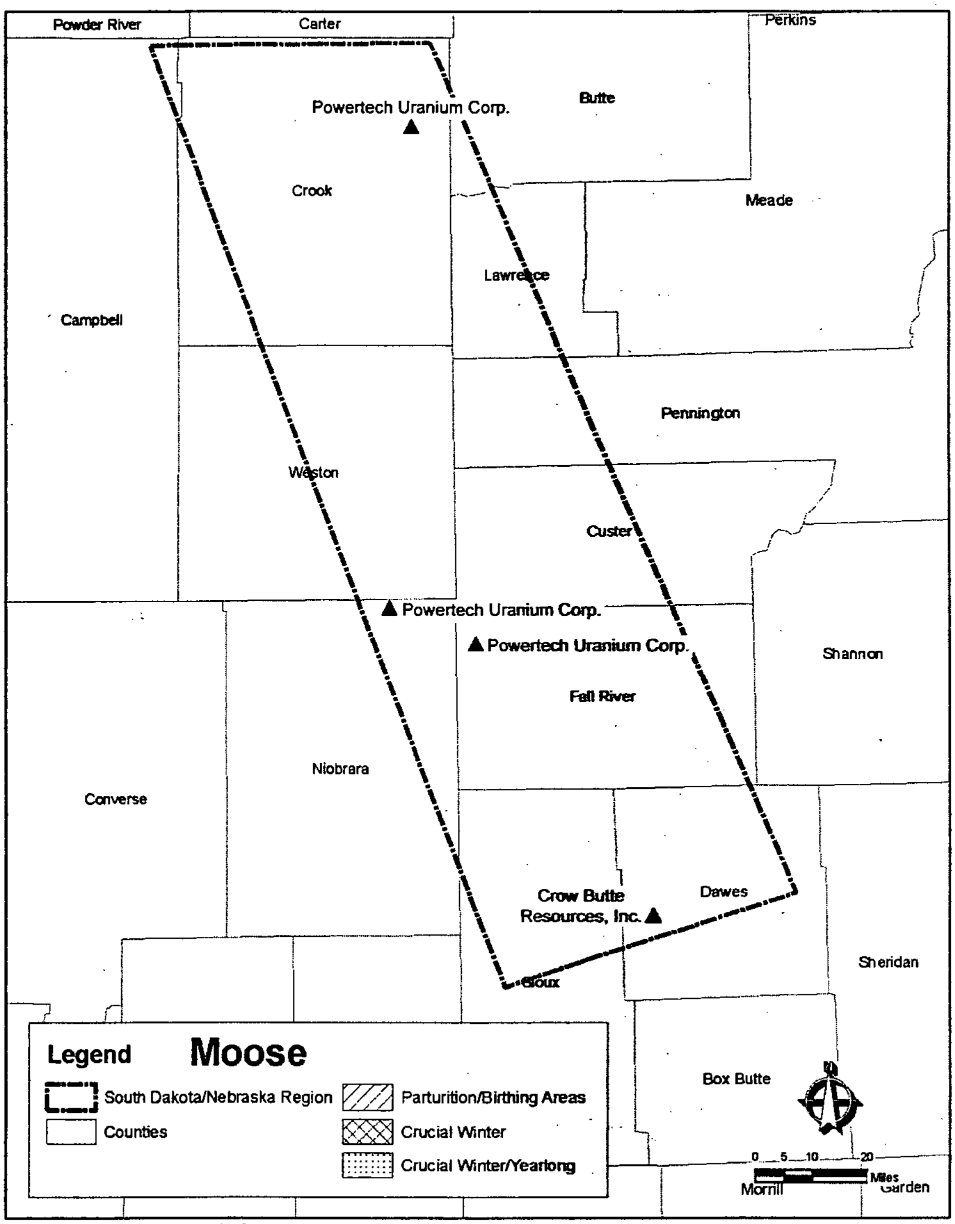



Figure 3.4-14. Elk Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.4-15. Moose Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**

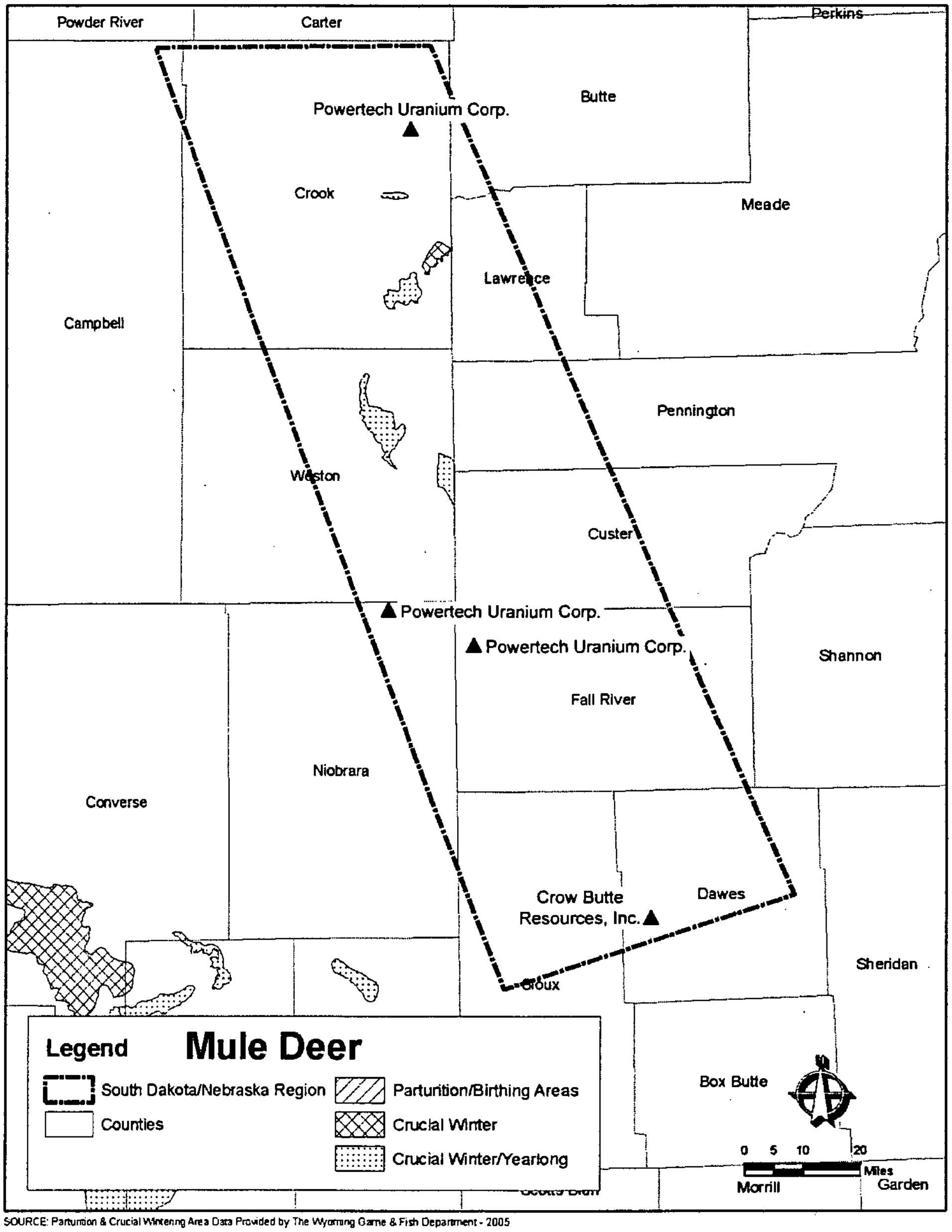
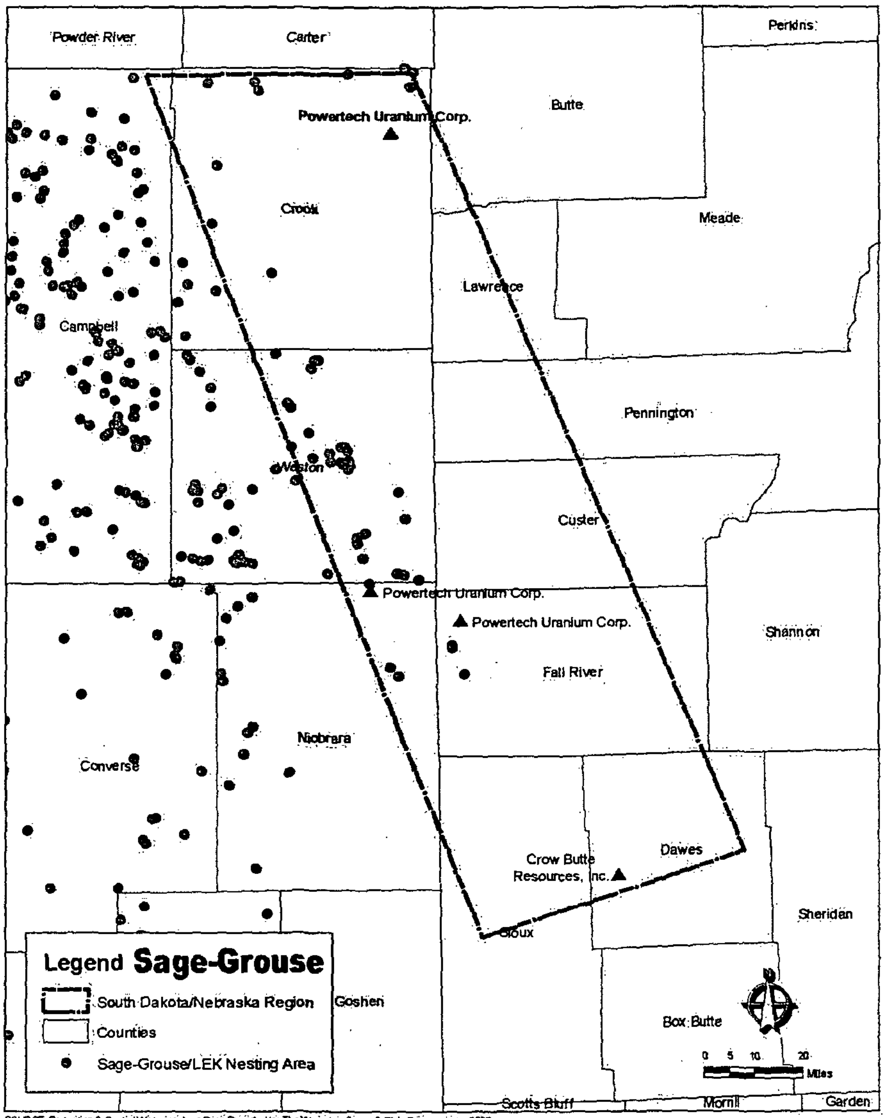
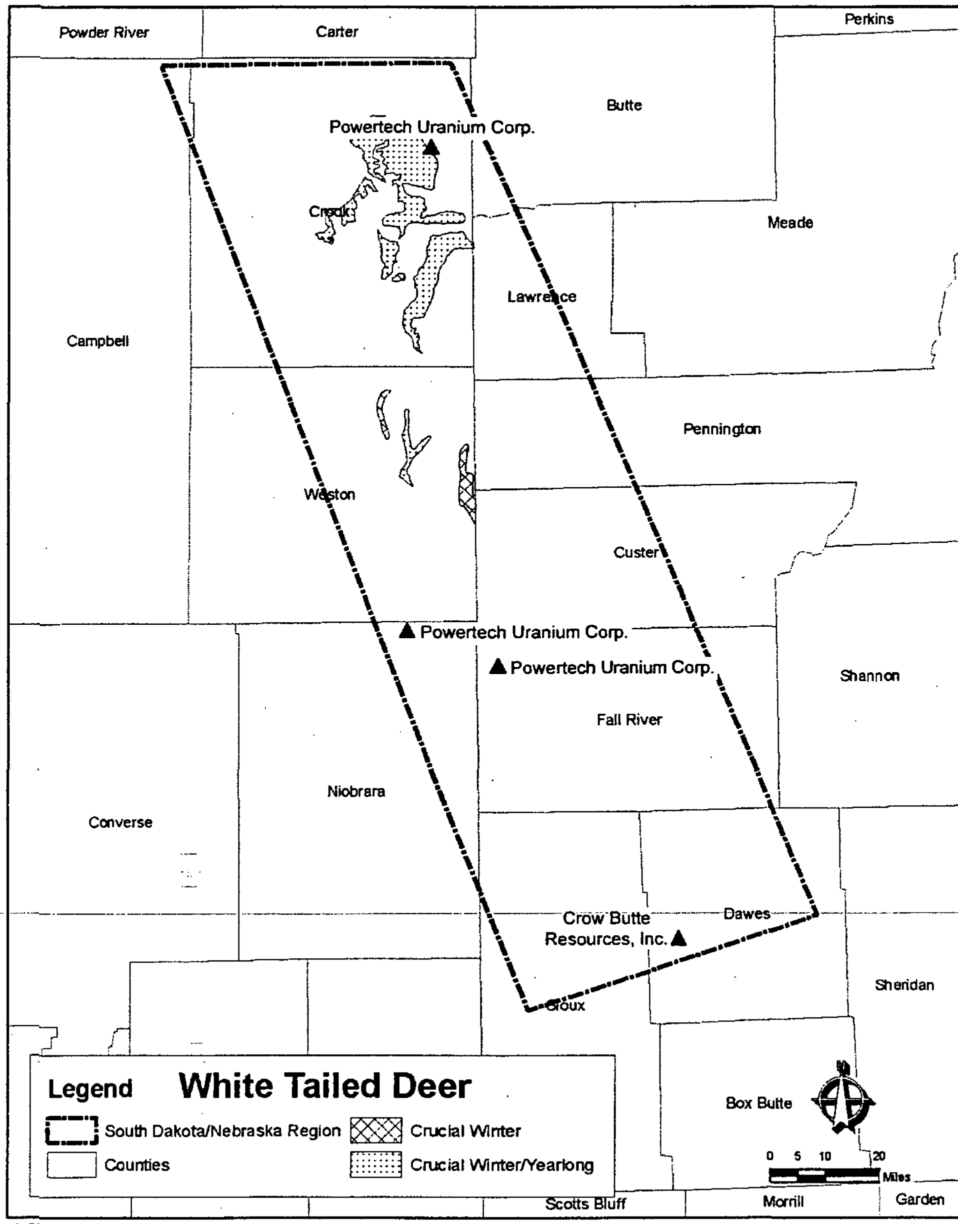



**Figure 3.4-16. Mule Deer Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.4-17. Sage-Grouse/Lek Nesting Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**




SOURCE: Parturition & Crucial Wintering Area Data Provided by The Wyoming Game & Fish Department - 2005

**Figure 3.4-18. White Tailed Deer Wintering Areas for the Nebraska-South Dakota-Wyoming Uranium Milling Region**

Sage-grouse leks appear to be located on the western side of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Southern Black Hills Uranium District.

A comprehensive listing of habitat types and species that have been surveyed within South Dakota are compiled as part of the South Dakota Gap Analysis Project (South Dakota State University, 2007).

According to the Nebraska Game and Parks Commission, Nebraska has approximately 400 bird species, 95 mammal species, and more than 60 reptile and amphibian species.

A comprehensive listing of habitat types and species that have been surveyed within Nebraska are compiled as part of the Gap Analysis Project (University of Nebraska, 2007).

### 3.4.5.2 Aquatic

**Wyoming**

As previously discussed, there are approximately 49 native fish species found in the watersheds throughout the state of Wyoming. These species are identified in Table 3.2-5. Current conditions of these watersheds found within the Nebraska-South Dakota-Wyoming Uranium Milling Region have been evaluated, and fish species that would benefit from conservation measures within these watersheds have been identified. These watersheds include the Little Missouri and the Cheyenne River Watersheds.

The Little Missouri Watershed is composed of numerous creeks such as Prairie and Cottonwood Creeks and the north fork of the Little Missouri River. This watershed is located in the northwestern portion of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Northern Black Hills Uranium District. The game fish habitat in the watershed is restricted to reservoirs and the streamflow in the Little Missouri River. Limiting conditions include small stream size, periods of low flow, high turbidity and sedimentation. Game fish species found in the watershed include brook trout, black bullhead, channel catfish, large mouth bass, rainbow trout, small mouth bass, and stonecat. Nongame species include brassy minnow, flathead chub, fathead minnow, goldeye, green sunfish, lake chub, longnose dace, shorthead redhorse, sand sucker, western silvery minnow, and white sucker (Wyoming Game and Fish Department, 2007).

The Cheyenne River Watershed is composed of the Lower Cheyenne River, Upper Cheyenne River, Bear Creek, Upper and Lower Antelope Creek, Little Thunder Creek, Black Thunder, and the Lodgepole Creek. This watershed is located in the central western portion of the Nebraska-South Dakota-Wyoming Uranium Milling Region in the vicinity of the Southern Black Hills Uranium District. The Cheyenne River is a free-flowing prairie stream until it reaches the Angostura reservoir in South Dakota. Most of the tributaries are intermittent with some perennial stream segments. Most game species are limited to small reservoirs and impoundments. Species found in the watershed include game fish such as the black bull head and channel catfish and nongame fish such as the carp, fathead minnow, green sunfish, longnose dace longnose sucker, plains killi fish, river carpsucker (*Carpiodes carpio*), sand shiner, and white sucker (Wyoming Game and Fish Department, 2007).

**South Dakota**

The major watersheds in South Dakota include the Red Water, Beaver, Middle Cheyenne-Spring, Rapid Creek, Angostura Reservoir Watershed, which includes the Cheyenne River. The list of fishes present in South Dakota is summarized in Table 3.4-5.

The South Dakota Division of Wildlife (2004) indicates that the Angostura Reservoir Watershed has an area of approximately 23,570 $km^2$ [9,100 $mi^2$]. Primary game fish in the watershed include walleye, channel catfish, smallmouth bass (*Micropterus dolomieu*), gizzard shad

**Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed***

| Common Name | Scientific Name |
|---|---|
| American Eel | *Anguilla rostrata* |
| Banded Killifish | *Fundulus diaphanus* |
| Bighead Carp | *Aristichthys nobilis* |
| Bigmouth Buffalo | *Ictiobus cyprinellus* |
| Bigmouth Shiner | *Notropis dorsalis* |
| Black Buffalo | *Ictiobus niger* |
| Black Bullhead | *Ameiurus melas* |
| Black Crappie | *Pomoxis nigromaculatus* |
| Blackchin Shiner | *Notropis hederdon* |
| Blacknose Dace | *Rhinichthys atratulus* |
| Blacknose Shiner | *Notropis hedrolepis* |
| Blackside Darter | *Percina maculata* |
| Blackspot Shiner | *Notropis atrocaudalis* |
| Blue Catfish | *Ictalurus furcatus* |
| Blue Sucker | *Cycleptus elongatus* |
| Bluegill | *Lepomis macrochirus* |
| Bluegill/Green Sunfish Hybrid | *Lepomis macrochirus x L. cyanellus* |
| Bluntnose Minnow | *Pimephales notatus* |
| Bowfin | *Amia calva* |
| Brassy Minnow | *Hybognathus hankinsoni* |
| Brook Silverside | *Labidesthes sicculus* |
| Brook Stickleback | *Culaea inconstans* |
| Brook Trout | *Salvelinus fontinalis* |
| Brown Bullhead | *Ameiurus nebulosus* |
| Brown Trout | *Salmo trutta* |
| Bullhead Minnow | *Pimephales vigilax* |
| Burbot | *Lota lota* |
| Central Mudminnow | *Umbri limi* |
| Central Stoneroller | *Campostoma anomalum* |
| Channel Catfish | *Ictalurus punctatus* |
| Chinook Salmon | *Oncorhynchus tshawytscha* |
| Coho Salmon | *Oncorhynchus kisutch* |
| Common Carp | *Cyprinus carpio* |
| Common Shiner | *Luxilus cornutus* |
| Creek Chub | *Semotilus atromaculatus* |
| Cutthroat Trout | *Oncorhynchus clarki* |
| Emerald Shiner | *Notropis atherinoides Rafinesque* |

| Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed* (continued) | |
|---|---|
| **Common Name** | **Scientific Name** |
| European Rudd | *Scardinius erythrophthalmus* |
| Fathead Minnow | *Pimephales promelas* |
| Finescale Dace | *Phoxinus neogaeus Cope* |
| Flathead Catfish | *Pylodictis olivaris* |
| Flathead Chub | *Platygobio gracilis* |
| Freshwater Drum | *Aplodinotus grunniens Rafinesque* |
| Gizzard Shad | *Dorosoma cepedianum* |
| Golden Redhorse | *Moxostoma erythrurum* |
| Golden Shiner | *Notemigonus crysoleucas* |
| Goldeye | *Hiodon alosoides* |
| Grass Carp | *Ctenopharyngodon idella* |
| Greater Redhorse | *Moxostoma valenciennesi* |
| Green Sunfish | *Lepomis cyanellus* |
| Hornyhead Chub | *Nocomis biguttatus* |
| Iowa Darter | *Etheostoma exile* |
| Johnny Darter | *Etheostoma nigrum* |
| Kokanee Salmon | *Oncorhynchus nerka* |
| Lake Chub | *Couesius plumeus* |
| Lake Herring | *Coregonus artedi* |
| Lake Sturgeon | *Acipenser flavescens Rafinwsque* |
| Lake Trout | *Salvelinus namaycush* |
| Lake Whitefish | *Coregonus clupeaformis* |
| Largemouth Bass | *Micropterus salmoides* |
| Logperch | *Percina caprodes* |
| Longnose Dace | *Rhinichthys cataractae* |
| Longnose Gar | *Lepisosteus osseus* |
| Longnose Sucker | *Catostomus catostomus* |
| Mississippi Silvery Minnow | *Hybognathus nuchalis* |
| Mooneye | *Hiodon tergisus Lesueur* |
| Mottled Sculpin | *Cottus bairdi* |
| Mountain Sucker | *Catostomus platyrhynchus* |
| Muskellunge | *Esox masquinongy* |
| Northern Hog Sucker | *Hypentelium nigricans* |
| Northern Pike | *Esox lucius* |
| Northern Redbelly Dace | *Phoxinus eos* |
| Orangespotted Sunfish | *Lepomis humilis* |
| Paddlefish | *Polyodon spathula* |
| Pallid Sturgeon | *Scaphirhynchus albus* |
| Pearl Dace | *Margariscus margarita Cope* |
| Plains Killifish | *Fundulus zebrinus* |
| Plains Minnow | *Hybognathus placitus* |
| Plains Topminnow | *Fundulus sciadicus* |
| Pugnose Shiner | *Notropis anogenus* |
| Pumpkinseed | *Lepomis gibbosus* |
| Quillback | *Carpiodes cyprinus* |
| Rainbow Smelt | *Osmerus mordax* |

**Table 3.4-5. Fishes of the Angostura Reservoir, Cheyenne River Watershed* (continued)**

| Common Name | Scientific Name |
|---|---|
| Rainbow Trout | *Oncorhynchus mykiss* |
| Red Shiner | *Cyprinella lutrensis* |
| Redear Sunfish | *Lepomis microlophus* |
| Ribbon Shiner | *Lythrurus Fumeus* |
| River Carpsucker | *Carpiodes carpio* |
| River Darter | *Percina shumardi* |
| River Shiner | *Notropis blennius* |
| Rock Bass | *Ambloplites rupestris* |
| Rosyface Shiner | *Notropis rubellus* |
| Sand Shiner | *Notropis stramineus* |
| Sauger | *Stizostedion canadense* |
| Saugeye | *Stizostedion vitreum x S. canadense* |
| Shorthead Redhorse | *Moxostoma macrolepidotum* |
| Shortnose Gar | *Lepisosteus platostomus* |
| Shovelnose Sturgeon | *Scaphirhynchus platorynchus* |
| Sicklefin Chub | *Macrhybopsis meeki* |
| Silver Chub | *Macrhybopsis storeriana* |
| Silver Lamprey | *Ichthyomyzon unicuspis* |
| Silverband Shiner | *Notropis shumardi* |
| Skipjack Herring | *Alosa chrysochloris* |
| Slender Madtom | *Noturus exilis Nelson* |
| Slenderhead Darter | *Percina phoxocehpala* |
| Smallmouth Bass | *Micropterus dolomieu* |
| Smallmouth Buffalo | *Ictiobus bubalus* |
| Spotfin Shiner | *Cyprinella spiloptera* |
| Spottail Shiner | *Notropis hudsonius* |
| Stonecat | *Noturus flavus* |
| Sturgeon Chub | *Macrhybopsis gelida* |
| Suckermouth Minnow | *Phenacobius mirabilis* |
| Tadpole Madtom | *Noturus gyrinus* |
| Threadfin Shad | *Dorosoma petenense* |
| Tiger Muskie | *Esox lucius X E. masquinongy* |
| Topeka Shiner | *Notropis topeka* |
| Trout-perch | *Percopsis omiscomaycus* |
| Walleye | *Stizostedion vitreum* |
| Western Silvery Minnow | *Hybognathus argyritis* |
| White Bass | *Morone chrysops* |
| White Crappie | *Pomoxis annularis* |
| White Perch | *Morone americana* |
| White Sucker | *Catostomus commersoni* |
| Wiper (hybrid) | *Morone saxatilis* |
| Yellow Bullhead | *Ameiurus natalis* |
| Yellow Perch | *Perca flavescens* |

*South Dakota Department of Game, Fish, and Parks. "Fishing in South Dakota." Pierce, South Dakota: South Dakota Game, Fish, and Parks. 2008. <www.sdgfp.info/Wildlife/fishing> (15 February 2008).

(*Dorosoma cepedianum*), largemouth bass, black crappie, and emerald shiner (*Notropis atherinoides*). (South Dakota Game ,Fish, and Parks, 2008)

The Cheyenne River originates in eastern Wyoming flowing on the south side of the Black Hills Uplift in the vicinity of the Southern Black Hills Uranium District. The Cheyenne River Watershed Assessment study area is approximately 4,690 km$^2$ [1,811 mi$^2$] in Pennington, Custer, and Fall River Counties in South Dakota. Approximately 45 fish species can be found in the Cheyenne River (South Dakota Game and Fish, 2008).

**Nebraska**

The White River-Hat Creek Basin is located in northwestern Nebraska above the Niobrara River basin north of the Crow Butte Uranium District. This basin originates in Nebraska and drains in the northeast to the confluence with the Missouri River (White River) and the Cheyenne River (Hat Creek) in South Dakota. The basin encompasses approximately 5,450 km$^2$ [2,130 mi$^2$]. Key aquatic species identified in the basin are the brown trout, rainbow trout, and channel catfish (Nebraska Department of Environmental Quality, 2005a).

The Niobrara River Basin located in the vicinity of the Crow Butte Uranium District in northwestern and north-central Nebraska originates in eastern Wyoming. The watershed covers approximately 30,745 km$^2$ [11,870 mi$^2$] and has approximately 4,054 km [2,519 mi] of streams. The basin also has watersheds that originate in South Dakota. Streamflow in the basin is a function of surface runoff and groundwater contributions. Major tributaries to the watershed include Ponca Creek, Verdigre Creek, Keya Paha River, Long Pine Creek, Plum Creek, Snake River, and Minnechaduza Creek (Nebraska Department of Environmental Quality, 2005b). Fish species found in the Niobrara Watershed region are listed in Table 3.4-6.

**Table 3.4-6. Fishes of the Niobrara River Watershed***

| Common Name | Scientific Name |
|---|---|
| Black Crappie | *Pomoxis nigromaculatus* |
| Blacknose Shiner | *Notropis hedrolepis* |
| Blue Catfish | *Ictalurus furcatus* |
| Bluegill | *Lepomis macrochirus* |
| Brook Stickleback | *Culaea inconstans* |
| Brook Trout | *Salvelinus fontinalis* |
| Brown Trout | *Salmo trutta* |
| Channel Catfish | *Ictalurus punctatus* |
| Common Shiner | *Luxilus cornutus* |
| Finescale Dace | *Phoxinus neogaeus Cope* |
| Flathead Catfish | *Pylodictis olivaris* |
| Golden Shiner | *Notemigonus crysoleucas* |
| Iowa Darter | *Etheostoma exile* |
| Johnny Darter | *Etheostoma nigrum* |
| Lake Chub | *Couesius plumeus* |
| Lake Sturgeon | *Acipenser flavescens Rafinwsque* |
| Largemouth Bass | *Micropterus salmoides* |
| Muskellunge | *Esox masquinongy* |
| Northern Pike | *Esox lucius* |
| Northern Redbelly Dace | *Phoxinus eos* |

| Table 3.4-6. Fishes of the Niobrara River Watershed* (continued) | |
|---|---|
| **Common Name** | **Scientific Name** |
| Orange Throat Darter | *Etheostoma spectabile* |
| Paddlefish | *Polyodon spathula* |
| Pallid Sturgeon | *Scaphirhynchus albus* |
| Pearl Dace | *Margariscus margarita Cope* |
| Pumpkinseed | *Lepomis gibbosus* |
| Rainbow Trout | *Oncorhynchus mykiss* |
| Redear Sunfish | *Lepomis microlophus* |
| Rock Bass | *Ambloplites rupestris* |
| Sauger | *Stizostedion canadense* |
| Shovelnose Sturgeon | *Scaphirhynchus platorynchus* |
| Smallmouth Bass | *Micropterus dolomieu* |
| Spotted Bass | *Micropterus punctulatus* |
| Striped Bass | *Morone saxatilis* |
| Sturgeon Chub | *Macrhybopsis gelida* |
| Topeka Shiner | *Notropis topeka* |
| Walleye | *Stizostedion vitreum* |
| White Bass | *Morone chrysops* |
| White Crappie | *Pomoxis annularis* |
| Yellow Perch | *Perca flavescens* |
| *Nebraska Department of Environmental Quality. "Total Maximum Daily Loads for the Niobrara River Basin." Lincoln, Nebraska: Nebraska Department of Environmental Quality. December 2005. | |

### 3.4.5.3 Threatened and Endangered Species

Federally listed threatened and endangered species that are known to exist within habitats found within the region include the following:

- Black-Footed Ferret—discussed in Section 3.2.5.3
- Blowout Penstemon—discussed in Section 3.2.5.3
- Interior Least Tern—discussed in Section 3.2.5.3
- Piping Plover—discussed in Section 3.2.5.3
- Pallid Sturgeon—discussed in Section 3.2.5.3
- Ute Ladies' Tresses Orchid—discussed in Section 3.2.5.3
- Western Praire Fringed Orchid—discussed in Section 3.2.5.3
- Whooping Crane—discussed in Section 3.2.5.3

State-listed threaten and endangered species for South Dakota, Nebraska, and special Status 1 and 2 species of concern for Wyoming that occur within the region include the following.

**South Dakota**

- American Dipper (*Cinclus mexicanus*), State Threatened—This bird is found in the cold, fast streams in the Black Hills. American dippers feed on insects found on stream bottoms, swimming underwater to depths of up to 6 m [20 ft] and even walking on the stream bed. Often nests on the underside of bridges over mountain streams (South Dakota Birds and Birding, 2008).

- Osprey (*Pandion haliaetus*), State Threatened—Osprey habitat includes lakes, large rivers and coastal bays. A reversible front toe and spiny nodules under its toes (spicules) to aid in grasping fish captured by plunge-diving feet first. Ospreys nest at the tops of large living or dead trees, on cliffs, on utility poles, or on other tall manmade structures. Clutch size ranges from two to four eggs with hatching in about 30 days. Young fly at 44–59 days and are dependent on parents for 6–12 weeks. This species has a worldwide distribution. In North America, the osprey breeds from northern Saskatchewan, Labrador, and Newfoundland in Canada, to the Great Lakes states and along the Pacific and Atlantic coasts. In South Dakota, it is a historical nester in the southeastern part of the state and an uncommon migrant. Many summer observations and the first modern (1991) successful osprey nest in the state raise hopes for the future of this species in South Dakota (U.S. Geological Survey, 2008b).

- Swift Fox State (*Vulpes velox*), Threatened—discussed in Section 3.3.5.3

- Finescale Dace (*Phoxinus neogaeus*) State Threatened—The finescale dace ranges widely but populations existing in Wyoming and Nebraska are considered glacial relics. Commonly occurs in the Niobrara River and several sites in Crook County where they are native to the North Fork Cow Creek in the Cheyenne River drainage. Typically occur in cool, boggy lakes and sluggish acidic streams. They are commonly found in lakes and ponds and are often associated with beaver ponds. Considered to be widespread, abundant, and globally secure but are considered threatened in South Dakota and of special concern in North Dakota, Nebraska, and Wyoming. Distribution is believed to be stable at drainage or subdrainage scale but is declining on the site and stream scale (Wyoming Game and Fish Department, 2008).

- Longnose Sucker *Catostomus catostomus)*, State Threatened—The longnose sucker is found in cool, spring-fed creeks where it feeds on the bottom on algae, crustaceans, snails, and insect larvae (caddisflies, mayflies, midges). It spawns in lakes or in shallow-flowing streams over gravel, where fry remain until 1–2 weeks old. Longnose suckers do not sexually mature until 4–9 years of age. The longnose is the most widespread sucker species in North America. It is found in Canada and Alaska, south from western Maryland, north to Minnesota, west and north through northern Colorado and through Washington. South Dakota populations are on the edge of its range and are found in the Belle Fourche River drainage north of the Black Hills (U.S. Geological Survey, 2008b).

- Bald Eagle (*Haliaeetus leucocephalus*), State Threatened—discussed in Section 3.2.5.3

- Piping Plover (*Charadrius melodus)*, State Threatened—The piping plover is present on breeding grounds from late March through August. It nests on sandbars and sand and gravel beaches with short, sparse vegetation along inland lakes; on natural and dredge islands in rivers; in gravel pits along rivers; and on salt-encrusted bare areas of sand, gravel or pebbly mud on interior alkali ponds and lakes. Nests are shallow, scraped depressions, occasionally lined with small pebbles, shells, or other material. A clutch of four eggs is usually laid in late May or early June, with hatching in 27–31 days. Both eggs and young are tended by both parents. Piping plovers feed along the water's edge on small insects, crustaceans, and mollusks. In South Dakota, the piping plover is a common breeding associate of the endangered interior least tern. Three North American breeding populations of piping plovers are recognized and have the following distributions: the Atlantic Coast from Newfoundland to Virginia; the Great Lakes, excluding the rocky north shores of Lakes Superior and Huron; and the northern Great Plains. The greatest number of piping plovers breed in the northern Great Plains. This breeding population occurs in scattered alkaline wetlands of the northern Great Plains and on the Missouri River and its tributaries in the Dakotas and Nebraska. In South Dakota, nesting occurs primarily on the natural stretches of the Missouri River below the Gavins Point and Fort Randall Dams, although some nesting may occur on tributaries. Piping plovers have also been reported from Bitter and Waubay Lakes in Day County and Horseshoe Lake in Codington County in northeastern South Dakota. This species overwinters along the Atlantic coast from North Carolina to Florida, along the Gulf coast, and in the Bahamas and West Indies (U.S. Geological Survey, 2008b).

- Northern River Otter *(Lontra Canadensis)*, State Threatened—The river otter is found in rivers, ponds, lakes and unpolluted waters in wooded areas. Key habitat components are riparian vegetation, temporary den and resting sites (cavities under tree roots, shrub patches, tall grass) and adequate food. It is active all year, mainly at night. Air trapped in the fur insulates the river otter while underwater, where it can stay for up to 4 minutes. Long, stiff whiskers to locate prey and good underwater vision aid in hunting success. The river otter is sexually mature at 2 years, breeding in early spring. The female has two–three pups (range one–six) in a secluded natal den site. Young leave the den at 2 months, are weaned by 3 months, but remain with the female until just prior to the birth of the mother's next litter. It occupies dens built by other animals, log jams and unused human structures. River otters primarily eat fish. Other aquatic foods include frogs, crayfish, and turtles, making the river otter a good barometer of water quality. The river otter is distributed throughout North America north of Mexico, except for the extreme southwestern United States. In South Dakota, it has been reported from Hughes County along the Missouri River, with unverified reports from adjacent counties.

In addition to federal- and state-listed species, South Dakota's Natural Heritage Program has identified species of greatest conservation need. South Dakota's Natural Heritage Program issued conservation modifiers for each species, which are defined as follows:

- G1 S1—Critically imperiled because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

- G2 S2—Imperiled because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

- G3 S3—Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 of 100 occurrences.

- G4 S4—Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. Cause for long-term concern.

- G5 S5—Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

- GU SU—Possibly in peril, but status uncertain; more information needed.

- GH SH—Historically known, may be rediscovered.
- GX SX—Believed extinct, historical records only.
- T—Rank of subspecies or variety.
- Q—Taxonomic status is questionable, rank may change with taxonomy.
- SZ—No definable occurrences for conservation purposes, usually assigned to migrants.
- SP—Potential exists for occurrence in the state, but no occurrences.
- SR—Element reported for the state, but no persuasive documentation.
- SA—Accidental or casual.

Subspecies are listed in some cases if the populations are disjunct and may be genetically unique. In addition to being important components of the ecosystems, subspecies can be federally listed if the U.S. Fish and Wildlife Service determines there is justification.

Species of greatest conservation need listed for South Dakota's Comprehensive Management Plan are identified as

- Birds
  - American white pelican (*Pelecanus erythrorhynchos*), G3, S3B, SZN
  - Trumpeter swan (*Cygnus buccinators*), G4, S3
  - Osprey (*Pandion haliaetus*), G5, S1B, SZN
  - Bald eagle (*Haliaeetus leucocephalus*), G4, S1B, S2N
  - Northern goshawk (*Accipiter gentilis*), G5, S3B, S2N
  - Ferruginous hawk (*Buteo regalis*), G4, S4B, SZN
  - Peregrine falcon (*Falco peregrinus*), G4, SXB, SZN
  - Greater sage-grouse (*Centrocercus urophasianus*), G4, S2
  - Greater prairie-chicken (*Tympanuchus cupido*), G4, S4
  - Whooping crane (*Grus americana*), G1, SZN
  - Piping plover (*Charadrius melodus*), G3, S2B, SZN
  - Willet (*Catoptrophorus semipalmatus*), G5, S5
  - Long-billed curlew (*Numenius americanus*), G5, S3B, SZN
  - Marbled godwit (*Limosa fedoa*), G5, S5
  - Wilson's phalarope (*Phalaropus tricolor*), G5, S4
  - Interior least tern (*Sterna antillarum athalassos*), G4, T2Q, S2B, SZN
  - Black tern (*Chlidonias niger*), G4, S3B, SZN
  - Burrowing owl (*Athene cunicularia*), G4, S3S4B, SZN
  - Lewis's woodpecker (*Melanerpes lewis*), G4, S3B,S3N
  - American three-toed woodpecker (*Picoides dorsalis*), G5, S2
  - Black-backed woodpecker (*Picoides arcticus*), G5, S3
  - American dipper (*Cinclus mexicanus*) G5, S2
  - Sprague's pipit (*Anthus spragueii*), G4, S2B, SZN
  - Lark bunting (*Calamospiza melanocorys*), G5, S5
  - Baird's sparrow (*Ammodramus bairdii*), G4 S2B, SZN

- — Le Conte's sparrow (*Ammodramus leconteii*), G4, S1S2B, SZN
- — White-winged junco (*Junco hyemalis aikeni*), G5T4, S5
- — Chestnut-collared longspur *(Calcarius ornatus)*, G5, S4

- Mammals
  - — Fringe-tailed myotis *(Myotis thysanodes pahasapensis)*, G4G5T2, S2
  - — Northern myotis *(Myotis septentrionalis)*, G4 S3
  - — Townsend's big-eared bat *(Corynorhinus townsendii)*, G4, S2S3
  - — Franklin's ground squirrel *(Spermophilus franklinii)*, G5, S5
  - — Richardson's ground squirrel *(Spermophilus richardsonii)*, G5, S5
  - — Northern flying squirrel *(Glaucomys sabrinus)*, G5, S2
  - — Bear lodge meadow jumping mouse *(Zapus hudsonius campestris)*, G5T3, not ranked
  - — Kit or swift fox *(Vulpes velox)*, G3, S1
  - — Black-footed ferret *(Mustela nigripes)*, G1, S1
  - — Northern river otter *(Lontra Canadensis)*, G5, S2

- Freshwater Mussels
  - — Elktoe *(Alasmidonta marginata)*, G4, S1
  - — Rock pocketbook *(Arcidens confragosus)*, G4, S1
  - — Creek heelsplitter *(Lasmigona compressa)*, G5, S1
  - — Higgins eye *(Lampsilis higginsii)*, G1, S1
  - — Scaleshell *(Leptodea leptodon)*, G1, S1
  - — Hickorynut *(Obovaria olivaria)*, G4, S1
  - — Mapleleaf *(Quadrula quadrula)*, G5, S2

- Gastropods
  - — Dakota vertigo *(Vertigo arthuri)*, G2, S2
  - — Mystery vertigo *(Vertigo paradoxa)*, G2G4, S1
  - — Frigid ambersnail *(Catinella gelida)*, G2, S1
  - — Cooper's Rocky Mountain snail *(Oreohelix strigosa cooperi)*, G5T1, S2

- Insects
  - — Ghost tiger beetle *(Cicindela lepida)*, G4, S1
  - — Great Plains tiger beetle *(Amblycheila cylindriformis)*, G5, S1
  - — American burying beetle *(Nicrophorus americanus)*, G2G3, S1
  - — Powesheik skipperling *(Oarisma powesheik)*, G2, S2
  - — Ottoe skipper *(Hesperia ottoe)*, G3G4, S2
  - — Dakota skipper *(Hesperia dacotae)*, G2G3, S2
  - — Iowa skipper *(Atrytone arogos iowa)*, G3G4T3T4, S2
  - — Regal fritillary *(Speyeria idalia)*, G3, S3
  - — Black Hills fritillary *(Speyeria atlantis pahasapa)*, G5T3, S3

- Fishes
  - — Banded killifish *(Fundulus diaphanous)*, G5, S1
  - — Blacknose shiner *(Notropis heterolepis)*, G5, S1
  - — Central mudminnow *(Umbra limi)*, G5, S1
  - — Finescale dace *(Phoxinus neogaeus)*, G5, S1
  - — Longnose sucker *(Catostomus catostomus)*, G5, S1
  - — Northern redbelly dace *(Phoxinus eos)*, G5, S2

- — Pallid sturgeon *(Scaphirhynchus albus),* G1G2, S1
- — Paddlefish *(Polyodon spathula),* G4, S4
- — Pearl dace *(Margariscus margarita),* G5, S2
- — Sicklefin chub *(Macrhybopsis meeki),* G3, S1
- — Sturgeon chub *(Macrhybopsis gelida),* G2, S2
- — Topeka shiner *(Notropis Topeka),* G3, S3
- — Trout-perch *(Percopsis omiscomaycus),* G5, S2
- — Lake chub *(Couesius plumbeus),* G5, S1
- — Mountain sucker *(Catostomus platyrhynchus),* G5, S3
- — Southern redbelly dace *(Phoxinus erythrogaster),* G5, S1
- — Hornyhead chub *(Nocomis biguttatus),* G5, S3
- — Rosyface shiner *(Notropis rubellus),* G5, S2
- — Logperch *(Percina caprodes),* G5, S3
- — Blackside darter *(Percina maculate),* G5, S2

- Reptiles and Amphibians
  - — Blanding's turtle *(Emys blandingii),* G4, S1
  - — False map turtle *(Graptemys pseudogeographica),* G5, S3
  - — Lined snake *(Tropidoclonion lineatum),* G5, S1
  - — Eastern hognose snake *(Heterodon platirhinos),* G5, S2
  - — Black Hills redbelly snake *(Storeria occipitomaculata pahasapae),* G5T3, S3
  - — Cope's gray treefrog *(Hyla chrysoscelis),* G5, S2
  - — Smooth softshell *(Apalone mutica),* G5, S2
  - — Western box turtle *(Terrapene ornate),* G5, S2
  - — Lesser earless lizard *(Holbrookia maculate),* G5, S2
  - — Northern cricket frog *(Acris crepitans),* G5, S1
  - — Many-lined skink *(Eumeces multivirgatus),* G5, S1
  - — Short-horned lizard *(Phrynosoma hernandesi),* G5, S2

**Nebraska**

- Finescale Dace, State Special Concern—discussed previously for South Dakota
- Swift Fox, State Endangered—discussed in Section 3.3.5.3
- Ute Ladies' Tresses Orchid, State Endangered—discussed in Section 3.2.5.3
- Whooping Crane State Endangered—discussed in Section 3.3.5.3

**Wyoming**

- Finescale Dace, Native Species Status 1—discussed previously for South Dakota

- Pearl Dace, Native Species Status 1—The pearl dace occurs in cool bogs, ponds, lakes, creeks, and clear streams. It spawns in the spring in clear water with a weak to moderate current over sand or gravel. This species feeds on invertebrates (insects and zooplankton) and algae (U.S. Geological Survey, 2008b).

- Western Silvery Minnow, Native Species Status 1—discussed in Section 3.2.5.3

- Canada Lynx (*Lynx canadensis*), Native Species Status 1—discussed in Section 3.2.5.3

- Plains Topminnow, Native Species Status 2— discussed in Section 3.2.5.3

- Goldeye, Native Species Status 2—In Wyoming, the goldeye can be found in the Powder, Little Powder and Little Missouri Rivers and in Clear and Crazy Woman Creeks. It prefers large rivers and their associated backwaters and marshes, or the shallow waters of large lakes and reservoirs. Young goldeye have never been found in Wyoming; it is thought that populations in the northeastern part of the state are maintained by the migration of adult fish seeking spawning grounds (Wyoming Game and Fish Department, 2008).

- Pale Milk Snake, Native Species Status 2—The pale milksnake prefers grasslands, sandhills, and scarp woodlands below 1,830 m [6,000 ft] in elevation. It is distributed throughout the northern Great Plains. In Wyoming, it can be found in the eastern counties and the Bighorn Basin (Wyoming Game and Fish Department, 2008).

- Smooth Green Snake (*Opheodrys vernalis*), Native Species Status 2—discussed in Section 3.2.5.3

- Yellow-Billed Cuckoo (*Coccyzus americanus*), Native Species Status 2—discussed in Section 3.2.5.3

- Greater Sage-Grouse, Native Species Status 2—discussed in Section 3.2.5.3

- Bald Eagle, Native Species Status 2—discussed in Section 3.2.5.3

- Trumpeter Swan Native, Species Status 2—discussed in Section 3.2.5.3

- Fringed Myotis (*Myotis thysanodes*), Native Species Status 2—discussed in Section 3.2.5.3

- Long-Eared Myotis (*Myotis evotis*), Native Species Status 2—discussed in Section 3.2.5.3

- Long-Legged Myotis (*Myotis volans*), Native Species Status 2—discussed in previous regions.

- Pallid Bat (*Antrozous pallidus*), Native Species Status 2—discussed in Section 3.2.5.3

- Spotted Bat (*Euderma maculatum*), Native Species Status 2—discussed in Section 3.2.5.3

- Townsend's Big-Eared Bat, Native Species Status 2—discussed in Section 3.2.5.3

## 3.4.6 Meteorology, Climatology, and Air Quality

### 3.4.6.1 Meteorology and Climatology

The Nebraska-South Dakota-Wyoming Uranium Milling Region contains portions of three states: Wyoming, Nebraska, and South Dakota. This region is characterized by hot summers and cold winters, and rapid temperature fluctuations are common. The Rocky Mountains have a great influence on the climate. As air crosses the Rockies from the west, much moisture is lost on the windward sides of the mountains and becomes warmer as it descends on the eastern slopes.

Table 3.4-7 identifies three climate stations located in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Climate data for these stations are found in the National Climatic Data Center's Climatography of the United States No. 20 Monthly Station Climate Summaries for 1971–2000 (National Climatic Data Center, 2004). This summary contains climate data for 4,273 stations throughout the United States and some territories. Table 3.4-8 contains temperature data for three stations in the Western Nebraska-South Dakota-Wyoming Uranium Milling Region.

Most precipitation in the Nebraska-South Dakota-Wyoming Uranium Milling Region occurs in the spring and summer. Rainstorms, hailstorms, and lighting are most likely to occur in the summer. Heavy rain can accompany thunderstorms and may cause some flooding. This flooding intensifies if these storms coincide with snow pack melting. Table 3.4-8 contains precipitation data for three stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region. The wettest month varies for the stations identified in Table 3.4-8. May is the wettest month for the Newcastle (Weston County, Wyoming) and Ardmore (Fall River County, South Dakota) stations and June is the wettest month for the Colony (Crook County, Wyoming) station. Based on the snow depth data, the wettest months coincide with melting snow pack (National Climatic Data Center, 2004). Data from National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the vast majority of thunderstorms in Crook, Weston, and Fall River Counties occurs between May and August with most occurring in July (National Climatic Data Center, 2007).

**Table 3.4-7. Information on Three Climate Stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region***

| Station (Map Number) | County | State | Longitude | Latitude |
|---|---|---|---|---|
| Colony | Crook | Wyoming | 104°11W | 44°55N |
| Newcastle | Weston | Wyoming | 104°13W | 43°51N |
| Ardmore 2 N | Fall River | South Dakota | 103°39W | 43°03N |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

**Table 3.4-8. Climate Data for Stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region***

| | | Colony | Newcastle | Ardmore 2 N |
|---|---|---|---|---|
| Temperature (°C)† | Mean—Annual | 8.3 | 7.9 | 8.1 |
| | Low—Monthly Mean | −5.3 | −5.7 | −6.0 |
| | High—Monthly Mean | 22.4 | 22.5 | 22.5 |
| Precipitation (cm)‡ | Mean—Annual | 37.8 | 40.7 | 43.7 |
| | Low—Monthly Mean | 0.9 | 1.1 | 1.0 |
| | High—Monthly Mean | 6.8 | 6.5 | 7.3 |
| Snowfall (cm) | Mean—Annual | 93.2 | 95.5 | 105 |
| | Low—Monthly Mean | 0 | 0 | 0 |
| | High—Monthly Mean | 19.6 | 19.8 | 18.5 |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

The mountains typically receive the most snow. Occasionally snow can accumulate to a considerable depth. During snow periods, there is often wind that may cause a large proportion to collect in gullies and behind windbreaks. Peak snowfall generally occurs in February and early March. Table 3.4-8 contains snowfall data for three stations in the Nebraska-South Dakota-Wyoming Uranium Milling Region.

The pan evaporation rates for the Western Nebraska-South Dakota-Wyoming Uranium Milling Region range from about 102–127 cm [40–50 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data are typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

### 3.4.6.2 Air Quality

The air quality general description for the Western Nebraska-South Dakota-Wyoming Uranium Milling Region would be similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region. The Nebraska-South Dakota-Wyoming Uranium Milling Region information in Section 3.4.6.2 is limited to the modification, supplementation, or summarization of the Wyoming West Uranium Milling Region information presented in Section 3.2.6.

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. The Nebraska-South Dakota-Wyoming Uranium Milling Region covers portions of Wyoming, South Dakota, and Nebraska. Except for Indian Country, New Source Review permits in these three states are regulated under the EPA-approved State Implementation Plan except for the Prevention of Significant Deterioration permits in South Dakota, which are regulated by 40 CFR 52.21 (EPA, 2007a). For Indian Country in these three states, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas is in Wyoming, South Dakota, or Nebraska. States may develop standards that are stricter or supplement the NAAQS. Wyoming has a more restrictive annual average standard for sulfur dioxide at 60 $\mu g/m^3$ [$1.6 \times 10^{-6}$ $oz/yd^3$] and a supplemental 50 $\mu g/m^3$ [$1.3 \times 10^{-6}$ $oz/yd^3$] $PM_{10}$ standard with an annual averaging time (Wyoming Department of Environmental Quality, 2006). Nebraska has a 50 $\mu g/m^3$ [$1.3 \times 10^{-6}$ $oz/yd^3$] $PM_{10}$ standard with an annual averaging time (Nebraska Department of Environmental Quality, 2002). South Dakota standards implement NAAQS straightforward (South Dakota Department of Environment and Natural Resources, 2007).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas and Class I areas have the most stringent requirements.

The Nebraska-South Dakota-Wyoming Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and Prevention of Significant Deterioration classifications in the region.

Figure 3.4-19 identifies the counties in and around the Western Nebraska-South Dakota-Wyoming Uranium Milling Region that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). All of the area within the Nebraska-South Dakota-Wyoming Uranium Milling Region is classified as attainment. Wyoming only has one area that is not in attainment. The City of Sheridan in Sheridan County is designated as nonattainment for $PM_{10}$. Nebraska only has one area not in attainment. A portion of the city of Omaha in Douglas County is designated as maintenance for lead but this is in eastern Nebraska, about 500 km [311 mi] from the Nebraska-South Dakota-Wyoming Uranium Milling Region. No areas in South Dakota are designated as nonattainment or maintenance. Two counties in southeast Montana are not in attainment. However, the two Montana counties that border the Nebraska-South Dakota-Wyoming Uranium Milling Region are in attainment.

Table 3.4-9 identifies the Prevention of Significant Deterioration Class I areas in Wyoming, South Dakota, Nebraska, and Montana. These areas are shown in Figure 3.4-20. The Nebraska-South Dakota-Wyoming Uranium Milling Region does contain a Class I area for the Wind Cave National Park in South Dakota (40 CFR Part 81).

### 3.4.7 Noise

The existing ambient noise levels for undeveloped rural and more urban areas in the Nebraska-South Dakota-Wyoming Uranium Milling Region would be similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region. This is a large region spanning parts of three different states. The largest community within the region, with a population of about 12,500, is Spearfish, South Dakota, in the northeastern portion. Smaller communities with populations from around 1,000 to 6,000 include Sundance and Newcastle, Wyoming; Hot Springs and Custer, South Dakota; and Crawford and Chadron in Dawes County, Nebraska (see Section 3.4.10). Ambient noise levels in these communities would likely be in the range of 45 to about 78 dB (Washington State Department of Transportation, 2006). In addition, the Pine Ridge Indian Reservation is just to the east of the Nebraska-South Dakota-Wyoming Uranium Milling Region.

A number of major highways cross the region, including Interstate 90 in the northern portion and a number of U.S. and state undivided highways. Ambient noise levels near these highways would be similar to or less than those measured at up to 70 dBA for Interstate 80, as the total traffic count and the percentages of heavy truck traffic are less (Wyoming Department of Transportation, 2005; Federal Highway Administration, 2004; see also Sections 3.2.7 and 3.4.2).

A number of scenic byways through the Black Hills could be more sensitive to noise impacts, but these are located more than 16 km [10 mi] east of the areas of interest for ISL uranium recovery.

For the three uranium districts located in the Nebraska-South Dakota-Wyoming Uranium Milling Region, there are several National Park Service and U.S. Forest Service properties, state parks, and other properties (see Figure 3.4-1) that may be sensitive to noise impacts. Much of this

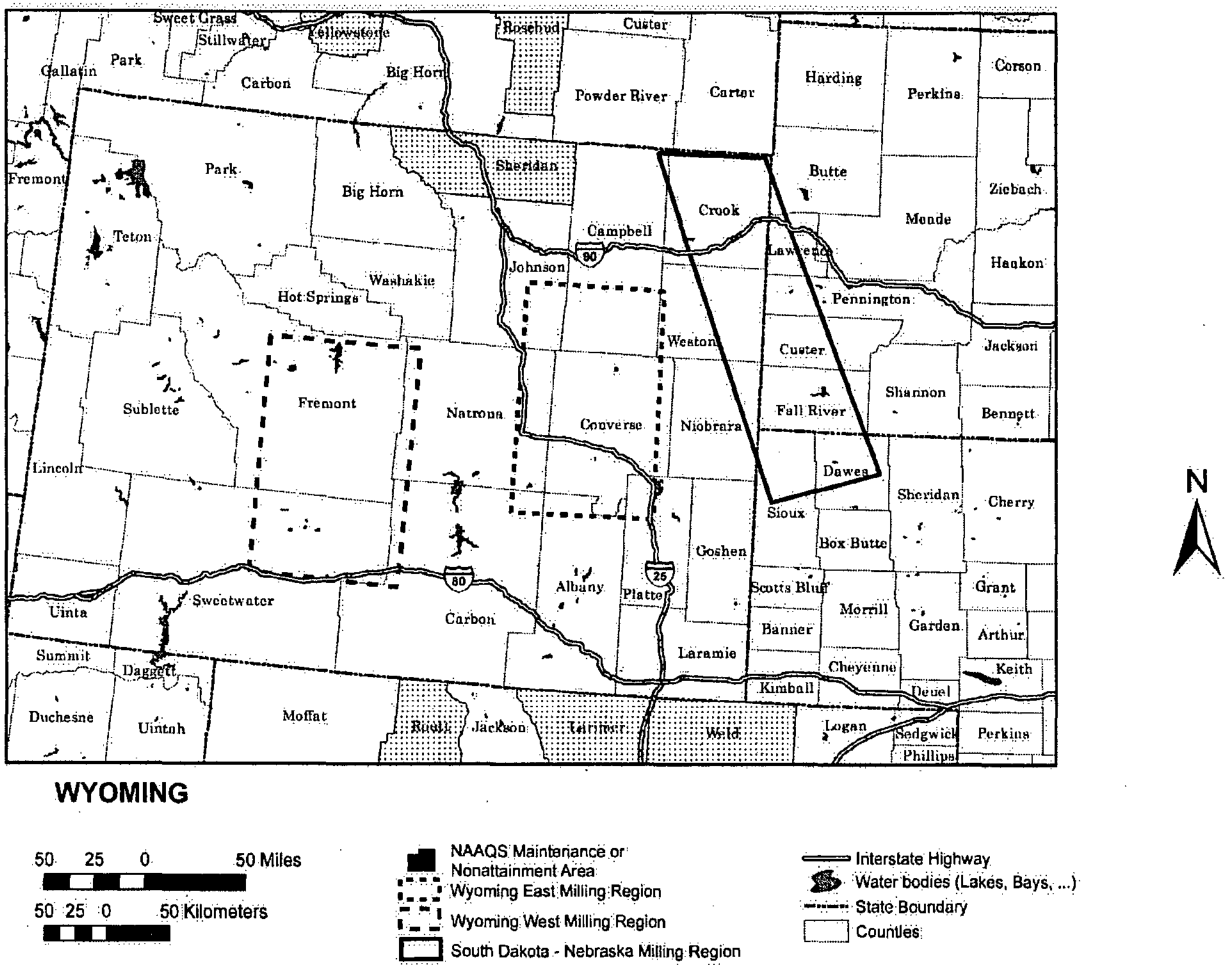



**Figure 3.4-19. Air Quality Attainment Status for Nebraska-South Dakota-Wyoming Uranium Milling Region and Surrounding Areas (EPA, 2007b)**

| Table 3.4-9. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in Wyoming, South Dakota, Nebraska, and Montana* | |
|---|---|
| WYOMING<br>Bridger Wilderness<br>Fitzpatrick Wilderness<br>Grand Teton National Park<br>North Absaroka Wilderness<br>Teton Wilderness<br>Washakie Wilderness<br>Yellowstone National Park | MONTANA<br>Anaconda-Pintlar Wilderness<br>Bob Marshall Wilderness<br>Cabinet Mountains Wilderness<br>Gates of the Mountain Wilderness<br>Glacier National Park<br>Medicine Lake Wilderness<br>Mission Mountain Wilderness<br>Red Rock Lakes Wilderness<br>Scapegoat Wilderness<br>Selway-Bitterroot Wilderness<br>U.L. Bend Wilderness<br>Yellowstone National Park |
| SOUTH DAKOTA<br>Badlands Wilderness<br>Wind Cave National Park | NEBRASKA<br>None |
| *Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005. | |

area is protected from extensive development, and the ambient noise levels would be expected to be similar to undeveloped rural areas (up to 38 dB) (DOE, 2007).

Northernmost uranium district (Wyoming)

- Devil's Tower National Monument (Wyoming)
- Black Hills National Forest (Wyoming-South Dakota)

Central uranium district (Wyoming, South Dakota)

- Thunder Basin National Grassland (Wyoming)
- Buffalo Gap National Grassland (South Dakota)

Southern uranium district (Nebraska)

- Oglala National Grassland (Nebraska)
- Nebraska National Forest (Nebraska)
- Fort Robinson State Park (Nebraska)

Small communities are located within and near each of the three uranium districts, including Aladdin, Wyoming, in the northernmost district; Riverview, Wyoming, and Burdock and Edgemont, South Dakota, in the central district; and Crawford, Nebraska, near the Crow Butte ISL facility in the southern district. In general, these small towns are located 8 km [5 mi] or more from the uranium projects.

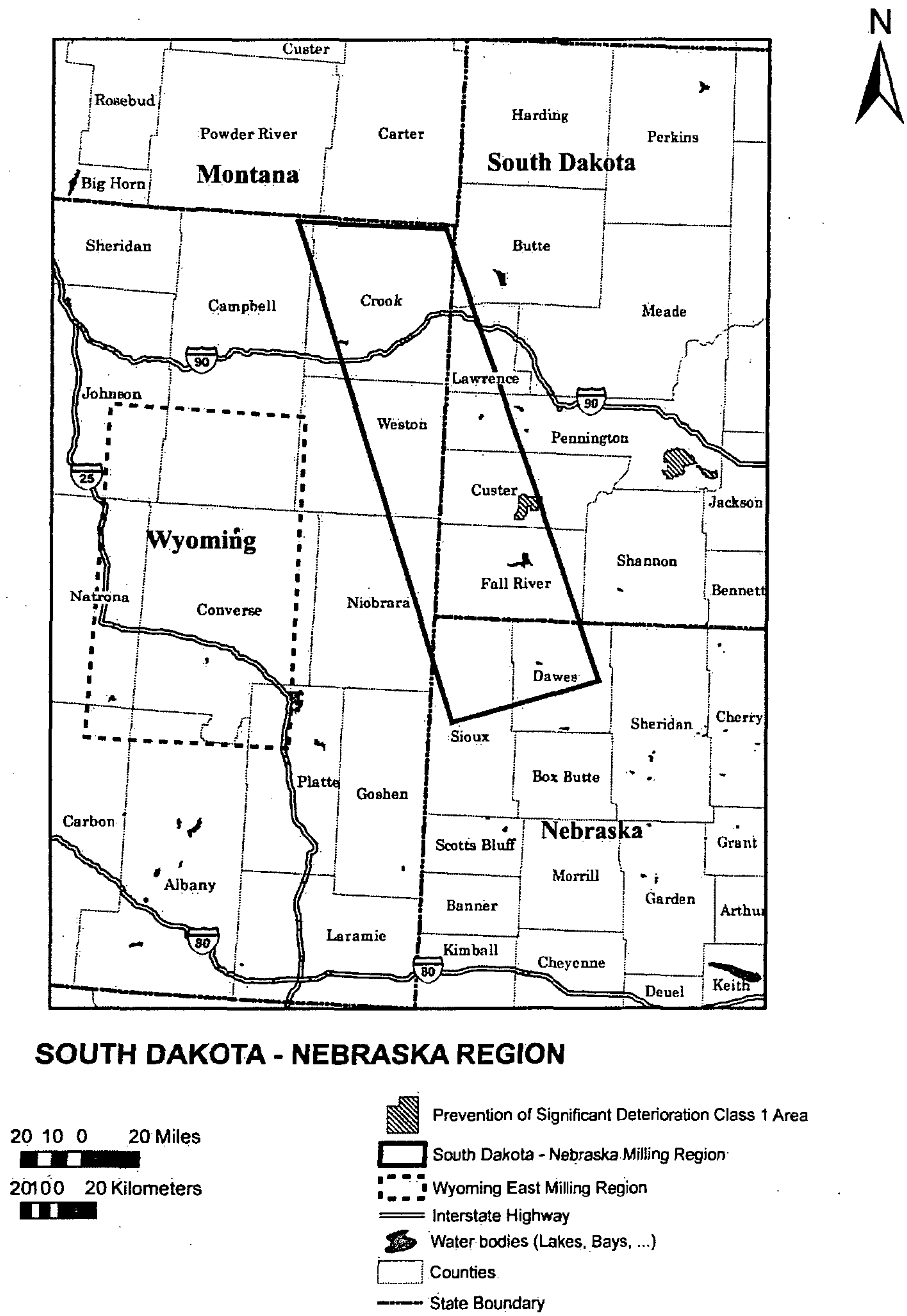



**Figure 3.4-20. Prevention of Significant Deterioration Class I Areas in the Nebraska-South Dakota-Wyoming Uranium Milling Region and Surrounding Areas (40 CFR Part 81)**

### 3.4.8 Historical and Cultural Resources of Western South Dakota and Nebraska

Appendix D provides a general overview of historical and cultural resource impact assessment at the federal level. As noted in Section 3.2.8, specific cultural resources in Wyoming, South Dakota, Nebraska, and New Mexico are described at the state level by the responsible state agencies. For the purposes of describing cultural and historical resources for the Nebraska-South Dakota-Wyoming Uranium Milling Region, an overview of Wyoming cultural and historical resources is provided in Section 3.2.8. Cultural and historical resources in South Dakota and Nebraska are described separately in this section (Section 3.4.8).

The South Dakota SHPO is a division of the South Dakota State Historical Society. The director of the South Dakota State Historical Society serves as the state's historic preservation officer. The South Dakota SHPO administers and is responsible for oversight and compliance with the NRHP, compliance and review for Section 106 of the NHPA, Preservation of Historic Property Procedures (South Dakota Codified Law 1-19-11.1), traditional cultural properties, NAGPRA, and archaeological survey through its Archaeology Division as well as compliance with other federal and state historic preservation laws, regulations, and statutes. Their webpage can be found at <http://www.sdhistory.org>. The State of South Dakota also has laws regarding human remains, entitled Cemeteries and Burials (SDCL 1-20-32, Chapter 34-27).

The Nebraska SHPO is a division of the Nebraska State Historical Society. The director of the Nebraska State Historical Society serves as the state's historic preservation officer. The NSHPO administers and is responsible for oversight and compliance with the NRHP, the Nebraska Historic Buildings Survey, compliance and review for Section 106 of the NHPA and traditional cultural properties, NAGPRA, and archaeological survey through its Archaeology Division and compliance with other federal and state historic preservation laws, regulations, and statutes. Their webpage can be found at <http://www.nebraskahistory.org/histpres>. The State of Nebraska also has laws regarding human remains, entitled Unmarked Human Burial Sites {Revised Statutes of Nebraska 1989 Supplement Article 12 [12-1201 to 12-1212]} and Human Skeletal Remains or Burial Goods, Prohibited Acts; Penalty (Article 28-1301).

#### 3.4.8.1 Cultural Resources Overview

3.4.8.1.1 Cultural Resources of Western and Southwestern South Dakota

The following provides a brief overview of prehistoric and historical cultures recognized in the central and northern plains region, which includes western South Dakota. The dating of cultural periods for the prehistoric period is provided in BP. Most prehistoric archaeological sites are concentrated along the James, Missouri, White, Cheyenne and Big Sioux River valleys, but can be found along many drainages in the state. Figures 3.2-18 and 3.2-19 illustrate the division of the plains into regional subdivisions.

**Paleoindian Big Game Hunters (12,000 to 6,500 B.P.).** The earliest well-defined cultural tradition in the central plains region is the Paleoindian. Early humans entered the areas shortly after deglaciation allowed movement onto the central plains sometime after 14,000 B.P. A variety of cultures, each defined by the presence of distinctive projectile points, are recognized during the Paleoindian period: Clovis, Goshen, Folsom, Hell Gap-Agate Basin, Cody Complex, and Plano. Most post-Clovis Paleoindian sites on the northern and upper central plains are known from bison kill sites. The Clovis culture (12,000 to 10,000 B.P.) is recognized by a distinctive projectile point style and a subsistence mode heavily reliant on hunting large, now-extinct mammals, notably mammoth and mastodon, which became extinct at the end of the Clovis period. The poorly defined Goshen Complex found at the Jim Pitts site in the Black Hills may be contemporary with Clovis and is technologically similar. The Folsom culture (ca. 10,000 to 8,500 B.P.) is also known for a distinctive projectile point style. Folsom subsistence is also characterized by reliance on large game—the ancient bison. Folsom sites consist of camp sites and kill sites. The latter tend to be located near cliffs and around water, such as ponds and springs. The Plano, Hell Gap-Agate Basin, and Cody Complex cultures (ca. 8,500 to 6,500 B.P.) are, in their earliest forms, a continuation of earlier Paleoindian hunting traditions. The distinctive projectile point forms that define these cultural complexes are, in comparison to earlier Clovis and Folsom, much more restricted in geographic distribution. Toward the middle and end of the period encompassing these cultures, however there is a transition in subsistence modes following the extinction of the ancient bison form to the modern form of bison and ultimately, a transition to Archaic broad-spectrum foraging. Post molds and stone circles suggesting the presence of ephemeral shelters are sometimes found, primarily toward the end of the period.

**Archaic Foragers (6,500 to 3,500 B.P.).** The Plains Archaic period represents the continuation of change in subsistence and settlement linked to an increasingly arid environment that occurs in the latter portion of the preceding late Paleoindian cultures. Distinctive Archaic cultures, from early to late, include Mummy Cave, Oxbow, McKean, and Pelican Lake complexes. Kill sites, characteristic of the preceding Paleoindian period, are virtually absent. Hunting and gathering wild plant foods is the primary mode of subsistence. Dietary breadth, indicated by increasing diversity and numbers of subsistence items, is believed to expand significantly with more medium and small mammals being hunted and the introduction of seed-bearing plants: dietary staples indicated by the introduction of stone seed-grinding implements. Through time, settlement is increasingly tethered to highly productive resource areas and sites tend to become larger and increasingly complex, indicating the presence of somewhat more sedentary lifestyles relative to earlier periods. Settlement is focused on river valleys and elevated areas. Artifact styles, principally projectile points, become increasingly diversified, suggesting increasing regionalization and cultural differentiation.

**Late Prehistoric/Plains Woodland (3,500 to 300 B.P.).** Early in the period, the preceding late Archaic broad-spectrum foraging subsistence and settlement patterns continue with little change. In the Northern Plains, the Besant and Avonlea Complexes continued the Archaic, virtually unchanged lifestyles until contact with European and American cultures. Subsistence focused on scheduled small- and medium-game hunting, gathering plant foods, and bison hunting according to a seasonal round. In western South Dakota, a basic hunting and gathering lifestyle differing little from the preceding Late Archaic period predominates. At the very end of the period, some villages located along water courses in western South Dakota may have practiced horticulture, but its contribution to diet among such Northern Plains groups was limited. Food procurement and site location appears to be focused primarily on elevated landforms near larger riverine systems and tributaries with increasing utilization of upland resources later in time. The Late Prehistoric/Plains Woodland of South Dakota is also characterized by the appearance of ceramics late in the period (Avonlea Complex), perhaps introduced from the Eastern Woodland cultural area. The late Avonlea Complex and later Old Woman Complex sites contain artifact types that suggest a high degree of specialization in hunting large, upland game animals, primarily bison.

In the eastern portions of South Dakota along the Missouri River, seasonal or permanent sedentary villages of various sizes occur. These villages were largely reliant on domesticated plants (corn, beans, and squash). Although horticulture was an important part of the subsistence base, wild plants and game animals formed a substantial part of the diet. Villages were primarily located along major river systems and larger tributaries. Most sites consisted of small clusters of rectangular wattle and daub lodges with a few larger village sites. Storage pits for food and other times are located within the structures. Pottery was diverse with globular jars and decorated exterior rims common.

In the 1500s to early 1700s A.D., large migrations occurred. The ancestors of the modern Apache, Arapaho, Comanches, and Kiowa migrated southward through western South Dakota in the 1500s and 1600s. The Crow also resided in western South Dakota for a time. The central portion of the state was occupied by the Arika, Mandan, and Cheyenne while, the Lakota, Omaha, Ponca, Otoe, and Ioway occupied the eastern portion of the state.

**Post-Contact Tribes (300 to 100 B.P.).** The post-contact period on the northern plains is that period after initial contact with Europeans and Americans. Although Euro-American trade goods may have appeared as early as the mid-1600s, the earliest documented contact in the northern and central plains is by Spanish and French explorers in the early 1700s A.D. The horse appears to have been introduced at about the same time. The lifeways of the late Avonlea and post-Avonlea/Old Woman nomadic bison-hunting cultural complexes appear to have continued well into the mid to late 1700s A.D. At the time of European exploration, Arikara and Mandan farming villages were noted along the Missouri river in central South Dakota. In the 1700s, the Cheyenne moved westward along with the Lakota and displaced the Mandan and Arikara. The Dakota and Nakota moved into eastern South Dakota from Minnesota and displaced the Ponca and the Omaha. By the mid-1800s, the entire state was occupied by nomadic Siouan-speaking tribes, primarily the Santee, Yankton, and Teton.

**Europeans and Americans (300 to 100 B.P.).** The earliest European presence in South Dakota was by French explorers of the de la Vénendrye family in 1743. In 1803, the United States completed the purchase of the Louisiana Territory from France. A portion of South Dakota was visited by the Lewis and Clark Expedition in 1804–1806. These early expeditions provide descriptions of varying quality for some of the early historical tribes in the region. In the later 1700s and early 1800s, more intensive contact and settlement occurred first through missionaries and then through the fur trade period in the 1830s through the 1860s. The American Fur Company and its fur trading posts located along the Big Sioux, James, Vermillion, Missouri, Cheyenne and White Rivers, and Big Stone Lake formed the foundation for later settlements. By the mid-1800s, missionary, settler, and military contacts led to increasing conflict with the Siouan tribes of South Dakota. The slowly increasing number of settlers passing through traditional tribal use areas in the mid-1800s led to increasing conflict over time and the establishment of military forts in tribal lands—yet another irritant to tribes.

Treaties, notably the Fort Laramie Treaty of 1851, were signed with the intent of removing tribes from along the emigrant trails and allowing for the building of trails and forts to protect settlers moving west. Continued conflict resulted in the creation of the Great Sioux Reservation bounded by the Missouri River on the east, the Bighorn Mountains on the west, and the 46$^{th}$ and 43$^{rd}$ parallels to the north and south, respectively. Continued conflict with the U.S. military over the failure of the government to abide by treaty obligations led to several punitive expeditions to return tribes to reservations. In 1874, General George Armstrong Custer led an expedition to the Black Hills where the presence of gold, previously only rumored, was confirmed. The intense interest by Americans to go to the Black Hills to mine for gold led to numerous treaty violations; the Black Hills regions was, by treaty, part of the Sioux reservation. The continued conflict over the Black Hills, along with reduction of the buffalo herds, led to the final military conquest of the Great Sioux Nation and their confinement to small reservations. The Black Hills gold rush led to the rapid settlement of much of South Dakota and the development of towns and cattle ranching.

Ranching, a livelihood well suited to the grassland plains of South Dakota, was practiced by settlers by the early 1870s. The arrival of the railroads (the Milwaukee) led to increased settlement and opened South Dakota to a flood of new settlers, most of them recent European immigrants intent on farming. These early settlers began a period of extensive agriculture throughout the state, mostly around well-watered regions, with many of the new farmers pursuing newly developed dry-land farming techniques. The Great Depression and the droughts that occurred at the same time led to the abandonment of many farms and the outmigration of a significant portion of South Dakota's population.

3.4.8.1.2 Cultural Resources of Western Nebraska

The following provides a brief overview of prehistoric and historical cultures recognized in the central plains region, which includes Nebraska. The dating of cultural periods for the prehistoric period are provided in B.P. Figures 3.2-18 and 3.2-19 illustrate the division of the plains into regional subdivisions.

**Paleoindian Big Game Hunters (12,000 to 8,000 B.P.).** The earliest well-defined cultural tradition in the central plains region is the Paleoindian. Early humans entered the plains shortly after deglaciation allowed movement onto the central plains sometime after 14,000 B.P. Three cultures are recognized during the Paleoindian period: Clovis, Folsom, and Plano. The Clovis culture (12,000 to 10,000 B.P.) is recognized by a distinctive projectile point style and a subsistence mode heavily reliant on big-game hunting, notably mammoth and mastodon, which became extinct at the end of the period. The Folsom culture (ca. 10,000 to 8,500 B.P.) is also known for a distinctive projectile point style. Folsom subsistence is also characterized by reliance on large game—the ancient bison. Folsom sites consist of camp sites and kill sites. The latter tend to be located near cliffs and around water, such as ponds and springs. The Plano culture (ca. 8,500 to 6,500 B.P.) is, in its earliest form, a continuation of earlier Paleoindian hunting traditions. Toward the end of the period, however, there is a transition in subsistence modes with the extinction of the ancient bison to the modern form of bison and a transition to Archaic foragers. Plano sites containing circular rock alignments and post mold circles suggest the present of structures.

**Archaic Foragers (6,500 to 2,000 B.P.).** The Plains Archaic period represents the continuation of change in subsistence and settlement linked to an increasingly arid environment that occurs in the latter portion of the preceding late Paleoindian Plano culture. Kill sites, characteristic of the preceding Paleoindian period, are virtually absent. Although hunting and gathering is the only mode of subsistence, dietary breadth, indicated by increasing diversity and numbers of subsistence items, is believed to expand significantly with more medium and small mammals being hunted and the introduction of seed-bearing plants as staples. Through time, settlement is increasingly tethered to highly productive resource areas and sites tend to become larger and increasingly complex, indicating the presence of more sedentary lifestyles relative to earlier periods. Artifact styles, principally projectile points, become increasingly diversified, suggesting increasing regionalization and cultural differentiation.

**Plains Woodland (2,000 to 1,000 B.P.).** The Plains Woodland period is characterized by largely sedentary lifestyles and a mixed subsistence economy consisting of wild game animals and plants and horticulture utilizing the domesticates, maize and beans. The defining settlement pattern of the Woodland Period consists of earth lodge villages, some of which may have been occupied only seasonally. There is variability in the size of Plains Woodland communities. The communities can be small, with as few as two or three structures, to very large (two to three hectares) with numerous contemporary structures. The majority of the larger settlements tended to be located along larger drainages (e.g., Missouri, Republican, Arkansas, and Red Rivers) with permanent water and located near abundant biotic and abiotic resources. The Plains Woodland is also characterized by the appearance of ceramics, perhaps introduced from the Eastern Woodland cultural area.

**Plains Village (1,000 to 600 B.P.).** The Plains Village period continues the trend toward increasing sedentism and increasing reliance on domesticated plants (corn, beans, and squash). Although horticulture was an important part of the subsistence base, wild plants and game animals formed a substantial part of the Plains Village diet. Villages were primarily located along major river systems and larger tributaries. Most sites, however, consisted of small clusters of rectangular wattle and daub lodges. Storage pits for food and other items are located within the structures. Pottery was diverse with globular jars and decorated exterior rims being common. Small, triangular side- and corner-notched projectile points are common. Early historical Plains Village groups include the Siouan-speaking Omaha, Ponca, Otoe-Missouria, Ioway, and Kansa along with the Caddoan-speaking groups including the Arikara and Pawnee. The Plains Village period is divided into several regional phases and includes the St. Helena, Nebraska, Itskari, and Smokey Hill phases.

**Post-Contact Tribes (400 to 100 B.P.).** The postcontact period on the central plains is that period after initial contact with Europeans and Americans. The earliest documented contact in the central plains is by Spanish and French explorers in the early 1700s A.D. Tribes present in Nebraska include the Caddoan farming villages of the Pawnee and Arikara in eastern Nebraska. Siouan-speaking tribes were the Omaha, Ponca, Otoe-Missouria, Ioway, and Kansa. Both Caddoan and Siouan-speaking groups lived in permanent earth lodge villages, were agriculturalists, and hunted bison in western Nebraska. Western Nebraska was also home to "nomadic" tribes that resided in tepee villages and were dependent on bison hunting. These tribes include the Apache, Crow, Kiowa, Cheyenne, Teton, Comanche, and Arapaho. The Lakota, Northern Cheyenne, and Arapaho resided in northwestern Nebraska, and the Oglala and Brule Sioux were concentrated around the Black Hills and the upper White and Niobrara Rivers in northern Sioux County. By the mid-1800s, the Oglala and Brule had extended their range to include the Platte River region.

**Europeans and Americans (300 to 100 B.P.).** The earliest European presence in Nebraska was by French and Spanish explorers in the early 1700s A.D. and possibly earlier in the late 1600s. The Villasur expedition to explore the area was led by Pedro de Villasur out of the Spanish province of New Mexico in 1720 AD. Later explorers included Lewis and Clark and Zebulon Pike. These early expeditions provide descriptions of varying quality for some of the early historical tribes in the region. In the later 1700s and early 1800s, more intensive contact and settlement occurred first through the fur trade in the 1830s and 1840s, and then through missionary and military contacts. By the mid-1800s, emigrant trails, notably the Oregon-California Trail, among others, traversed the Nebraska area.

The large number of settlers moving along the emigrant trails passing through tribal use areas led to increasing conflict over time and the establishment of military forts in tribal lands—yet another irritant to tribes. Treaties, notably the Fort Laramie Treaty of 1851 were signed with the intent of removing tribes from along the emigrant trails and allowing for the building of trails and forts to protect settlers moving west. Continued conflict resulted in the creation of the Great Sioux Reservation bounded by the Missouri River on the east, the Bighorn Mountains on the west, and the 46$^{th}$ and 43$^{rd}$ parallels to the north and south, respectively. Fort Robinson in Dawes County was established in 1874 adjacent to the Red Cloud Agency near the White River. Fort Robinson served as a military outpost to contain the Sioux tribes on the Great Sioux Reservation during the Sioux Wars and the Cheyenne Outbreak. Fort Robinson is important in both Native American and American history because it is the place in which the Oglala Sioux chief, Crazy Horse, was killed and the place where Dull Knife, chief of the Northern Cheyenne, broke free of U.S. military confinement. Use of Fort Robinson continued through World War I, and in World War II, it was a training site for soldiers and a prisoner of war camp. It ceased to be used as a military camp in 1948, and today is a Nebraska state park and historic site.

Ranching, a livelihood well suited to the grassland plains of western Nebraska, was practiced by early settlers by the early 1870s. The arrival of the railroads (Chicago and Northwestern and the Fremont, Elkhorn, and Missouri Valley) in 1885 opened northwestern Nebraska to a flood of settlers, most of them recent European immigrants. These early settlers began a period of extensive agriculture throughout western Nebraska, mostly around well-watered regions, but many of the settlers pursued newly developed dry-land farming techniques. The established ranching community relied on open range cattle grazing. Agricultural practices relied on fencing cattle out of fields. In response, ranchers would often fence off public lands to prevent settlement. This and other issues often led to conflict between farmers and ranchers and the eventual decline of ranching. In 1903, the North Platte irrigation project was authorized by Congress. The project included the construction of five reservoirs, six power plants, and an irrigation canal system (the Interstate Canal).

### 3.4.8.2 National Register of Historic Properties and State Registers

#### 3.4.8.2.1 Historic Properties in Western South Dakota

In addition to the sites listed in Table 3.4-10, the following sites in western South Dakota are listed on South Dakota state and/or the National Register of Historic Places. There are no historic properties listed in the NRHP or state register in Butte, Fall River, or Pennington Counties as of this writing.

**Custer County**

- Custer Campsite #1 rural road
- Borglum Ranch & Studio Historic District rural road

**Lawrence County**

- Thoen Stone & Site
- Frawley Ranch

| Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region | | | |
|---|---|---|---|
| County | Resource Name | City | Date Listed YYYY-MM-DD |
| *Wyoming* | | | |
| Crook | DXN Bridge Over Missouri River | Hulett | 1985-02-22 |
| Crook | Entrance Road—Devils Tower National Monument | Devils Tower | 2000-07-24 |
| Crook | Entrance Station—Devils Tower National Monument | Devils Tower | 2000-07-24 |
| Crook | Inyan Kara Mountain | Sundance | 1973-04-24 |
| Crook | Old Headquarters Area Historic District | Devils Tower | 2000-07-20 |
| Crook | Ranch A | Beulah | 1997-03-17 |
| Crook | Sundance School | Sundance | 1985-12-02 |
| Crook | Sundance State Bank | Sundance | 1984-03-23 |
| Crook | Tower Ladder—Devils Tower National Monument | Devils Tower | 2000-07-24 |
| Crook | Vore Buffalo Jump | Sundance | 1973-04-11 |
| Crook | Wyoming Mercantile | Aladdin | 1991-04-16 |
| Niobrara | DSD Bridge Over Cheyenne River | Riverview | 1985-02-22 |
| Weston | Cambria Casino | Newcastle | 1980-11-18 |
| Weston | Jenney Stockade Site | Newcastle | 1969-09-30 |
| Weston | U.S. Post Office—Newcastle Main | Newcastle | 1987-05-19 |
| Weston | Weston County Courthouse | Newcastle | 2001-09-01 |
| Weston | Wyoming Army National Guard Cavalry Stable | Newcastle | 1994-07-07 |
| *South Dakota* | | | |
| Custer | Archaeological Site No. 39CU1619 | Custer | 1999-06-03 |
| Custer | Archaeological Site No. 39CU70 | Custer | 1993-10-20 |
| Custer | Archaeological Site No. 39CU890 | Hermosa | 1993-08-06 |
| Custer | Ayres, Lonnie and Francis, Ranch | Custer | 1991-01-25 |
| Custer | Badger Hole | Custer | 1973-03-07 |
| Custer | Bauer, Maria, Homestead Ranch | Custer | 1992-06-09 |
| Custer | Beaver Creek Bridge | Hot Springs | 1984-08-08 |
| Custer | Beaver Creek Rockshelter | Pringle | 1993-10-25 |
| Custer | Buffalo Gap Cheyenne River Bridge | Buffalo Gap | 1988-02-08 |
| Custer | Buffalo Gap Historic Commercial District | Buffalo Gap | 1995-06-30 |
| Custer | CCC Camp Custer Officers' Cabin | Custer | 1992-06-09 |
| Custer | Cold Springs Schoolhouse | Custer | 1973-03-07 |
| Custer | Custer County Courthouse | Custer | 1972-11-27 |
| Custer | Custer State Game Lodge | Custer | 1983-03-30 |
| Custer | Custer State Park Museum | Hermosa | 1983-03-30 |
| Custer | Fairburn Historic Commercial District | Fairburn | 1995-06-30 |
| Custer | First National Bank Building | Custer | 1982-03-05 |
| Custer | Fourmile School No. 21 | Custer | 1991-01-25 |
| Custer | Garlock Building | Custer | 2004-01-28 |
| Custer | Grace Coolidge Memorial Log Building | Custer | 2001-06-21 |
| Custer | Historic Trail and Cave Entrance | Custer | 1995-04-19 |
| Custer | Lampert, Charles and Ollie, Ranch | Custer | 1990-07-05 |
| Custer | Mann, Irene and Walter, Ranch | Custer | 1990-07-05 |
| Custer | Norbeck, Peter, Summer House | Custer | 1977-09-13 |
| Custer | Pig Tail Bridge | Hot Springs | 1995-04-07 |
| Custer | Ranger Station | Custer | 1995-04-05 |
| Custer | Roetzel, Ferdinand and Elizabeth, Ranch | Custer | 1991-01-25 |
| Custer | Site No. 39 Cu 510 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 511 | City Restricted | 1982-05-20 |

| Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued) | | | |
|---|---|---|---|
| County | Resource Name | City | Date Listed YYYY-MM-DD |
| | *South Dakota (continued)* | | |
| Custer | Site No. 39 Cu 512 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 513 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 514 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 515 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 516 | City Restricted | 1982-05-20 |
| Custer | Site No. 39 Cu 91 | City Restricted | 1982-05-20 |
| Custer | South Dakota Dept. of Transportation Bridge No. 17–289–107 | Custer | 1993-12-09 |
| Custer | Stearns, William, Ranch | Custer | 1990-07-05 |
| Custer | Streeter, Norman B., Homestead | Buffalo Gap | 1995-06-30 |
| Custer | Towner, Francis Averill (T.A.) and Janet Leach, House | Custer | 1990-06-21 |
| Custer | Tubbs, Newton Seymour, House | Custer | 1993-12-09 |
| Custer | Ward, Elbert and Harriet, Ranch | Custer | 1990-07-05 |
| Custer | Way Park Museum | Custer | 1973-03-07 |
| Custer | Wind Cave National Park Administrative and Utility Area Historic District | Custer | 1984-07-11 |
| Custer | Young, Edna and Ernest, Ranch | Custer | 1990-07-05 |
| Fall River | Allen Bank Building and Cascade Springs Bath House-Sanitarium | Hot Springs | 1984-02-23 |
| Fall River | Archeological 39FA1638 | Edgemont | 2005-07-14 |
| Fall River | Archeological Site 39FA1336 | Edgemont | 2005-07-14 |
| Fall River | Archeological Site 39FA1937 | Edgemont | 2005-07-14 |
| Fall River | Archeological Site No. 39FA1010 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1013 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1046 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1049 | Hot Springs | 1993-08-06 |
| Fall River | Archeological Site No. 39FA1093 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1152 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1154 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1155 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1190 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA1201 | Edgemont | 1993-08-06 |
| Fall River | Archeological Site No. 39FA1204 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA243 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA244 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA316 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA321 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA395 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA446 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA447 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA448 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA542 | Edgemont | 1993-10-25 |
| Fall River | Archeological Site No. 39FA678 | Edgemont | 1993-08-06 |
| Fall River | Archeological Site No. 39FA679 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA680 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA682 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA683 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA686 | Edgemont | 1993-10-20 |

| Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued) | | | |
|---|---|---|---|
| **County** | **Resource Name** | **City** | **Date Listed YYYY-MM-DD** |
| | ***South Dakota (continued)*** | | |
| Fall River | Archeological Site No. 39FA688 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA690 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA691 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA767 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA788 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA806 | Hot Springs | 1993-08-06 |
| Fall River | Archeological Site No. 39FA819 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA86 | Edgemont | 1993-08-06 |
| Fall River | Archeological Site No. 39FA88 | Edgemont | 1993-10-20 |
| Fall River | Archeological Site No. 39FA89 | Edgemont | 1993-08-06 |
| Fall River | Archeological Site No. 39FA90 | Hot Springs | 1993-10-20 |
| Fall River | Archeological Site No. 39FA99 | Edgemont | 1993-10-20 |
| Fall River | Bartlett—Myers Building | Edgemont | 2006-05-31 |
| Fall River | Chilson Bridge | Edgemont | 1993-12-09 |
| Fall River | Flint Hill Aboriginal Quartzite Quarry | Edgemont | 1978-07-14 |
| Fall River | Hot Springs High School | Hot Springs | 1980-05-07 |
| Fall River | Hot Springs Historic District | Hot Springs | 1974-06-25 |
| Fall River | Jensen, Governor Leslie, House | Hot Spring | 1987-09-25 |
| Fall River | Log Cabin Tourist Camp | Hot Springs | 2004-01-28 |
| Fall River | Lord's Ranch Rockshelter | Edgemont | 2005-07-14 |
| Fall River | Petty House | Hot Springs | 1999-02-12 |
| Fall River | Site 39FA1303 | Edgemont | 2005-06-08 |
| Fall River | Site 39FA1639 | Edgemont | 2005-06-09 |
| Fall River | Site No. 39 FA 277 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 389 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 554 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 58 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 676 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 677 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 681 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 684 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 685 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 687 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 7 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 75 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 79 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 91 | City Restricted | 1982-05-20 |
| Fall River | Site No. 39 FA 94 | City Restricted | 1982-05-20 |
| Fall River | St. Martin's Catholic Church and Grotto | Oelrichs | 2005-05-30 |
| Fall River | Wesch, Phillip, House | Hot Springs | 1984-02-23 |
| Lawrence | Ainsworth, Oliver N., House | Spearfish | 1990-10-25 |
| Lawrence | Baker Bungalow | Spearfish | 1996-10-24 |
| Lawrence | Buskala, Henry Ranch | Dumont | 1985-11-13 |
| Lawrence | Cook, Fayette, House | Spearfish | 1988-07-13 |
| Lawrence | Corbin, James A., House | Spearfish | 1990-10-25 |
| Lawrence | Court, Henry, House | Spearfish | 1990-10-25 |
| Lawrence | Dakota Tin and Gold Mine | Spearfish | 2005-06-08 |
| Lawrence | Deadwood Historic District | Deadwood | 1966-10-15 |

| Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued) | | | |
|---|---|---|---|
| **County** | **Resource Name** | **City** | **Date Listed YYYY-MM-DD** |
| | ***South Dakota (continued)*** | | |
| Lawrence | Dickey, Eleazer C. and Gwinnie, House | Spearfish | 1989-07-13 |
| Lawrence | Dickey, Walter, House | Spearfish | 1988-05-16 |
| Lawrence | Driskill, William D., House | Spearfish | 1989-07-13 |
| Lawrence | Episcopal Church of All Angels | Spearfish | 1976-04-22 |
| Lawrence | Evans, Robert H., House | Spearfish | 1991-11-01 |
| Lawrence | Frawley Historic Ranch | Spearfish | 1974-12-31 |
| Lawrence | Halloran-Matthews-Brady House | Spearfish | 1976-12-12 |
| Lawrence | Hewes, Arthur, House | Spearfish | 1990-10-25 |
| Lawrence | Hill, John, Ranch—Keltomaki | Brownsville | 1985-11-13 |
| Lawrence | Homestake Workers House | Spearfish | 1991-11-01 |
| Lawrence | Keets, Henry, House | Spearfish | 1988-07-13 |
| Lawrence | Knight, Webb S., House | Spearfish | 1989-07-13 |
| Lawrence | Kroll Meat Market and Slaughterhouse | Spearfish | 1988-05-20 |
| Lawrence | Lead Historic District | Lead | 1974-12-31 |
| Lawrence | Lown, William Ernest, House | Spearfish | 1976-05-28 |
| Lawrence | Mail Building, The | Spearfish | 1988-05-16 |
| Lawrence | McLaughlin Ranch Barn | Spearfish | 2002-02-14 |
| Lawrence | Mount Theodore Roosevelt Monument | Deadwood | 2005-12-22 |
| Lawrence | Old Finnish Lutheran Church | Lead | 1985-11-13 |
| Lawrence | Redwater Bridge, Old | Spearfish | 1993-12-09 |
| Lawrence | Riley, Almira, House | Spearfish | 1989-07-13 |
| Lawrence | Spearfish City Hall | Spearfish | 1990-10-25 |
| Lawrence | Spearfish Filling Station | Spearfish | 1988-05-16 |
| Lawrence | Spearfish Fisheries Center | Spearfish | 1978-05-19 |
| Lawrence | Spearfish Historic Commercial District | Spearfish | 1975-06-05 |
| Lawrence | Spearfish Post Office (Old) | Spearfish | 1999-02-12 |
| Lawrence | St. Lawrence O'Toole Catholic Church | Central City | 2003-02-05 |
| Lawrence | Tomahawk Lake Country Club | Deadwood | 2005-10-26 |
| Lawrence | Toomey House | Spearfish | 1997-11-07 |
| Lawrence | Uhlig, Otto L., House | Spearfish | 1989-07-13 |
| Lawrence | Walsh Barn | Spearfish | 2003-05-30 |
| Lawrence | Walton Ranch | Spearfish | 2005-05-30 |
| Lawrence | Whitney, Mary, House | Spearfish | 1990-10-25 |
| Lawrence | Wolzmuth, John, House | Spearfish | 1988-07-13 |
| Pennington | Archeological Site No. 39PN376 | Spearfish | 1989-07-13 |
| Pennington | Burlington and Quincy High Line Hill City to Keystone Branch | Spearfish | 1990-10-25 |
| Pennington | Byron, Lewis, House | Spearfish | 1988-05-16 |
| Pennington | Calumet Hotel | Spearfish | 1978-05-19 |
| Pennington | Casper Supply Company of SD | Spearfish | 1975-06-05 |
| Pennington | Cassidy House | Spearfish | 1999-02-12 |
| Pennington | Church of the Immaculate Conception | Central City | 2003-02-05 |
| Pennington | Dean Motor Company | Deadwood | 2005-10-26 |
| Pennington | Dinosaur Park | Spearfish | 1997-11-07 |
| Pennington | Emmanuel Episcopal Church | Spearfish | 1989-07-13 |
| Pennington | Fairmont Creamery Company Building | Spearfish | 2003-05-30 |
| Pennington | Feigel House | Spearfish | 2005-05-30 |
| Pennington | First Congregational Church | Spearfish | 1990-10-25 |

| Table 3.4-10. National Register Listed Properties in Counties Included in the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued) | | | |
|---|---|---|---|
| County | County | County | County |
| *South Dakota (continued)* | | | |
| Pennington | Gambrill Storage Building | Spearfish | 1988-07-13 |
| Pennington | Harney Peak Hotel | Custer | 1993-10-25 |
| Pennington | Harney Peak Tin Mining Company Buildings | Hill City | 2003-02-05 |
| Pennington | Otho Mining District | Hermosa | 1999-12-17 |
| Pennington | Pennington County Courthouse | Hill City | 1977-04-11 |
| Pennington | Quinn, Michael, House | Custer | 1983-03-10 |
| Pennington | Rapid City Carnegie Library | Hill City | 1977-07-21 |
| Pennington | Rapid City Garage | Keystone | 1981-02-22 |
| Pennington | Rapid City Historic Commercial District | Keystone | 1982-06-17 |
| Pennington | Rapid City Laundry | Hill City | 1994-06-03 |
| Pennington | Site No. 39 PN 108 | City Restricted | 1982-05-20 |
| Pennington | Site No. 39 PN 438 | City Restricted | 1982-05-20 |
| Pennington | Site No. 39 PN 439 | City Restricted | 1982-05-20 |
| Pennington | Site No. 39 PN 57 | City Restricted | 1982-05-20 |
| Pennington | Von Woehrmann Building | Hill City | 1977-04-13 |
| *Nebraska* | | | |
| Dawes | Army Theatre | Crawford | 1988-07-07 |
| Dawes | Bordeaux Trading Post | Chadron | 1972-03-16 |
| Dawes | Chadron Public Library | Chadron | 1990-06-21 |
| Dawes | Co-operative Block Building | Crawford | 1985-09-12 |
| Dawes | Crites Hall | Chadron | 1983-09-08 |
| Dawes | Dawes County Courthouse | Chadron | 1990-07-05 |
| Dawes | Fort Robinson and Red Cloud Agency | Crawford | 1966-10-15 |
| Dawes | Hotel Chadron | Chadron | 2002-08-15 |
| Dawes | Library | Chadron | 1983-09-08 |
| Dawes | Miller Hall | Chadron | 1983-09-08 |
| Dawes | Sparks Hall | Chadron | 1983-09-08 |
| Dawes | U.S. Post Office—Crawford | Crawford | 1992-05-11 |
| Dawes | Wohlers, Henry, Sr., Homestead | Crawford | 2004-10-15 |
| Dawes | Work, Edna, Hall | Chadron | 1983-09-08 |
| Sioux | Cook, Harold J., Homestead Cabin | Agate | 1977-08-24 |
| Sioux | Hudson-Meng Bison Kill Site | Crawford | 1973-08-28 |
| Sioux | Sioux County Courthouse | Harrison | 1990-07-05 |

3.4.8.2.2 Historic Properties in Western Nebraska

In addition to the sites listed in Table 3.4-10, the following historic properties in western Nebraska are listed on the Nebraska state and/or the National Register of Historic Places:

**Dawes County**

- James Bordeaux Trading Post [DW00-002] Listed 1972/03/16
- Henry Wohlers, Sr. Homestead [DW00-043] Listed 2004/10/15
- Chadron Commercial Historic District [DW03] Listed 2007/03/27
- Chadron State College Historic Buildings [DW03] Listed 1983/09/08
- Hotel Chadron [DW03-023] Listed 2002/08/15
- Dawes County Courthouse [DW03-081] Listed 1990/07/05
- Chadron Public Library [DW03-091] Listed 1990/06/21

- Crawford United States Post Office [DW04-007] Listed 1992/05/11
- Co-Operative Block Building [DW04-024] Listed 1985/09/12
- Fort Robinson and Red Cloud Agency [DW07] Listed 1966/10/15

The historic properties listed previously are located within about 5–8 km [3–5 mi] of the existing Crow Butte ISL Facility.

**Sioux County**

- Hudson-Meng Bison Kill Site [25-SX-115] Listed 1973/08/28
- Harold J. Cook Homestead (Bone Cabin Complex) [SX00-028] Listed 1977/08/24
- Sandford Dugout [SX00-032] Listed 2000/03/09
- Wind Springs Ranch Historic and Archeological District [SX00-033, 25-SX-77, 25-SX-600-655] Listed 2000/11/22
- Sioux County Courthouse [SX04-002] Listed 1990/07/05

### 3.4.8.3 Tribal Consultations

#### 3.4.8.3.1 South Dakota Tribal Consultation

There are 10 Native American Tribes located within or immediately adjacent to the state of South Dakota. These are the Cheyenne River Sioux, Flandreau Santee Sioux, Lower Brulé Sioux, the Crow Tribe of Montana Oglala Sioux, Rosebud Sioux, Sisseton-Whapeton Oyate, Standing Rock Sioux, Yankton Sioux, and the Ponca Tribe of Nebraska. The Siouan tribes are located throughout South and North Dakota, whereas the Ponca are located in northeastern Nebraska, but have interests in South Dakota. These and other Siouan-speaking tribes in North Dakota, Wyoming, Montana and Nebraska may have traditional land use claims in western South Dakota.

The U.S. government and the State of South Dakota recognize the sovereignty of certain Native America tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires federal agencies to undertake consultation and coordination with Native Amrican tribal governments on a government-to-government basis. In addition, the NRHP provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the South Dakota SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. To date, several tribes in South Dakota have achieved status as a THPO as provided by the NHPA (Oglala Sioux at Pine Ridge, Standing Rock Sioux, Rosebud Sioux, and the Cheyenne River Sioux). Other tribes may have applied for THPO status, but are not yet officially recognized. Projects proponents must, however, contact tribal cultural resources personnel as part of the consultation process along with the South Dakota SHPO. The National Organization of Tribal Historic Preservation Officers also maintains a list of THPOs on its website at <http://www.nathpo.org/THPO/state_list.htm>. The SHPO ensures compliance with applicable federal laws on tribal lands and consults with the tribes and the Bureau of Indian Affairs for undertakings that might occur on tribal reservation lands. Some tribes have historic and cultural preservation offices that are not recognized as THPOs, but must also be consulted where they exist.

3.4.8.3.2 Nebraska Tribal Consultation

There are six Native American tribes located within the state of Nebraska. These are the Omaha, Ponca, Winnebago, Santee Sioux, the Iowa Tribe of Kansas and Nebraska, and the Sac and Fox Nation of Missouri, Kansas, and Nebraska. These tribes are located near the Missouri River in eastern Nebraska. There are no reservation lands in western Nebraska. However, the Oglala Sioux Tribe of the Pine Ridge Reservation is located at the Nebraska-South Dakota border adjacent to the Nebraska-South Dakota-Wyoming Uranium Milling Region. These and other Siouan-speaking tribes in South Dakota, Wyoming, and Nebraska may have traditional land use claims in western Nebraska.

The U.S. government and the State of Nebraska recognize the sovereignty of certain Native America tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires executive branch federal agencies to undertake consultation and coordination with Native American tribal governments on a government-to-government basis. NRC, as an independent federal agency, has agreed to voluntarily comply with Executive Order 13175.

In addition, the NHRP provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the Nebraska SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. To date, no tribes in Nebraska have applied for status as a THPO as provided by the NHPA. In addition, some tribes in South Dakota with THPO offices may have interests in western Nebraska. Some tribes have historic and cultural preservation offices that are not recognized as THPOs, but they should be consulted where they exist. NRC, in meetings its responsibilities under the NHPA, contacts tribal cultural resources personnel as part of the consultation process, along with consulting with the Nebraska SHPO.

**3.4.8.4 Places of Cultural Significance**

As described in Section 3.2.8.4, traditional cultural properties are places of special heritage value to contemporary communities because of their association with cultural practices and beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (Parker and King, 1998; King, 2003). Religious places are often associated with prominent topographic features like mountains, peaks, mesas, springs, and lakes. In addition, shrines may be present across the landscape to denote specific culturally significant locations and vision quest sites where an individual can place offerings.

Information on traditional land use and the location of culturally significant places is often protected information within the community (King, 2003). Therefore, the information presented on religious places is limited to those that are identified in the published literature and is therefore restricted to a few highly recognized places on the landscape within southwestern South Dakota.

Traditional cultural properties are ones that refer to beliefs, customs, and practices of a living community that have been passed down over the generations. Native American traditional cultural properties are often not found on the state or national registers of historic properties or described in the extant literature or in SHPO files. There is, however, a range of cultural property types of religious or traditional use that might be identified during the tribal consultation process. These might include

- Sites of ritual and ceremonial activities and related features
- Shrines
- Marked and unmarked burial grounds
- Traditional use areas
- Plant and mineral gathering areas
- Traditional hunting areas
- Caves and rock shelters
- Springs
- Trails
- Prehistoric archaeological sites

The U.S. Bureau of Indian Affairs website contains a list, current as of May 2007, of tribal leaders and contact information at <http://www.doi.gov/bia/Tribal%20Leaders-June%202007-2.pdf>. The National Organization of Tribal Historic Preservation Officers also maintains a list of THPOs on its website at <http://www.nathpo.org/THPO/state_list.htm>. These tribal groups should be contacted for consultations associated with ISL milling activities in their respective states (see Table 3.2-12). Additional tribal contact information may be obtained from the respective SHPO in Nebraska, Montana, South Dakota, and Wyoming.

3.4.8.4.1 Places of Cultural Significance in Southwestern South Dakota

There are no culturally significant historic properties listed in the NRHP or state registers in Butte, Lawrence, Pennington, Custer, or Fall River Counties. However, the Siouan tribes who once occupied portions of South Dakota (Cheyenne River Sioux, Flandreau Santee Sioux, Lower Brule Sioux, Oglala Sioux, Rosebud Sioux, Sisseton-Whapeton Oyate, Standing Rock Sioux, Yankton Sioux, and the Ponca Tribe of Nebraska) consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant.

Areas of western South Dakota once used by these tribes may contain additional, undocumented or undisclosed culturally significant places and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

3.4.8.4.2 Places of Cultural Significance in Western Nebraska

There are no culturally significant historic properties listed in the NRHP or state register in Dawes and Sioux Counties. However, the tribes who once occupied western Nebraska (Lakota, Northern Cheyenne, Arapaho, Oglala, and Brule Sioux, among others) along the upper White and Niobrara Rivers and extending into the Black Hills of South Dakota all consider the Black Hills in Wyoming and South Dakota, Devil's Tower in northeastern Wyoming, Pumpkin Buttes in eastern Wyoming, and Bear Butte in southwestern South Dakota to be culturally significant.

Areas of western Nebraska once used by these tribes and perhaps other tribes in the region may contain additional, undocumented culturally significant sites and traditional cultural properties. Mountains, peaks, buttes, prominences, and other elements of the natural and cultural environment are often considered important elements of a traditional, culturally significant landscape.

### 3.4.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook, the Nebraska-South Dakota-Wyoming Uranium Milling Region (BLM, 2007a–c) is located within the Great Plains physiographic province, adjacent to the southern end of the Black Hills. The northwestern corner of Wyoming (see Figure 3.3-17) is located within the area managed by the Newcastle BLM field office (BLM, 2000b). Most of the area is categorized as VRM Class III, but there are some Class II areas identified around Devil's Tower National Monument and the Black Hills National Forest along the Wyoming-South Dakota border (see Figure 3.4-1). One potential uranium ISL facility has been identified for development in the northeast corner of Nebraska-South Dakota-Wyoming Uranium Milling Region, about 16 km [10 mi] northeast of the Black Hills National Forest, and about 45 km [28 mi] northeast of Devils Tower. There are no Wyoming (1) Unique and Irreplaceable and (2) Rare or Uncommon designated areas within the Nebraska-South Dakota-Wyoming Uranium Milling Region (Girardin, 2006).

Uranium resources in South Dakota are being evaluated near Fall River County in the southwestern corner of the state. Although it does not assign a VRM classification to the region, the Nebraska and South Dakota BLM field offices resource management plan classifies this region as having natural vegetation of wheatgrass, grama grass, sagebrush, and pine savanna (BLM, 1992, 1985). Similar areas are identified as Class III VRM areas in Wyoming. The USFS has also performed some visual resource classification in association with its forest and grasslands management plans in the region (see text box in Section 3.2.9). The revisions to Northern Great Plains Management Plans (USFS, 2001a) indicate that for the grasslands in Fall River County, almost 95 percent of the area is categorized with a scenic integrity objective of low to moderate (moderately to heavily altered). The Black Hills National Forest land and resource management plan and subsequent amendments (USFS, 1997, 2001b, 2005) identified management plans to maintain about 85 percent of the region for low to moderate scenic integrity objectives. About 15 percent has high (13.6 percent) to very high (1.2 percent) scenic integrity objectives (USFS, 2005). In areas lacking human-caused disturbances, the landscape has attributes that potentially have a high level of scenic integrity (USFS, 2005). There is a Prevention of Significant Deterioration Class 1 area identified for the Wind Cave National Park in South Dakota as described in Section 3.4.6.2 and shown in Figure 3.4-20, but this is at least 40 km [25 mi] east of the closest potential uranium ISL facility.

Similar to South Dakota, uranium resources in Dawes County in northwestern Nebraska are located in the Great Plains physiographic province. The Crow Butte ISL facility in Dawes County is located near the Pine Ridge Unit of the Nebraska National Forest. The revisions to Northern Great Plains Management Plans (USFS, 2001a) indicate that for the Oglala National Grassland and the Pine Ridge Unit of the Nebraska National Forest, about 87 percent of the landscape is classified as having low to moderate scenic integrity objective classification, with the remaining 13 percent roughly divided between high (7.3 percent) and very high (5.4 percent).

### 3.4.10 Socioeconomics

For the purpose of this GEIS, the socioeconomic description for the Nebraska-South Dakota-Wyoming Region includes communities within the region of influence for potential ISL facilities in the three uranium districts in the region. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined by (1) proximity to an ISL facility {generally within 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment within the Nebraska-South Dakota-Wyoming Uranium Milling Region consists of counties and Native American communities. The affected environment is listed in Table 3.4-11.

The following subsections describe areas most likely to have implications to socioeconomics and are listed below. A CBSA, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000. A Metropolitan Area has a population greater than 50,000, and a town is considered to have less than 10,000 in population (U.S. Census Bureau, 2008). Smaller communities are considered as part of the county demographics.

### 3.4.10.1 Demographics

Demographics for the year 2000 are based on population and racial characteristics of the affected environment and are provided in Tables 3.4-12 through 3.4-14. Figure 3.4-21 illustrates the populations of communities within the Nebraska-South Dakota-Wyoming Uranium Milling Region. Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic areas of interest.

Based on review of Tables 3.4-12 through 3.4-14, the most populated county is Campbell County, Wyoming and the most sparsely populated county is Sioux County, Nebraska. For communities located within 48 km [30 mi] of potential ISL facilities, the most populated town is Pine Ridge, South Dakota (Pine Ridge Indian Reservation), and the smallest populated town is Oglala, South Dakota (Pine Ridge Indian Reservation). The county with the largest percentage of nonminorities is Niobrara County, Wyoming, with a white population of 98.0 percent. The town with the largest minority population is Pine Ridge, South Dakota, with a white population of 3.7 percent. The largest minority-based county is Shannon County, South Dakota, with a white population of only 4.5 percent. The largest minority-based town is Oglala, South Dakota, with a white population of only 0.7 percent.

Although not listed in Table 3.4-12, the population counts based on 2000 U.S. U.S. Census data for the Pine Ridge Indian Reservation totaled 15,521 individuals (U.S. Census Bureau, 2008), with approximately 93 percent Native American. However, recent studies suggest that the population may be larger (Housing Assistance Council, 2002).

**Table 3.4-11. Summary of Affected Environment Within the Nebraska-South Dakota-Wyoming Uranium Milling Region**

| Counties Within Nebraska | Counties Within South Dakota | Counties Within Wyoming | Native American Communities Within South Dakota |
|---|---|---|---|
| Dawes | Butte | Campbell | Pine Ridge Indian Reservation |
| Sioux | Custer | Crook | |
| | Fall River | Niobrara | |
| | Shannon | Weston | |

| Table 3.4-12. 2000 U.S. Bureau of Census Population and Race Categories of Nebraska* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Affected Environment** | **Total Population** | **White** | **African American** | **Native American** | **Some Other Race** | **Two or More Races** | **Asian** | **Hispanic Origin†** | **Native Hawaiian and Other Pacific Islander** |
| Nebraska | 1,711,263 | 1,533,261 | 68,541 | 14,896 | 47,845 | 23,953 | 21,931 | 94,425 | 836 |
| *Percent of total* | | 89.6% | 4.0% | 0.9% | 2.8% | 1.4% | 1.3% | 5.5% | 0.0% |
| Dawes County | 9,060 | 8,457 | 73 | 261 | 93 | 143 | 28 | 220 | 5 |
| *Percent of total* | | 93.3% | 0.8% | 2.9% | 1.0% | 1.6% | 0.3% | 2.4% | 0.1% |
| Sioux County | 1,475 | 1,440 | 0 | 2 | 17 | 13 | 3 | 34 | 0 |
| *Percent of total* | | 97.6% | 0.0% | 0.1% | 1.2% | 0.9% | 0.2% | 2.3% | 0.0% |

*U.S. Census Bureau. "American FactFinder." 2000. <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 26 February 2008).

†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%.

**Table 3.4-13. 2000 U.S. Bureau of Census Population and Race Categories of South Dakota***

| Affected Environment | Total Population | White | African American | Native American | Some Other Race | Two or More Races | Asian | Hispanic Origin† | Native Hawaiian and Other Pacific Islander |
|---|---|---|---|---|---|---|---|---|---|
| South Dakota | 754,854 | 669,404 | 4,685 | 62,283 | 3,677 | 10,156 | 4,378 | 10,903 | 261 |
| *Percent of total* | | 88.7% | 0.6% | 8.3% | 0.5% | 1.3% | 0.6% | 1.4% | 0.0% |
| Butte County | 9,094 | 8,687 | 9 | 150 | 99 | 127 | 22 | 266 | 0 |
| *Percent of total* | | 95.5% | 0.1% | 1.6% | 1.1% | 1.4% | 0.2% | 2.9% | 0.0% |
| Custer County | 7,275 | 6,851 | 20 | 227 | 26 | 137 | 13 | 110 | 1 |
| *Percent of total* | | 94.2% | 0.3% | 3.1% | 0.4% | 1.9% | 0.2% | 1.5% | 0.0% |
| Fall River County | 7,453 | 6,746 | 24 | 451 | 22 | 189 | 17 | 130 | 4 |
| *Percent of total* | | 90.5% | 0.3% | 6.1% | 0.3% | 2.5% | 0.2% | 1.7% | 0.1% |
| Shannon County | 12,466 | 562 | 10 | 11,743 | 28 | 114 | 3 | 177 | 6 |
| *Percent of total* | | 4.5% | 0.1% | 94.2% | 0.2% | 0.9% | 0.0% | 1.4% | 0.0% |
| Oglala (Pine Ridge Indian Reservation | 1,229 | 9 | 0 | 1,214 | 1 | 4 | 1 | 4 | 0 |
| *Percent of total* | | 0.7% | 0.0% | 98.8% | 0.1% | 0.3% | 0.1% | 0.3% | 0.0% |

| Table 3.4-13. 2000 U.S. Bureau of Census Population and Race Categories of South Dakota* (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Affected Environment** | **Total Population** | **White** | **African American** | **Native American** | **Some Other Race** | **Two or More Races** | **Asian** | **Hispanic Origin†** | **Native Hawaiian and Other Pacific Islander** |
| Pine Ridge (Pine Ridge Indian Reservation | 3,171 | 118 | 3 | 2,987 | 16 | 43 | 1 | 57 | 3 |
| *Percent of total* | | 3.7% | 0.1% | 94.2% | 0.5% | 1.4% | 0.0% | 1.8% | 0.1% |

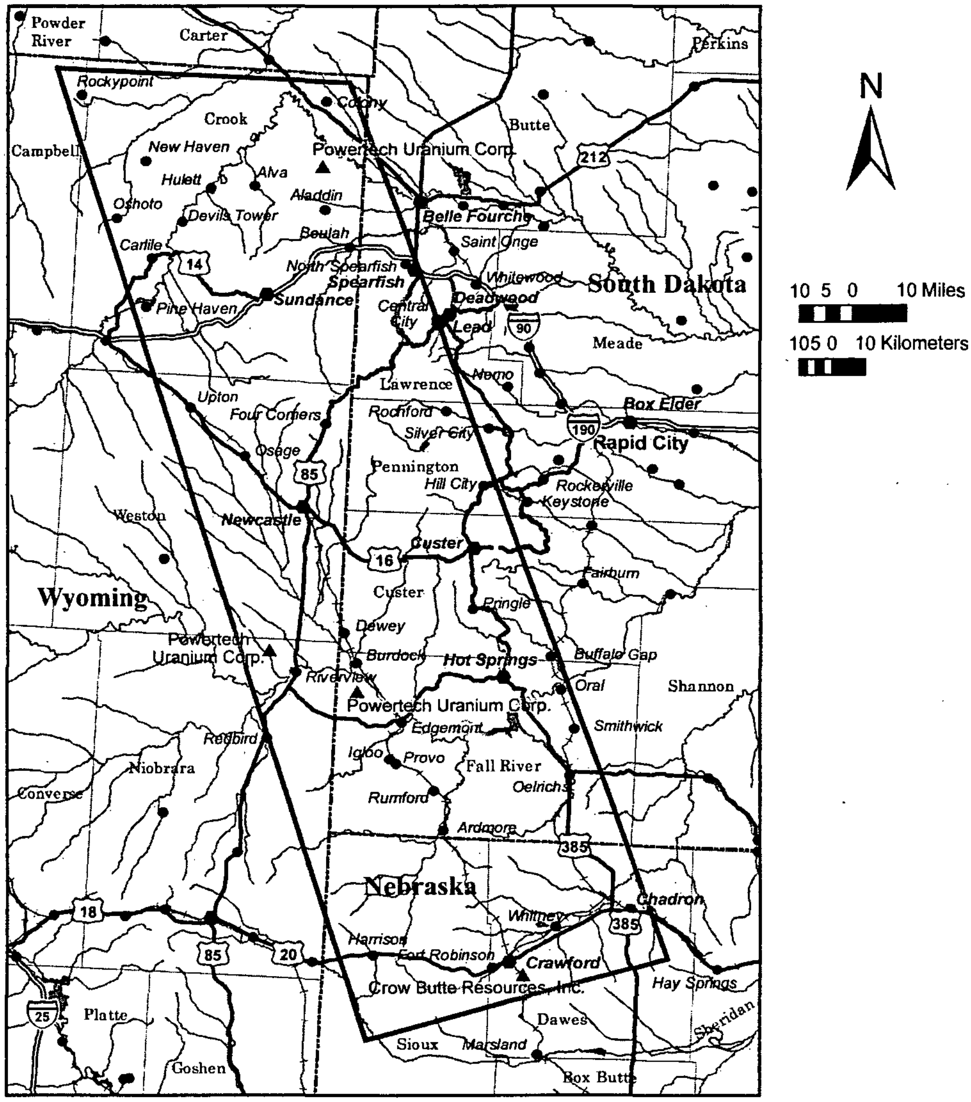
*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, and 15 April 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%).

**Table 3.4-14. 2000 U.S. Bureau of Census Population and Race Categories of Northwestern Wyoming***

| Affected Environment | Total Population | White | African American | Native American | Some Other Race | Two or More Races | Asian | Hispanic Origin† | Native Hawaiian and Other Pacific Islander |
|---|---|---|---|---|---|---|---|---|---|
| Wyoming | 493,782 | 454,670 | 3,722 | 11,133 | 12,301 | 8,883 | 2,771 | 31,669 | 302 |
| *Percent of total* | | 92.1% | 0.8% | 2.3% | 2.5% | 1.8% | 0.6% | 6.4% | 0.1% |
| Campbell County | 33,698 | 32,369 | 51 | 313 | 378 | 450 | 108 | 1,191 | 29 |
| *Percent of total* | | 96.1% | 0.2% | 0.9% | 1.1% | 1.3% | 0.3% | 3.5% | 0.1% |
| Crook County | 5,887 | 5,761 | 3 | 60 | 15 | 44 | 4 | 54 | 0 |
| *Percent of total* | | 97.9% | 0.1% | 1.0% | 0.3% | 0.7% | 0.1% | 0.9% | 0.0% |
| Niobrara County | 2,407 | 2,360 | 3 | 12 | 12 | 17 | 3 | 36 | 0 |
| *Percent of total* | | 98.0% | 0.1% | 0.5% | 0.5% | 0.7% | 0.1% | 1.5% | 0.0% |
| Weston County | 6,644 | 6,374 | 8 | 84 | 62 | 102 | 13 | 137 | 1 |
| *Percent of total* | | 95.9% | 0.1% | 1.3% | 0.9% | 1.5% | 0.2% | 2.1% | 0.0% |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 25 April 2008).

†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100%).




**SOUTH DAKOTA - NEBRASKA REGION**

▲ Ur milling Sites (NRC)
South Dakota - Nebraska Milling Region
Interstate Highway
US Highway
Water bodies (Lakes, Bays, ...)
Rivers and Streams
State Boundary
Counties
Railroad

**Cities by Populatioin**
- Over 50,000
- 10,001 - 50,000
- 1,000 - 10,000
- Less than 1,000

**Figure 3.4-21. Nebraska-South Dakota-Wyoming Uranium Milling Region With Population**

### 3.4.10.2 Income

Income information from the 2000 U.S. Census including labor force, income, and poverty levels for the affected environment in the Nebraska-South Dakota-Wyoming Uranium Milling Region is based on data collected at the state and county levels.

Data collected at the state level also includes information on towns, CBSAs, or Metropolitan Areas and considered an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or unspecialized). Data collected from a county level is generally for the same affected environment previously discussed in Table 3.4-11 and also includes information on Native American communities near the Nebraska-South Dakota-Wyoming Uranium Milling Region. State-level information is provided in Table 3.4-15, and county data are listed in Table 3.4-16.

For the surrounding region, the state with the largest labor force population and families and individuals below poverty level is Nebraska (Table 3.4-15). The population with the largest labor force is Rapid City, South Dakota {48 km [30 mi] from the nearest potential ISL facility}, and the smallest labor force population is Sturgis, South Dakota {32 km [20 mi] from the nearest potential ISL facility}. The population with the largest per capita income is Rapid City, South Dakota, and the smallest per capita income population is Chadron, Nebraska {16 km [10 mi] from the nearest ISL facility}. The population with the highest percentage of individuals and families below poverty levels is Scottsbluff, Nebraska {32 km [20 mi] from the nearest ISL facility).

Within the Nebraska-South Dakota-Wyoming Uranium Milling Region, the county with the largest labor force population is Campbell County, Wyoming, and the county with the smallest labor force population is Sioux County, Nebraska (Table 3.4-16). The town with the largest labor force population is Pine Ridge, South Dakota (Pine Ridge Indian Reservation), and the town with the smallest labor force population is Oglala, South Dakota (Pine Ridge Indian Reservation). The county with the largest per capita income is Campbell County, Wyoming, and the lowest per capita income county is Shannon County, South Dakota. The county with the highest percentage of individuals and families below poverty levels is Shannon County, South Dakota, and the town with the highest percentage of individuals and families below poverty levels is Pine Ridge, South Dakota.

### 3.4.10.3 Housing

Housing information from the 2000 U.S. Census data for the affected environment is provided in Tables 3.4-17 through 3.4-19.

The availability of housing within the immediate vicinity of the proposed ISL facilities is limited (Housing Assistance Council, 2002). The majority of housing is available in larger populated areas such as the CBSA and towns of Rapid City, South Dakota {48 km [30 mi] from the nearest ISL facility}, Spearfish, South Dakota {16 km [10 mi] to nearest potential ISL facility}, Sturgis, South Dakota {32 km [20 mi] from the nearest ISL facility}, Chadron, Nebraska {16 km [10 mi] to nearest ISL facility}, Alliance, Nebraska {16 km [10 mi] from the nearest ISL facility}, and Gillette, Wyoming {64 km [40 mi] from the nearest ISL facility}. There are approximately 10 housing units including manufactured housing (trailer homes) and residential property (neighborhoods) currently available in the region (MapQuest, 2008c).

| Table 3.4-15. U.S. Bureau of Census State Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 Years and Over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Nebraska | 917,470 | $39,250 | $48,032 | $19,613 | 29,977 | 161,269 |
| South Dakota | 394,945 | $35,282 | $43,237 | $17,562 | 18,172 | 95,900 |
| Wyoming | 257,808 | $37,892 | $45,685 | $19,134 | 10,585 | 54,777 |
| Alliance, Nebraska | 4,531 | $39,408 | $47,766 | $18,584 | 255 | 979 |
| *Percent of total†* | 66.7% | NA | NA | NA | 10.6% | 11.2% |
| Chadron, Nebraska | 3,228 | $27,400 | $44,420 | $16,312 | 127 | 1,025 |
| *Percent of total†* | 68.26% | NA‡ | NA | NA | 11.0% | 21.4% |
| Gering, Nebraska | 3,927 | $35,185 | $42,378 | $18,775 | 130 | 590 |
| *Percent of total†* | 64.1% | NA | NA | NA | 5.9% | 7.8% |
| Rapid City, South Dakota | 31,948 | $35,978 | $44,818 | $19,445 | 1,441 | 7,328 |
| *Percent of total†* | 68.8% | NA | NA | NA | 9.4% | 12.7% |
| Scottsbluff, Nebraska | 7,122 | $29,938 | $37,778 | $17,065 | 562 | 2,654 |
| *Percent of total†* | 62.5% | NA | NA | NA | 14.5% | 18.3% |

| Table 3.4-15. U.S. Bureau of Census State Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region* (continued) | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 Years and Over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Spearfish, South Dakota | 4,635 | $26,887 | $40,257 | $16,565 | 189 | 1,362 |
| *Percent of total†* | 65.1% | NA | NA | NA | 9.8% | 17.4% |
| Sturgis, South Dakota | 3,199 | $30,253 | $38,698 | $16,763 | 187 | 756 |
| *Percent of total†* | 63.0% | NA | NA | NA | 11.0% | 12.0% |
| Casper, Wyoming | 26,343 | $36,567 | $46,267 | $19,409 | 1,122 | 5,546 |
| *Percent of total†* | 68.4% | NA | NA | NA | 8.5% | 11.4% |

U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, 15 April 2008, and 25 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA = not applicable.

**Table 3.4-16. U.S. Bureau of Census County and Native American Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region***

| South Dakota* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 Years and Over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Butte County | 4,683 | $29,040 | $34,173 | $13,997 | 234 | 1,147 |
| *Percent of total†* | 68.3% | NA‡ | NA | NA | 9.4% | 12.8% |
| Custer County | 3,535 | $36,303 | $43,628 | $17,945 | 129 | 659 |
| *Percent of total†* | 59.6% | NA | NA | NA | 6.2% | 9.4% |
| Fall River County | 3,408 | $29,631 | $37,827 | $17,048 | 153 | 951 |
| *Percent of total†* | 59.6% | NA | NA | NA | 7.8% | 13.6% |
| Shannon County | 3,884 | $20,916 | $20,897 | $6,286 | 1,056 | 6,385 |
| *Percent of total†* | 52.4% | NA | NA | NA | 45.1% | 52.3% |
| Oglala (Pine Ridge Indian Reservation | 339 | $17,300 | $19,688 | $3,824 | 88 | 733 |
| *Percent of total†* | 49.9% | NA | NA | NA | 45.1% | 55.8% |
| Pine Ridge (Pine Ridge Indian Reservation | 1,149 | $21,089 | $20,170 | $6,067 | 320 | 2,057 |
| *Percent of total†* | 57.0% | NA | NA | NA | 49.2% | 61.0% |

**Table 3.4-16. U.S. Bureau of Census County and Native American Income Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region (continued)***

| Affected Environment | 2000 Labor Force Population (16 Years and Over) | Median Household Income in 1999 | Median Family Income in 1999 | Per Capita Income in 1999 | Families Below Poverty Level in 2000 | Individuals Below Poverty Level in 2000 |
|---|---|---|---|---|---|---|
| Dawes County | 4,989 | $29,476 | $41,092 | $16,353 | 207 | 1,548 |
| *Percent of total*† | 66.8% | NA‡ | NA | NA | 9.8% | 18.9% |
| Sioux County | 749 | $29,851 | $31,406 | $15,999 | 48 | 227 |
| *Percent of total*† | 64.7% | NA | NA | NA | 11.1% | 15.4% |
| **Wyoming*** | | | | | | |
| Campbell County | 18,805 | $49,536 | $53,927 | $20,063 | 507 | 2,544 |
| *Percent of total*† | 76.6% | NA | NA | NA | 5.6% | 7.6% |
| Crook County | 2,937 | $35,601 | $43,105 | $17,379 | 129 | 529 |
| *Percent of total*† | 64.4% | NA | NA | NA | 7.8% | 9.1% |
| Niobrara County | 1,193 | $29,701 | $33,714 | $15,757 | 74 | 309 |
| *Percent of total*† | 61.5% | NA | NA | NA | 10.7% | 13.4% |
| Weston County | 3,183 | $32,348 | $40,472 | $17,366 | 119 | 628 |
| *Percent of total*† | 60.0% | NA | NA | NA | 6.3% | 9.9% |

U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, 15 April 2008, and 25 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA = not applicable.

| Table 3.4-17. U.S. Bureau of Census Housing Information for the Nebraska Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| Affected Environment | Single Family Owner-Occupied Homes | Median Value in Dollars | Median Monthly Costs With a Mortgage | Median Monthly Costs Without a Mortgage | Occupied Housing Units | Renter-Occupied Units |
| Nebraska | 370,495 | $88,000 | $895 | $283 | 666,184 | 207,216 |
| Dawes County | 1,553 | $55,200 | $684 | $262 | 3,512 | 1,211 |
| Sioux County | 140 | $42,600 | $600 | $257 | 605 | 106 |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 26 February 2008).

| Table 3.4-18. U.S. Bureau of Census Housing Information for South Dakota* | | | | | | |
|---|---|---|---|---|---|---|
| Affected Environment | Single Family Owner-Occupied Homes | Median Value in Dollars | Median Monthly Costs With a Mortgage | Median Monthly Costs Without a Mortgage | Occupied Housing Units | Renter-Occupied Units |
| South Dakota | 137,531 | $79,600 | $828 | $279 | 290,245 | 87,887 |
| Butte County | 1,360 | $60,200 | $706 | $272 | 3,516 | 841 |
| Custer County | 1,073 | $89,100 | $884 | $292 | 2,970 | 1,073 |
| Fall River County | 1,286 | $54,300 | $687 | $271 | 3,127 | 901 |
| Shannon County | 631 | $25,900 | $515 | $192 | 2,785 | 1,323 |
| Oglala (Pine Ridge Indian Reservation) | 29 | $70,700 | $450 | $99 | 239 | 145 |
| Pine Ridge (Pine Ridge Indian Reservation) | 126 | $15,000 | $0 | $185 | 709 | 473 |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 26 February 2008, and 15 April 2008).

| Table 3.4-19. U.S. Bureau of Census Housing Information for the Nebraska-South Dakota-Wyoming Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **Single Family Owner-Occupied Homes** | **Median Value in Dollars** | **Median Monthly Costs With a Mortgage** | **Median Monthly Costs Without a Mortgage** | **Occupied Housing Units** | **Renter-Occupied Units** |
| Wyoming | 95,591 | $96,600 | $825 | $229 | 193,608 | 55,793 |
| Campbell County | 5,344 | $102,900 | $879 | $247 | 12,207 | 3,174 |
| Crook County | 836 | $85,4000 | $682 | $207 | 2,308 | 411 |
| Niobrara County | 480 | $60,300 | $562 | $200 | 1,011 | 222 |
| Weston County | 1,174 | $66,700 | $664 | $199 | 2,624 | 549 |
| Source: U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 25 April 2008). | | | | | | |

Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the proposed ISL facilities is not as limited. The majority of apartments is available in larger populated areas such as the CBSA and towns of Rapid City, Spearfish, and Sturgis in South Dakota; Chadron and Alliance in Nebraska; and Gillette in Wyoming, with about 25 apartment complexes currently available (MapQuest, 2008). There are also approximately 10 hotels/motels located along major highways or towns near the proposed ISL facilities. In addition to apartments and lodging, there are 20 trailer camps situated along major roads or near towns (MapQuest, 2008c).

### 3.4.10.4 Employment Structure

The regional employment structure from the 2000 U.S. Census data, including employment rate and type, is collected at the state and county levels. Data collected at the state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for employment opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or un-specialized). Data collected from a county level is the same for the affected environment previously discussed in Table 3.4-11 and also includes information on Native American communities.

For the region surrounding the Nebraska-South Dakota-Wyoming Uranium Milling Region, the state with the highest percentage of employment is Nebraska. The population with the highest percentage of employment is the town of Chadron, Nebraska, and the population with the highest unemployment rate is Spearfish, South Dakota.

Within the Nebraska-South Dakota-Wyoming Uranium Milling Region, the county with the highest percentage of employment is Campbell County, Wyoming, and the county with the highest unemployment rate is Shannon County, Nebraska. The towns with the highest unemployment rate are located on the Pine Ridge Indian Reservation (Table 3.4-20).

#### 3.4.10.4.1 State Data

##### 3.4.10.4.1.1 Nebraska

The state of Nebraska has an employment rate of 66.7 percent and unemployment rate of 2.5 percent. The largest sector of employment is management, professional, and related occupations at 33.0 percent. The largest type of industry is educational, health, and social services at 20.7 percent. The largest class of worker is private wage and salary workers at 77.1 percent (U.S. Census Bureau, 2008).

<u>Gering</u>

Gering has an employment rate of 61.6 percent and unemployment rate the same as that of the state at 2.5 percent. The largest sector of employment is management, professional, and related occupations at 34.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

**Table 3.4-20. Employment Structure of the Pine Ridge Indian Reservation Within the Affected Area***

| Affected Environment | 2003 Labor Force Population | Unemployed as Percent of Labor Force | Employed Below Poverty Guidelines | |
|---|---|---|---|---|
| Oglala Sioux Tribe of Pine Ridge | 27,778 | 87% | 716 | 21% |

* U.S. Department of the Interior. "Affairs American Indian Population and Labor Force Report 2003." <http://www.doi.gov/bia/labor.html>. Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs, Office of Tribal Affairs. 2003.

Scottsbluff

Scottsbluff has an employment rate of 57.6 percent and unemployment rate much higher than that of the state at 4.6 percent. The largest sector of employment is management, professional, and related occupations at 29.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Alliance

Alliance has an employment rate of 63.1 percent and unemployment rate higher than that of the state at 3.6 percent. The largest sector of employment is production, transportation, and material-moving occupations at 25.9 percent. The largest type of industry is transportation and warehousing, and utilities. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Chadron

Chadron has an employment rate of 65.2 percent and unemployment rate lower than that of the state at 2.8 percent. The largest sector of employment is management, professional, and related occupations at 29.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.4.10.4.1.2 South Dakota

The state of South Dakota has an employment rate of 64.9 percent and unemployment rate of 3.0 percent. The largest sector of employment is management, professional, and related occupations at 32.6 percent. The largest type of industry is educational, health, and social services at 22.0 percent. The largest class of worker is private wage and salary workers at 72.9 percent (U.S. Census Bureau, 2008).

Rapid City

Rapid City has an employment rate of 63.7 percent and unemployment rate higher than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 32.8 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Spearfish

Spearfish has an employment rate of 53.5 percent and unemployment rate much higher than that of the state at 11.5 percent. The largest sector of employment is management, professional, and related occupations at 33.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Sturgis

Sturgis has an employment rate of 59.5 percent and unemployment rate lower than that of the state at 2.8 percent. The largest sector of employment is sales and occupations at 27.6 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.4.10.4.1.3 Wyoming

The state of Wyoming has an employment rate of 63.1 percent and unemployment rate of 3.5 percent. The largest sector of employment is sales and office occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Casper

Casper has an employment rate of 64.9 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is sales and office occupations at 30.6 percent followed by management, professional, and related occupations at 29.7 percent. The largest type of industry is educational, health, and social services at 22.1 percent. The largest class of worker is private wage and salary workers at 76.6 percent (U.S. Census Bureau, 2008).

3.4.10.4.2 County Data

3.4.10.4.2.1 Nebraska

Dawes County

Dawes County has an employment rate of 63.8 percent and unemployment rate slightly higher than that of the state at 2.7 percent. The largest sector of employment is management, professional, and related occupations at 32.4 percent. The largest type of industry is educational, health, and social services at 28.9 percent. The largest class of worker is private wage and salary workers at 58.8 percent (U.S. Census Bureau, 2008).

Sioux County

Sioux County has an employment rate of 62.1 percent and unemployment rate slightly higher than that of the state at 2.7 percent. The largest sector of employment is management, professional, and related occupations at 50.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 40.5 percent. The largest class of worker is private wage and salary workers at 52.8 percent (U.S. Census Bureau, 2008).

3.4.10.4.2.2 South Dakota

Butte County

Butte County has an employment rate of 64.3 percent and unemployment rate higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 27.0 percent. The largest type of industry is agriculture, forestry, fishing, and hunting, and mining at 19.4 percent. The largest class of worker is private wage and salary workers at 66.8 percent (U.S. Census Bureau, 2008).

Custer County

Custer County has an employment rate of 57.5 percent and unemployment rate lower than that of the state at 2.0 percent. The largest sector of employment is management, professional, and related occupations at 34.6 percent. The largest type of industry is educational, health, and social services at 20.6 percent. The largest class of worker is private wage and salary workers at 58.5 percent (U.S. Census Bureau, 2008).

Fall River County

Custer County has an employment rate of 52.9 percent and unemployment rate higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 34.7 percent. The largest type of industry is educational, health, and social services at 31.1 percent. The largest class of worker is private wage and salary workers at 58.2 percent (U.S. Census Bureau, 2008).

Shannon County

Shannon County has an employment rate of 35.1 percent and unemployment rate considerably higher than that of the state at 17.3 percent. The largest sector of employment is management, professional, and related occupations at 37.8 percent. The largest type of industry is educational, health and social services. The largest class of worker is government workers (U.S. Census Bureau, 2008).

3.4.10.4.2.3 Wyoming

Campbell County

Campbell County has an employment rate of 73.2 percent and an unemployment rate lower than that of the state at 3.4 percent. The largest sector of employment is management, professional, and related occupations at 23.9 percent followed by construction, extraction, and maintenance occupations at 23.7 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 23.3 percent followed by educational, health, and social services at 16.7 percent. The largest class of worker is private wage and salary workers at 78.4 percent (U.S. Census Bureau, 2008).

Crook County

Crook County has an employment rate of 62.2 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 29.9 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 59.5 percent (U.S. Census Bureau, 2008).

Niobrara County

Niobrara County has an employment rate of 59.4 percent and an unemployment rate lower than that of the state at 2.1 percent. The largest sector of employment is management, professional, and related occupations at 34.4 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 24.7 percent. The largest class of worker is private wage and salary workers at 62.6 percent (U.S. Census Bureau, 2008).

Weston County

Weston County has an employment rate of 56.6 percent and an unemployment rate lower than that of the state at 3.3 percent. The largest sector of employment is management, professional, and related occupations at 24.3 percent. The largest type of industry is agriculture, forestry, fishing and hunting, and mining at 22.4 percent. The largest class of worker is private wage and salary workers at 68.9 percent (U.S. Census Bureau, 2008).

3.4.10.4.3 Native American Communities

Information on labor force and poverty levels for the Pine Ridge Indian Reservation is based on 2003 Bureau of Indian Affairs data and is provided in Table 3.4-20. The Oglala Sioux Tribe reports unemployment rates of more than 80 percent, much higher than the statewide levels that range from 2.5 percent for Nebraska to 3.5 percent for Wyoming (U.S. Census Bureau, 2008; U.S. Department of the Interior, 2003).

### 3.4.10.5 Local Finance

Local finance information such as revenue and tax information for the affected environment is provided in the following sections.

3.4.10.5.1 Nebraska

Sources of revenue for the State of Nebraska come from income, sales, cigarette, motor, and lodging taxes. Personal income tax rates for Nebraska range from 2.56 percent to 6.84 percent. The sales and use tax rate is 5.5 percent. Information on ad valorem taxes or mineral taxes such as that from uranium extraction is not available (Nebraska Department of Revenue, 2007). Information on local finance for the affected communities within the region of influence is presented next.

Dawes County

Sources of revenue for Dawes County come from real estate and property taxes. The net property taxes levied in 2003 were $1,634,113 with a state aid of $634,793 (Nebraska Department of Revenue, 2007).

Sioux County

Sources of revenue for Sioux County come from real estate and property taxes (Nebraska Department of Revenue, 2007).

3.4.10.5.2 South Dakota

Sources of revenue for the State of South Dakota come from 36 different state taxes. These taxes are grouped into four main categories: sales, use, and contractors' excise taxes; motor fuel taxes; motor vehicle fees and taxes; and special taxes. Once collected, these tax revenues are distributed into the state's general fund, local units of government, and the state highway fund. In 2006, 72 percent came from sales, use, and contractors' excise taxes; 11 percent from motor fuel taxes; 9 percent from special taxes; and 8 percent from vehicle taxes. South Dakota also imposes an energy minerals tax on owners of energy minerals (such as uranium). In 2006, the tax rate base was 4.5 percent of the taxable value and approximately 50 percent was disbursed to local government (South Dakota Department of Revenue and Regulation, 2007). Information on local finance for the affected communities within the region of influence is presented next.

Butte County

The majority of revenue for Butte County comes from sales, use, and property taxes. In 2004, a total revenue of $1,578,000 was collected from property taxes (City-Data.com, 2008).

Custer County

The majority of revenue for Custer County is from property taxes. In 2006, there were approximately 13,000 parcels of land in Custer County and $9.3 million was collected in real estate taxes. Other sources of revenue come from motor vehicle fees (Custer County South Dakota, 2007).

Fall River County

In 2004, the majority of revenue for Fall River County was from property taxes ($2,101,000) and motor vehicle fees ($482,000) (City-Data.com, 2007).

Shannon County

The majority of revenue for Shannon County comes from retail sales at $30,594 as of 2002 and federal grants at $197,565 as of 2004 (U.S. Census Bureau, 2008).

3.4.10.5.3 Wyoming

The State of Wyoming does not have an income tax nor does it assess tax on retirement income received from another state. Wyoming has a 4 percent state sales tax, 2 percent to 5 percent county lodging tax, and 5 percent use tax. Counties have the option of collecting an additional 1 percent tax for general revenue and 2 percent tax for specific purposes. Wyoming also imposes "ad valorem" taxes on mineral extraction properties. Taxes levied for uranium production were 10.0 percent in 2007 (6.0 percent "ad valorem" and 4 percent severance) totaling $1.7 million dollars (Wyoming Department of Revenue, 2007). None of this uranium tax revenue was generated in the Nebraska-South Dakota-Wyoming Uranium Milling Region. Annual sales and use tax distribution information for affected counties (including cities and towns) is presented in Table 3.4-21.

**Table 3.4-21. 2007 State and Local Annual Sales and Use Tax Distribution of Affected Counties Within Wyoming (Through September 28, 2007*)**

| Affected Counties | Use Tax | | Sales Tax | | Gross Revenue |
|---|---|---|---|---|---|
| | State | Local | State | Local | |
| Campbell County | 9,104,434 | 8,130,984 | 72,443,855 | 64,724,530 | 155,316,435 |
| Crook County | 542,748 | 630,596 | 2,305,618 | 2,677,933 | 6,266,869 |
| Niobrara County | 156,916 | 182,363 | 1,091,293 | 1,268,288 | 2,745,320 |
| Weston County | 630,016 | 506,201 | 2,572,484 | 2,066,940 | 5,886,521 |

*Wyoming Department of Revenue. "State of Wyoming Department of Revenue 2007 Annual Report." 2007. <http://revenue.state.wy.us/PortalVBVS//uploads/2007%20DOR%20Annual%20Report.pdf> (7 April 2009).

3.4.10.5.4 Native American Communities

The Pine Ridge Indian Reservation is the poorest reservation in the United States. The majority of revenue for Pine Ridge comes from employment by the Oglala Sioux Tribe, Oglala Lakota College, Bureau of Indian Affairs, and the Indian Health Service. Some revenue also comes from agricultural production, gaming, hunting, and ranching (Housing Assistance Council, 2002)).

### 3.4.10.6 Education

Information on education for the affected communities is presented in the following paragraphs.

Based on review of the affected environment, the county with the largest number of schools is Campbell County, Wyoming, and the county with the smallest number of schools is Niobrara, Wyoming. The towns with the smallest number of schools or smaller schools are located on the Pine Ridge Indian Reservation.

3.4.10.6.1 Nebraska

Dawes County

Dawes County has a total of 17 schools including public schools, elementary schools, middle schools, high schools, and 1 academy. There are a total of approximately 5,500 students. The majority of schools provides bus services (Schoolbug.org, 2007a).

Sioux County

Sioux County has a total of 6 schools including 5 public schools and 1 high school, with a total of approximately 565 students. Information as to whether these schools provide bus services is not available (Publicschoolsreport.com, 2008).

3.4.10.6.2 South Dakota

Butte County

Butte County has three elementary schools, two middle schools, and two high schools. There are a total of approximately 1,789 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2008).

Custer County

Custer County has five elementary schools, one middle school, one high school, and one alternative school for a total of nine schools. There are a total of approximately 1,207 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2007b).

Fall River County

Fall River County has 4 elementary schools, 2 middle schools, 1 junior high school, and 3 high schools for a total of 10 schools. There are a total of approximately 1,200 students. Information as to whether these schools provide bus services is not available (Schoolbug.org, 2007c).

Shannon County

Shannon County has one school district, which consists of four elementary and junior high schools. There are approximately 991 students. Information as to whether these schools provide bus services is not available (Greatschools.net, 2008).

Native American Communities

The Pine Ridge Indian Reservation has the Pine Ridge School and the Oglala elementary school (Housing Assistance Council, 2002; Pine Ridge School, 2008). Specific information pertaining to school population or bus services is not available.

3.4.10.6.3 Wyoming

Campbell County

Campbell County has 1 school district with 24 schools consisting of 15 elementary schools, 2 junior high schools, 1 junior/senior high school, 1 high school, 1 alternative school, and 1 aquatic center. There are a total of approximately 7,441 students. The majority of schools provides bus services (Campbell County School District No. 1, 2007).

Crook County

Crook County has 1 school district with 2 elementary schools, 2 secondary schools, and 1 high school, with a total of approximately 1,142 students. Information as to whether these schools provide bus services is not available (Crook County School District, 2008).

Niobrara County

Niobrara County has one school district, Niobrara County School District No. 1, with a total of approximately 422 students. There is one elementary and middle school, one high school, and one private school. Information as to whether these schools provide bus services is not available (Niobrara County School District No. 1, 2008).

Weston County

Weston County has one school district, Weston County School District No. 1, with a total of approximately 1,134 students. There are two elementary schools, one middle school, and one high school. Information as to whether these schools provide bus services is not available (Weston County School District No. 1, 2008).

### 3.4.10.7 Health and Social Services

The majority of health care facilities is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the potential ISL facilities are located in Spearfish, Edgemont, Rapid City, and Sturgis, South Dakota; Alliance, Gordon, and Chadron, Nebraska; and Gillette, Sundance, and Torrington, Wyoming, and have a total of at least 18 facilities (MapQuest, 2008b). These consist of hospitals, clinics, emergency centers, and medical services. The following hospitals are located proximate to the Nebraska-South Dakota-Wyoming Uranium Milling Region: Spearfish, South Dakota (one); Rapid City, South Dakota (two); Alliance, Nebraska (one); Gordon, Nebraska (one); Chadron, Nebraska (two); Gillette, Wyoming (two); and Torrington, Wyoming (one).

Local police within the Nebraska-South Dakota-Wyoming Uranium Milling Region are under the jurisdiction of each county. There are 20 police, sheriff, or marshals offices within the region: Butte County, South Dakota (2); Custer County, South Dakota (1); Fall River County, South Dakota (2); Shannon County, South Dakota (1); Dawes County, Nebraska (3); Sioux County, Nebraska (1); Campbell County, Wyoming (2); Crook County, Wyoming (3); Niobrara County, Wyoming (2); and Weston County, Wyoming (3) (Usacops, 2008).

Fire departments within the affected area are comprised at the county, town or CBSA level. There are 45 fire departments within the milling region: Rapid City, South Dakota (16); Sturgis, South Dakota (14); Spearfish, South Dakota (5); Alliance, Nebraska (1); Campbell County, Wyoming (2); Crook County, Wyoming (1); and Gillette, Wyoming (2) (50states, 2008).

## 3.4.11 Public and Occupational Health

### 3.4.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council on Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels that those with other types of soils/bedrock (EPA, 2006). Radiological background for Wyoming is provided in Section 3.2.11.1. For the states of South Dakota and Nebraska, the average background rate including natural and man-made sources is 6.0 and 3.5 mSv/yr [600 and 350 mrem/yr], respectively (EPA, 2006). The average background rate for South Dakota is significantly higher than the U.S. average background rate of 3.6 mSv/yr [360 mSv/yr], and for Nebraska it is very similar.

For South Dakota, the radon dose is 4.4 mSv/yr [440 mrem/yr] compared to the U.S. average radon dose of 2.0 mSv/yr [200 mrem/yr]. For South Dakota, the indoor average radon rate is significantly higher than the U.S. average due to geological reasons and poor ventilation within homes (EPA, 2006). For the western region of South Dakota of interest here, the radon levels are half as much when compared to the state average (South Dakota Department of Environmental and Natural Resources, 2008), and therefore, background dose is expected to be closer to the national average for this region.

#### 3.4.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. Therefore, see Section 3.2.11.2 for further discussion of these standards.

#### 3.4.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. Therefore, see Section 3.2.11.3 for further discussion of these standards.

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# 3.5 Northwestern New Mexico Uranium Milling Region

## 3.5.1 Land Use

The Northwestern New Mexico Uranium Milling Region defined in this GEIS lies within the Navajo section of the Colorado Plateau (U.S. Geological Survey, 2004). This region includes McKinley County and the northern part of Cibola County (Figure 3.5-1). Past, current and potential uranium milling operations are found in two areas: (1) the central western part of McKinley County, east of Gallup, New Mexico and (2) the southeastern part of McKinley County and the northern part of Cibola County, east and northeast of Grants, New Mexico. These two areas are parts of the Grants Uranium District (Figure 3.5-2). Details on the geology and soils of this district and its subdivisions are provided in Section 3.5.3.

Land distribution statistics in Table 3.5-1 were calculated using the Geographic Information System used to construct the map shown in Figure 3.5-1. The data show that 91 percent of the Northwestern New Mexico Uranium Milling Region is composed of private (surface ownership) land (50 percent), Indian Reservation land (27 percent), and U.S. national forest land (14 percent).

Indian Reservation land, administered by the Bureau of Indian Affairs, comprises Acoma Pueblo, Laguna, Navajo, Ramah Navajo, and Zuni Indian land. Navajo land forms the northwest corner of McKinley County and abuts the northwestern part of the Grants Uranium District. Portions of any potential new ISL facility in this area of this district could fall within Navajo allottees, who own the surface and mineral rights. Bureau of Indian Affairs administers the leases needed for both the surface use and mineral rights on such land. In this area of McKinley County, the Crownpoint and Church Rock Chapters of the Navajo Nation are part of an area known as the checkerboard due to its mixed private tribal and government property rights. Certain properties are under the Navajo Tribal Trust while individual Navajo allotments are privately held, with some Bureau of Indian Affairs oversight. In this area, the Crownpoint Unit 1 site is located on allotted land and the Church Rock site is located on Navajo Tribal Trust land (NRC, 1997).

Land use issues in the area of the Navajo Nation are a sensitive issue and consideration should be paid to ongoing jurisdictional disputes over the checkerboard lands. In addition, contamination of water supplies within the Rio San Jose Basin as a result of uranium milling has further heightened the Navajo Nation's sensitivity to land uses that may affect their ability to use tribal lands for raising livestock.

BLM lands occupy only approximately 8 percent of the region and are mostly concentrated in the northeastern corner of McKinley County (Figure 3.5-1). Other federal lands managed by the U.S. Department of Defense (Fort Wingate Military Reservation) and the National Park Service represent less than 1 percent of the region.

Although sparsely populated, this region has three fairly large population centers: Gallup, with more than 20,000 people; Grants, with approximately 9,000 people; and Zuni Pueblo, with about 6,400 people. Smaller communities are scattered along the Interstate 40 corridor (Figure 3.5-2). Generally, private, federal, and Indian Reservation lands in this region are rural, mainly undeveloped, sparsely populated, and mostly used for livestock grazing and to a lesser extent for timber and agricultural production. In McKinley County, for example, more than 85 percent of the land is used for agricultural purposes and 83 percent of that land is used for livestock grazing. Only 9 percent and 0.6 percent of the land is used for timber production and for dry

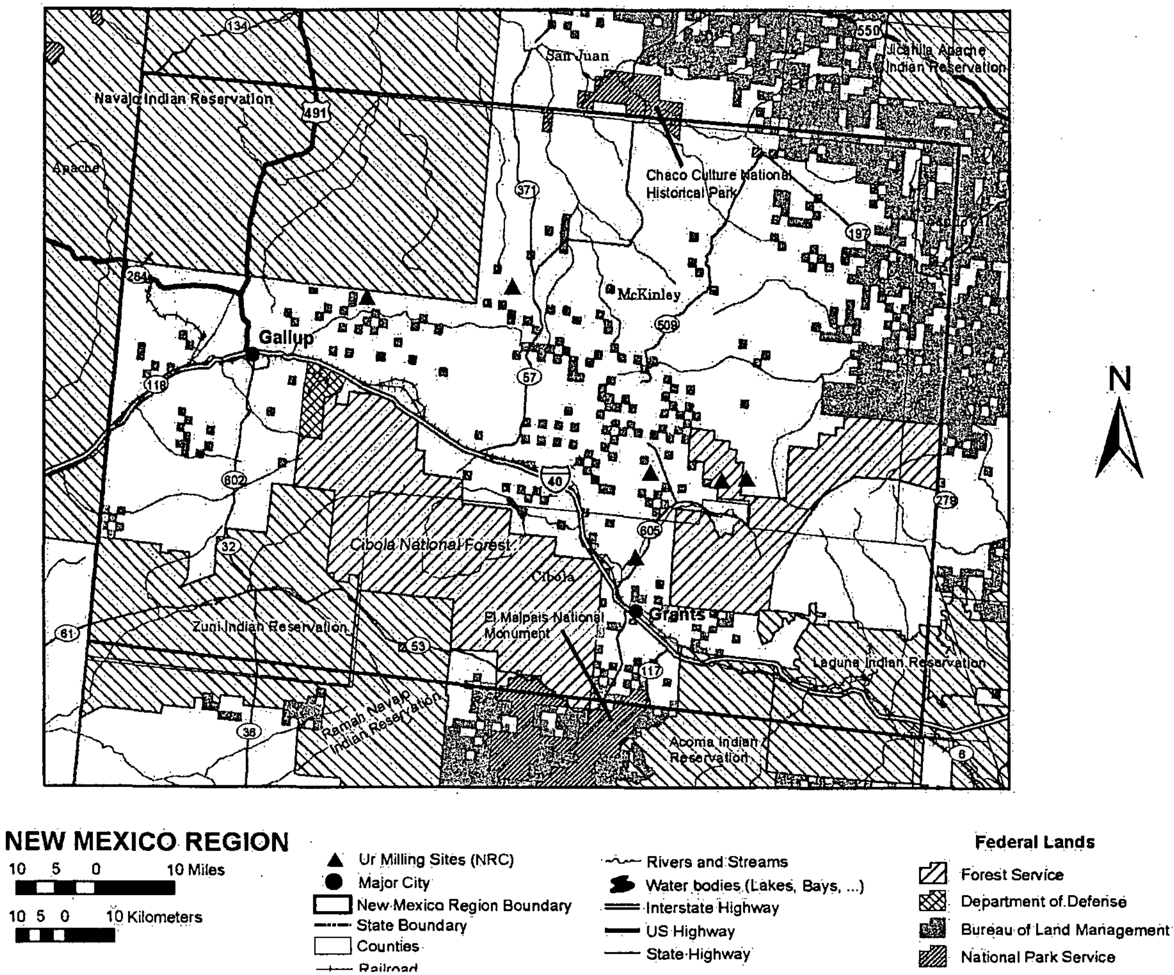



**Figure 3.5-1. Northwestern New Mexico Uranium Milling Region General Map With Current and Future Uranium Milling Site Locations**

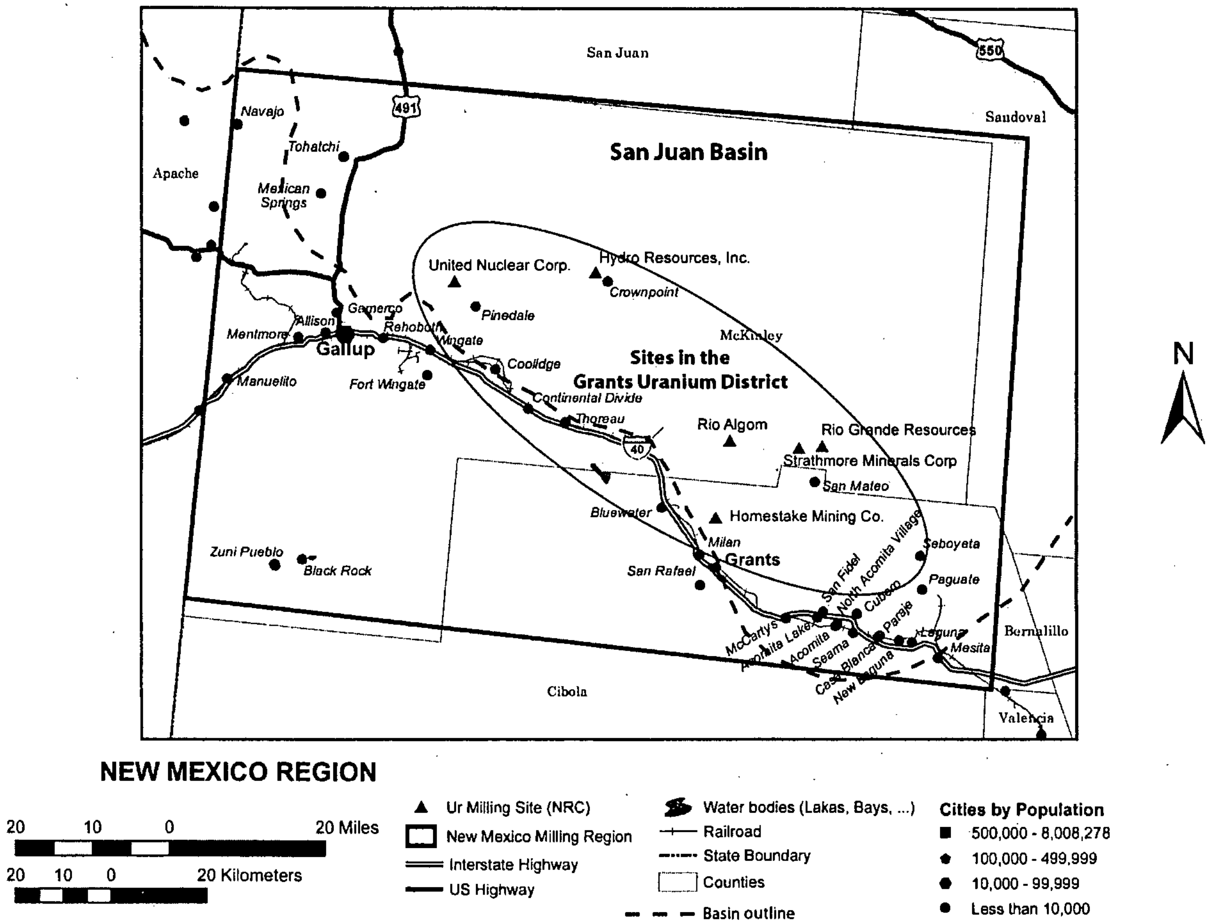



**Figure 3.5-2. Map Showing Outline of the Northwestern New Mexico Region and the Location of the Grants Uranium District Along the Southern Margin of the San Juan Basin**

| Table 3.5-1. Land Surface Ownership and General Use in the Northwestern New Mexico Uranium Milling Region | | | |
|---|---|---|---|
| Land Surface Ownership and General Use | Area ($mi^2$) | Area ($km^2$) | Percent |
| State and Private Lands | 3,682 | 9,537 | 50.1 |
| Bureau of Indian Affairs, Indian Reservations | 1,999 | 5,176 | 27.2 |
| U.S. Forest Service, National Forest | 1,028 | 2,662 | 14 |
| U.S. Bureau of Land Management (BLM), Public Domain Land | 579 | 1,501 | 7.9 |
| U.S. Department of Defense (Army) | 29 | 75 | 0.4 |
| National Park Service, National Monument | 25 | 64 | 0.3 |
| National Park Service, National Historic Park | 6 | 16 | 0.08 |
| BLM, National Conservation Area | 1 | 2 | 0.01 |
| BLM, Wilderness | 0.5 | 1 | 0.01 |
| **Totals** | 7,350 | 19,035 | 100 |

and irrigated crop production, respectively. Coal and uranium milling activities use less than 1 percent of the land in McKinley County (NRC, 1997).

Recreational and cultural activities for the public are available in the Mount Taylor Ranger District, part of the Cibola National Forest. This forest includes the Zuni Mountains to the west of Grants and the San Mateo Mountains and Mount Taylor, about 24 km [15 mi] to the east-northeast of Grants. Mount Taylor is designated by the Navajo Nation as one of six sacred mountains. In Navajo tradition, Mount Taylor has a special significance as it represents the southern boundary of the Navajo traditional homeland (USFS, 2006). On June 14, 2008, the New Mexico Cultural Properties Review Committee approved a 1-year emergency listing of more than 171,000 ha [422,000 acres] of land surrounding Mount Taylor on the New Mexico Register of Cultural Properties (Los Angeles Times, 2008) (see Section 3.5.8.3).

El Malpais National Monument in Cibola County and the Chaco Culture National Historical Park, which has several sites in McKinley County and San Juan County farther north, are the two main recreational and cultural areas managed by the National Park Service in the Northwestern New Mexico Uranium Milling Region.

### 3.5.2 Transportation

Past experience at NRC-licensed ISL facilities indicates these facilities rely on roads for transportation of most goods and personnel (Section 2.8). As shown in Figure 3.5-3, the Northwestern New Mexico Uranium Milling Region is accessed from the east and west by Interstate 40, from the north by U.S. Highway 491 (formerly U.S. Highway 666) and State Routes 371 and 509, and from the south by State Routes 36 and 602. A rail line traverses the region east and west along the path of Interstate 40.

Areas of past, present, or future interest in uranium milling in the region are shown in Figure 3.5-3. These areas are located in three subregions when considering site access by local roads. Areas of milling interest from west to east include areas near Pinedale northeast of Gallup, the area near Crownpoint north of Thoreau, and the area northeast of Milan and Grants near Ambrosia Lake and San Mateo. All these areas have access to Interstate 40 to the south using local access roads to State Routes 566 near Pinedale, 371 near Crownpoint, and 509 and 605 near Ambrosia Lake and San Mateo.

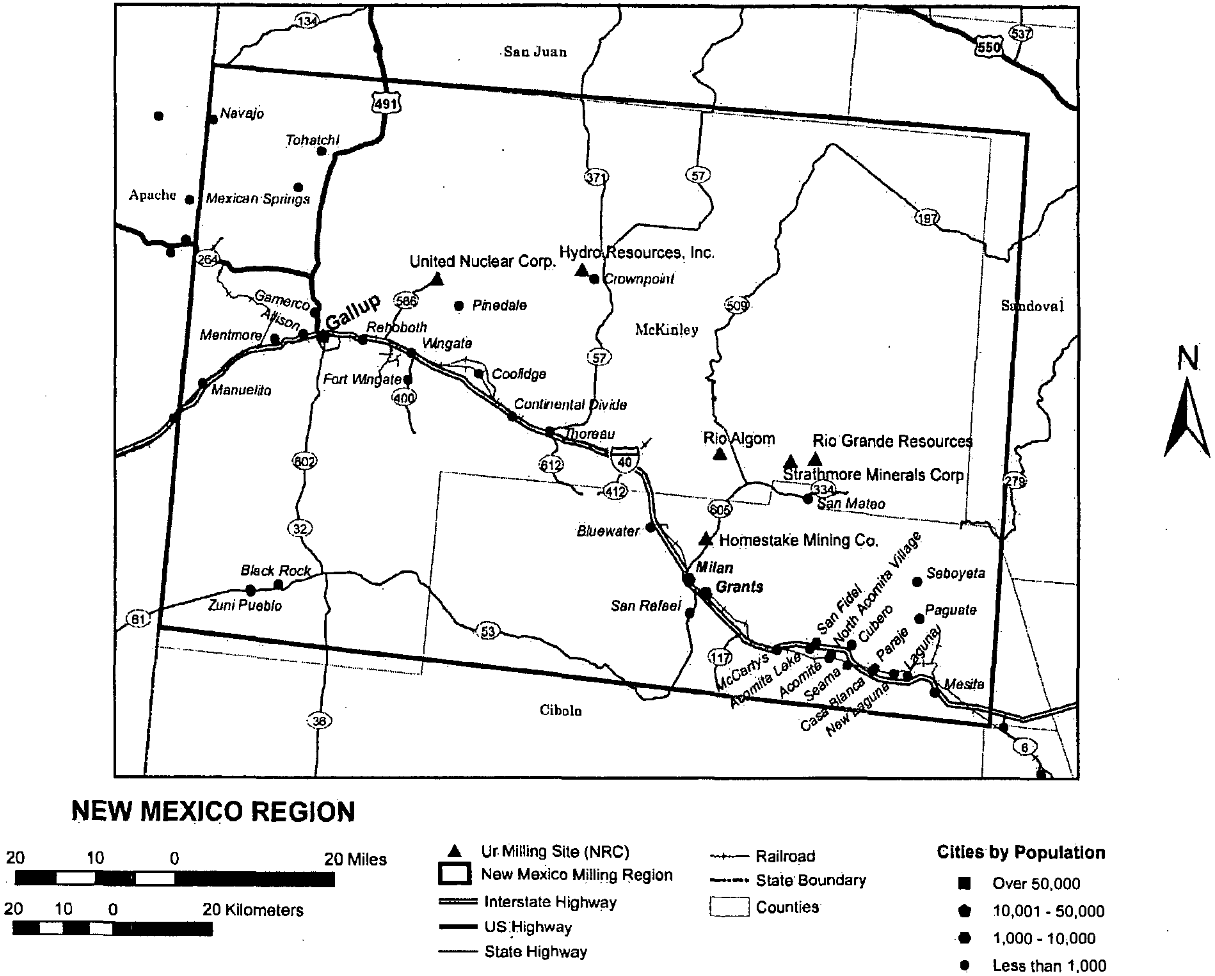



**Figure 3.5-3. Northwestern New Mexico Uranium Milling Region Transportation Corridor Locations**

Table 3.5-2 provides available traffic count data for roads that support areas of past, present, or future milling interest in the Northwestern New Mexico Uranium Milling Region. Counts are variable, with the minimum all-vehicle count at 330 vehicles per day on State Route 509 North at State Route 605 and the maximum on Interstate 40, Thoreau Interchange North at 11,709 vehicles per day. Most all vehicle counts in the Northwestern New Mexico Uranium Milling Region are above 1,500 vehicles per day.

Yellowcake product shipments are expected to travel from the milling facility to a uranium hexafluoride production (conversion) facility in Metropolis, Illinois (the only facility currently licensed by NRC in the United States for this purpose). Major interstate transportation routes are expected to be used for these shipments, which are required to follow NRC packaging and transportation regulations in 10 CFR Part 71 and U.S. Department of Transportation hazardous material transportation regulations at 49 CFR Parts 171–189. Table 3.5-3 describes representative routes and distances for shipments of yellowcake from locations of uranium milling interest in the Northwestern New Mexico Uranium Milling Region. Representative routes are considered owing to the number of routing options available that could be used by a future ISL facility. Because transportation risks are dependent on shipment distance, identification of representative routes is used to generate estimates of shipment distances for evaluation of transportation impacts in Chapter 4 (Section 4.2.2). An ISL facility could use a variety of routes for actual yellowcake shipments, but the shipment distances for alternate routes are not expected to differ significantly from those estimated for the representative routes.

### 3.5.3 Geology and Soils

New Mexico ranks second in uranium reserves in the United States. In the Northwestern New Mexico Uranium Milling Region, uranium resources are located primarily within the Morrison

**Table 3.5-2. Average Annual Daily Traffic Counts for Roads in the Northwestern New Mexico Uranium Milling Region***

| Road Segment | County | All Vehicles | |
|---|---|---|---|
| | | 2005 | 2006 |
| State Route 566 North at State Route 118 | McKinley | 4,605 | 4.637 |
| State Route 371 at Interstate 40 (Thoreau) | McKinley | 5,514 | 5,552 |
| State Route 371 North at Navajo 9 to Mariano Lake | McKinley | 3,842 | 3,868 |
| State Route 605 North at County Line North of Milan | McKinley | 2,522 | 2,488 |
| State Route 605 North at State Route 509 to Ambrosia Lake | McKinley | 1,595 | 1,562 |
| State Route 509 North at State Route 605 | McKinley | 338 | 330 |
| Interstate 40, Thoreau Interchange North | McKinley | 11,676 | 11,709 |
| State Route 605 North at State Route 122 in Milan | Cibola | 1,232 | 1,196 |
| Interstate 40, Grants-Milan Interchange | Cibola | 10,186 | 9,993 |

*NMDOT. "Road Segments by Traffic (AADT) Info." Data for Cibola and McKinley Counties from the New Mexico State Highway and Transportation Department's Consolidated Highway Data Base, provided by request. Santa Fe, New Mexico: New Mexico Department of Transportation. April 2008.

**Table 3.5-3. Representative Transportation Routes for Yellowcake Shipments From the Northwestern New Mexico Uranium Milling Region***

| Origin | Destination | Major Links | Distance* (mi) |
|---|---|---|---|
| North of Pinedale, New Mexico | Metropolis, Illinois | Local access road to State Route 566<br>State Route 566 south to Interstate 40<br>Interstate 40 east to Memphis, Tennessee<br>Interstate 55 north to Interstate 155<br>Interstate 155 north to Interstate 24<br>Interstate 24 north to Metropolis, Illinois | 1,360 |
| Crownpoint, New Mexico | Metropolis, Illinois | Local access road to State Route 371<br>State Route 371 south to Interstate 40<br>Interstate 40 east to Metropolis, Illinois (as above) | 1,360 |
| North of San Mateo, New Mexico | Metropolis, Illinois | Local access road to State Route 334 at San Mateo<br>State Route 334 west to State Route 605<br>State Route 605 to Interstate 40 at Milan near Grants | 1,300 |

*American Map Corporation. "Road Atlas of the United States, Canada, and Mexico." Long Island City, New York: American Map Corporation. p. 144. 2006.

Formation in the Grants Uranium District (see Figure 3.5-2). The Grants Uranium District includes a belt of sandstone-type uranium deposits stretching 135 km [85 mi] along the south side of the San Juan Basin. The Grants Uranium District consists of eight subdistricts, which extend from east of Laguna to west of Gallup (Figure 3.5-4) (McLemore and Chenoweth, 1989). The sandstone-type uranium deposits in the Grants Uranium District are generally in a geologic setting favorable for exploitation by ISL milling. More than 150,000 metric tons [170,000 tons] of $U_3O_8$ have been produced from these deposits from 1948 to 2002, accounting for 97 percent of the total production in New Mexico and more than 30 percent of the total production in the United States (McLemore and Chenoweth, 1989). Estimates of uranium reserves indicate that there are an additional 150,000 metric tons [170,000 tons] of $U_3O_8$ in the Morrison Formation (McLemore, 2007).

The San Juan Basin is a structural depression occupying a major portion of the southeastern Colorado Plateau physiographic province (Hunt, 1974). The plateau encompasses much of western Colorado, eastern Utah, northeastern Arizona, and northwestern New Mexico. The San Juan Basin is underlain by up to 3,000 m [10,000 ft] of sedimentary strata, which generally dip gently from the margins toward the center of the basin. The margins of the basin are characterized by relatively small elongate domes, uplifts, and synclinal depressions.

Uranium mineralization in the Grants Uranium District occurs within Upper Jurassic (144- to 159-million-year-old) and Cretaceous (65 to 144 million year old) sandstones. Stratigraphic descriptions presented here are limited to formations that would be involved in potential milling operations or formations that may have environmental significance, such as important aquifers and confining units above and below potential milling zones. A generalized stratigraphic column of formations in the Grants Uranium District is shown in Figure 3.5-5.

The Morrison Formation is composed of the Recapture, Westwater Canyon, and Brushy Basin Members and is the host formation for major uranium deposits in the Grants Uranium District. Most of the deposits are within the main sandstone bodies of the Westwater Canyon Member. In addition, the Westwater Canyon is an important regional aquifer. Large uranium deposits are

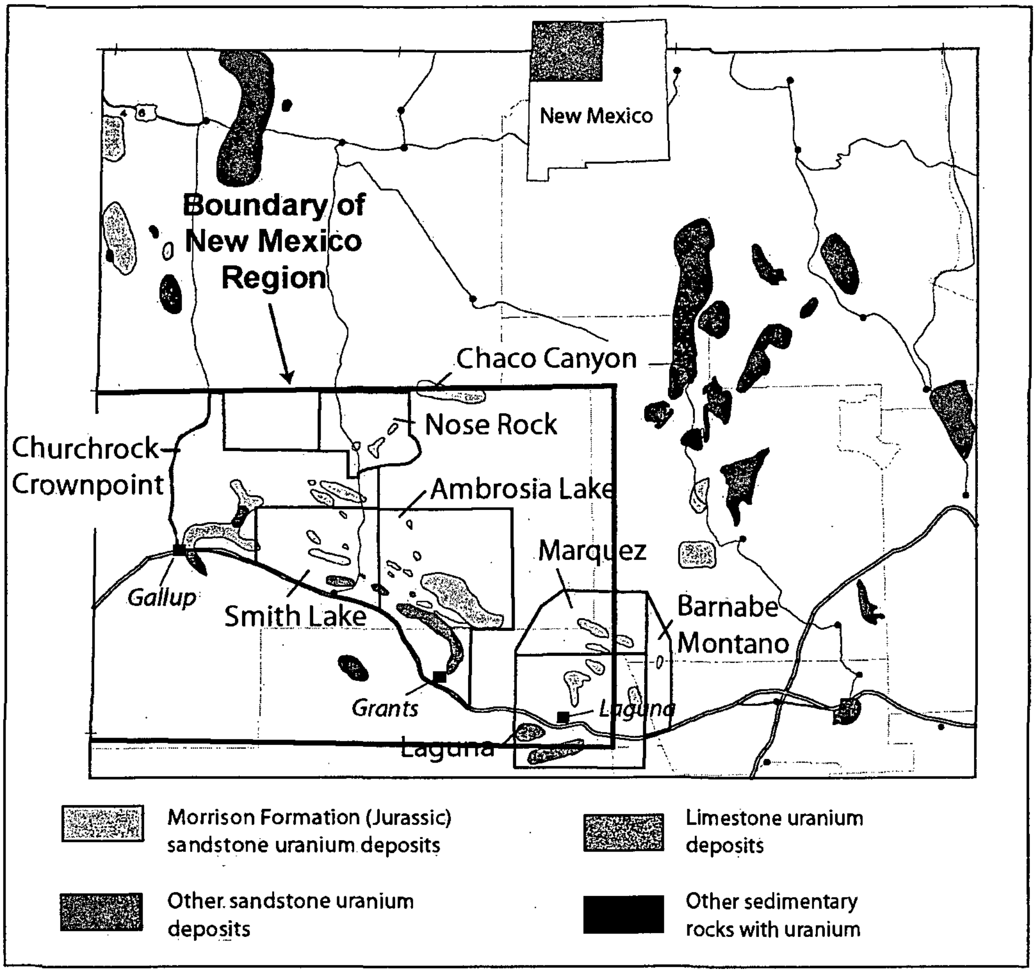



**Figure 3.5-4. Index Map of the Grants Uranium District, San Juan Basin, New Mexico, Showing Eight Subdistricts (Modified From McLemore, 2007)**

also found in a series of sandstone beds, known collectively as the Poison Canyon sandstones of economic usage, which occur near the base of the Brushy Basin Member in the Blackjack (Smith Lake), Poison Canyon, and Ambrosia Lake mining areas (Holen and Hatchell, 1986). Deposits also occur in sandstone lenses higher in the Brushy Basin in the Blackjack (Smith Lake) mining area. In the Laguna district, a bed of sandstone overlying the Brushy Basin, the Jackpile Sandstone Member of the Morrison (Owen, 1984), contains the large Jackpile-Paguate, L-Bar, and Saint Anthony deposits. Relationships of the deposits in the various Morrison units are shown in Figure 3.5-6.

Elsewhere in the San Juan Basin, significant but relatively small sandstone-type deposits also occur in the Dakota Sandstone in the Church Rock area and in the Burro Canyon Formation in the Carjilon area (Holen and Hatchell, 1986). The Todilto Limestone in the Grants Uranium District, which has accounted for about 2 percent of total production, is quite impermeable and is unlikely to be amenable to production by ISL. Beyond the San Juan Basin, significant but

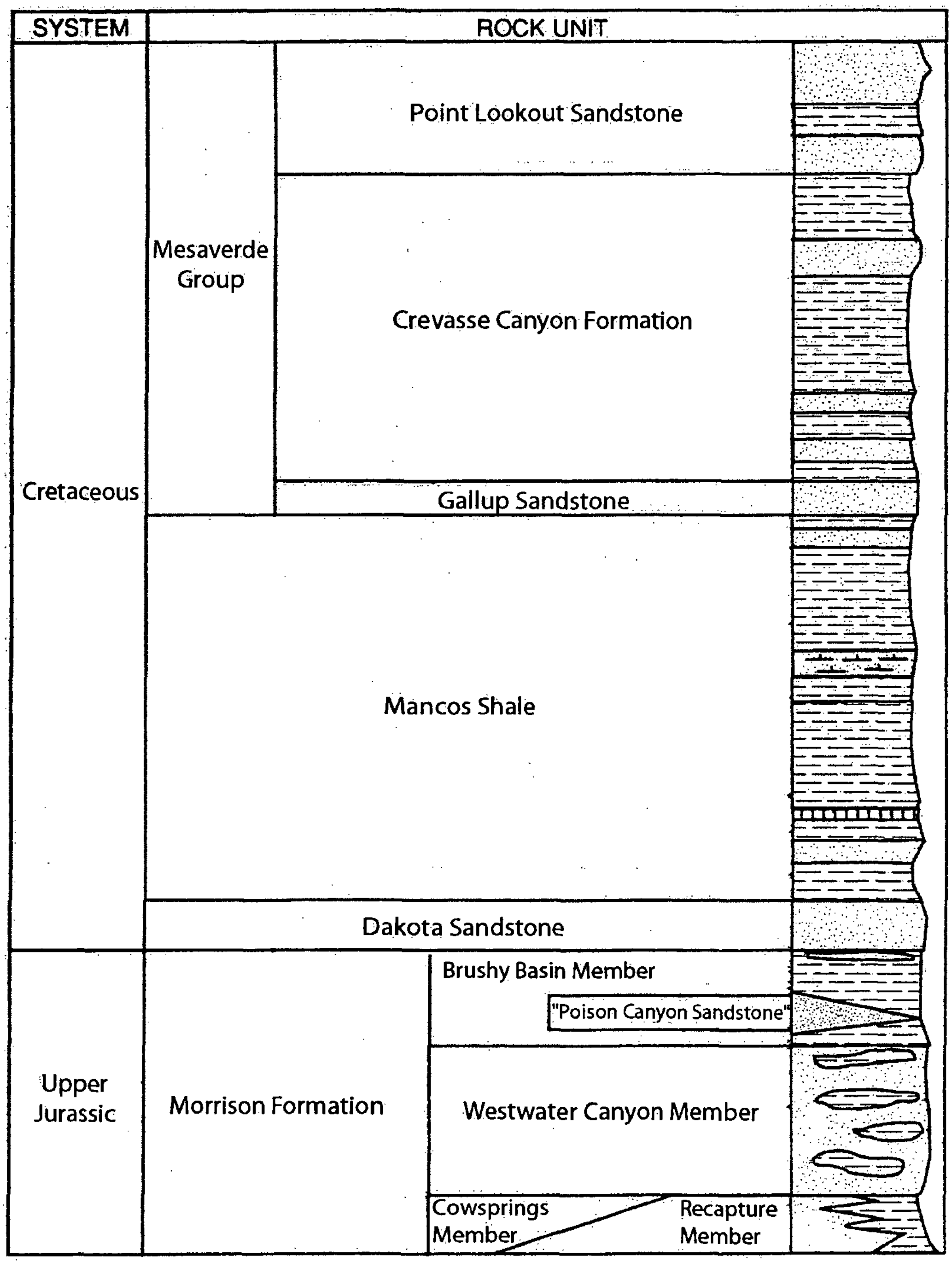



**Figure 3.5-5. Generalized Stratigraphic Section of Upper Jurassic and Cretaceous Formations in the Grants Uranium District (NRC, 1997)**

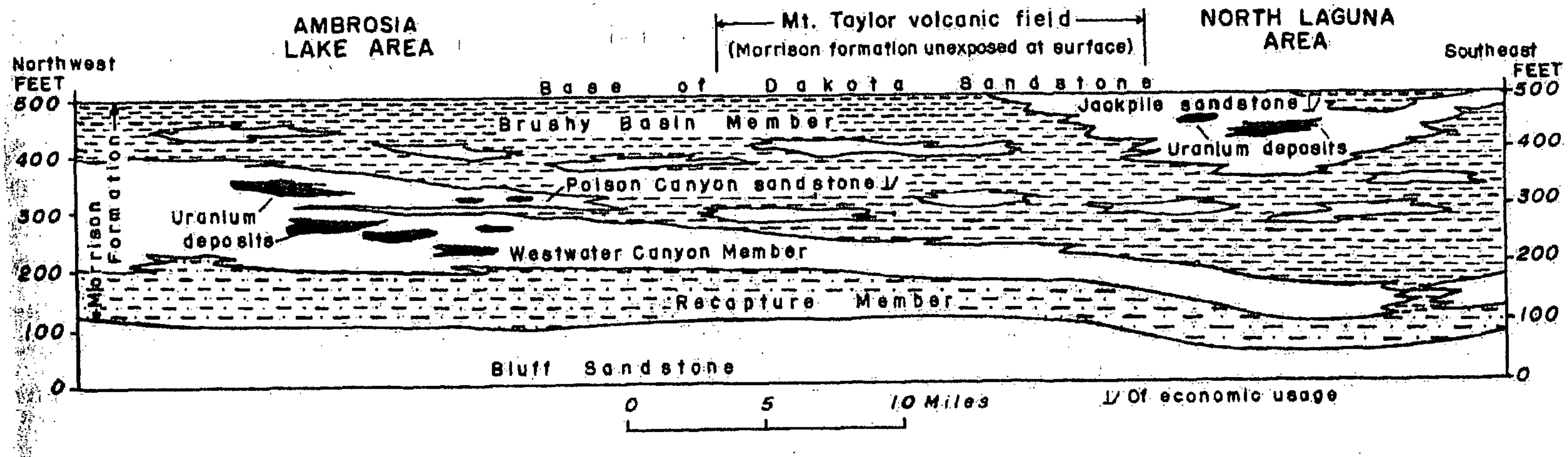



**Figure 3.5-6. Generalized Geologic Section Showing the Stratigraphic Relations of the Morrison Formation Between the Ambrosia Lake and Laguna Areas (From Hilpert, 1969)**

relatively small sandstone-type deposits occur in the Galisteo Formation in the Hagan Basin, and in the Crevasse Canyon and Baca Formations in the Riley-Pie Town areas.

The following regional descriptions of the stratigraphic units within the San Juan Basin are derived from reports by Green and Pierson (1977), Hilpert (1963, 1969), Chenoweth and Learned (1980), and Holen and Hatchell (1986).

The Recapture Member is the bottommost member of the Morrison Formation. It is as thick as 150 m [500 ft] northwest of Gallup but thins to 45 to 90 m [150 to 300 ft] in outcrops near Gallup and eastward. The Recapture is one of the most variable stratigraphic units in the area. It occurs in the Gallup Mining District as a sequence of interbedded siltstone, mudstone, and sandstone strata. Individual strata range from centimeters to meters [inches to feet] in thickness. Sandstone beds are generally less than 5 m [15 ft] thick (Hilpert, 1969). The Recapture is believed to interfinger with the underlying Cow Springs Sandstone, and several authors have combined the two units as one. No significant uranium deposits occur in the Recapture Member.

The Westwater Canyon Member of the Morrison Formation consists of interbedded fluvial red, tan, and light-gray arkosic sandstone (i.e., sandstone containing a significant fraction of feldspar), claystone, and mudstone. It is a major water-bearing member of the Morrison. The unit ranges from 53 to 85 m [175 to 275 ft] thick in outcrops from Gallup to the Continental Divide (Hilpert, 1969) and is known to be considerably thicker locally. In most places, the Westwater Canyon displays one or more mudstone units that range from thin partings to units up to 6 m [20 ft] thick. The mudstone units have limited lateral continuity, and only the thicker ones are extensive. The Westwater Canyon is host for the major uranium deposits in the region. The uranium occurs in coarse-grained, poorly sorted sandstone units and is closely associated with the carbonaceous material that coats the sand grains.

Three types of stratabound uranium deposits are present in the Westwater Canyon Member: primary (trend or tabular), roll front (redistributed), and remnant-primary sandstone uranium deposits (Figure 3.5-7) (Holen and Hatchell, 1986; McLemore, 2007). Primary sandstone-hosted uranium deposits, also known as prefault, trend, blanket, and black-band ores, are found as blanketlike, roughly parallel ore bodies along sandstone trends. These deposits are characteristically less than 2.5 m [8 ft] thick, average more than 0.20 percent $U_3O_8$, and have sharp ore-to-waste boundaries. The largest deposits in the Grants Uranium District contain more than 13,600 metric tons [15,000 tons] of $U_3O_8$.

During the Tertiary (1.8 to 65 million years ago) period, oxidizing groundwaters migrated through the Morrison Formation and remobilized some of the primary sandstone uranium deposits (Saucier, 1981). Uranium was reprecipitated ahead of the oxidizing waters forming roll-front sandstone uranium deposits (see Section 3.1.1). Roll-front uranium deposits are also known as postfault, stack, secondary, and redistributed ores. A schematic diagram of the formation of a redistributed or roll-front uranium deposit is shown in Figure 3.1-5. They are discordant, asymmetrical, irregularly shaped, and characteristically more than 2.5 m [8 ft] thick; have diffuse ore-to-waste contacts; and cut across sedimentary structures. The average deposit contains approximately 8,500 metric tons [9,400 tons] $U_3O_8$ with an average grade of 0.16 percent. Some redistributed uranium deposits are vertically stacked along faults (see Figure 3.5-7).

Remnant sandstone-hosted uranium deposits were preserved in sandstone after oxidizing waters that formed roll-front uranium deposits had passed. Some remnant sandstone-hosted

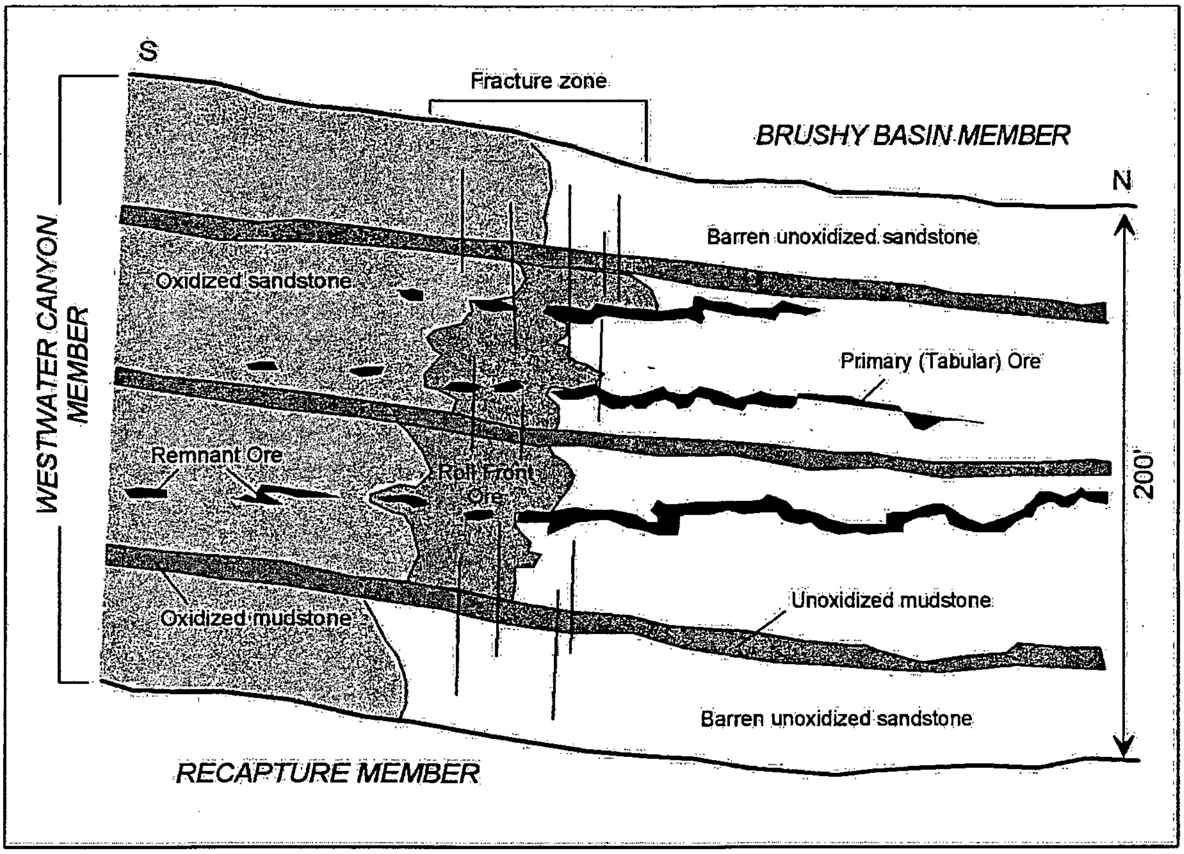



**Figure 3.5-7. Schematic Diagram of the Different Types of Uranium Deposits in the Morrison Formation, Grants Uranium District, New Mexico (Modified From Holen and Hatchell, 1986). See Text for Description.**

uranium deposits were preserved because they were surrounded by or found in less permeable sandstone and could not be reached by oxidizing groundwaters. These deposits are similar to primary sandstone-hosted uranium deposits, but are difficult to locate because they occur sporadically within the oxidized sandstone. The average size is approximately 1,200 metric tons [1,400 tons] $U_3O_8$ at a grade of 0.20 percent.

There is no consensus on the origin of the Morrison Formation sandstone uranium deposits and the source of uranium is not well constrained (Sanford, 1992). Uranium could be derived from alteration of volcanic detritus and shales within the Morrison Formation (Thamm, et al., 1981; Adams and Saucier, 1981) or from groundwater derived from a volcanic highland to the southwest. The majority of the proposed models for their formation suggests that deposition occurred at a groundwater interface between two fluids of different chemical compositions and/or oxidation/reduction states. Bleaching of the Morrison sandstones and the geometry of tabular uranium bodies floating in sandstone beds supports the reaction of two chemically different waters, most likely a dilute meteoric water and saline brine from deeper in the basin (McLemore, 2007).

The Brushy Basin Member overlies the Westwater Canyon and ranges from 12 to 40 m [40 to 125 ft] thick in the Gallup region. It is mainly composed of light greenish gray and varicolored claystone, interbedded with sandstone lenses having similar lithology and appearance to sandstones found in the Westwater Canyon Member (Ristorcelli, 1980). The mudstones are largely derived from volcanic ash falls (Peterson, 1980) and contain considerable amounts of bentonite. The contact between the Brushy Basin and the Westwater Canyon is gradational and interfingering.

The Dakota Sandstone is the basal formation of the Cretaceous System and unconformably overlies the Morrison Formation. The Dakota is a gray-brown quartz sandstone with some interbedded conglomerate, shale, carbonaceous shale, and coal. The Dakota Sandstone is marine in origin and is considered to represent the earliest transgression of late Cretaceous seas. The Dakota crops out around the margins of the San Juan Basin and thickens toward the center of the basin to about 60 m [200 ft]. The Mancos Shale overlies the Dakota Sandstone and is a thick, mostly uniform gray marine shale containing thin lenses of fine-grained sandstone.

Approximately 227 metric tons [250 tons] of $U_3O_8$ have been produced from roll-front uranium deposits in the Dakota Sandstone in the southern part of the San Juan Basin (Chenoweth, 1989). Uranium deposits in the Dakota Sandstone are typically tabular masses that range in size from thin pods a few meters [feet] long and wide to masses as much as 760 m [2,500 ft] long and 300 m [1,000 ft] wide. The larger deposits are only a few meters [feet] thick, but a few are as much as 8 m [25 ft] thick (Hilpert, 1969). Ore grades range from 0.12 to 0.30 percent and average 0.21 percent $U_3O_8$. Uranium is found with carbonaceous plant material near or at the base of channel sandstones or in carbonaceous shale and lignite and is associated with fractures, joints, or faults and with underlying permeable sandstone of the Brushy Basin or Westwater Canyon Members. The largest deposits in the Dakota Sandstone are found in the Old Church Rock mine in the Church Rock subdistrict, where uranium is associated with a major northeast-trending fault. More than 81 metric tons [90 tons] of $U_3O_8$ have been produced from the Dakota Sandstone in the Old Church Rock mine (Chenoweth, 1989).

The San Juan Basin is part of the Colorado Plateau physiographic province, which is generally characterized by rough, broken terrain, including small steep mountainous areas, plateaus, cuestas, and mesas intermingled with steep canyon walls, escarpments, and valleys. Thick colluvium deposits are commonly found forming a mantle on steep slopes surrounding sandstone mesas and cuestas in the San Juan Basin. In contrast, Quaternary alluvium is found on the valley floors of the region. These deposits consist of fine sand, silt, and clay derived from the weathering of sandstone, siltstone, and mudstone exposed at the surface. Alluvial deposits generally are thin but are known to exceed a thickness of 10 m [30 ft] in larger valleys.

General soils information associated with landforms in the southern part of the San Juan Basin was obtained from the Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NRCS, 2001). For site-specific evaluations at proposed ISL milling facilities, more detailed soils information would be expected to be obtained from published county soil surveys or the U.S. Department of Agriculture NRCS.

In the southern part of the San Juan Basin, soils on hills and mountains vary greatly in horizon development, from soils with no development to soils that have well-developed clay horizons. Gravelly clay loams having little or no horizon development are usually found on steeper slopes where erosional activity is greatest. Clay loam soils that have well-developed horizons are generally found on gently sloping to moderately steep slopes, where erosion is slight to moderate. Gravelly to fine-sand loam soils characterized by well-developed clay horizons are found on mesa summits and cuesta dip slopes, which are nearly level to gently sloping. Sandy to fine sandy loam soils with little or no horizon development are found on the escarpment of mesas and cuestas and on hogbacks, where erosional activity is great. Fine sandy loam soils are found on the summits of ridges and are mostly shallow, whereas sandy loam soils are found on the side slopes of ridges and are generally shallow but sometimes deeper. Soils on alluvial fans are generally very deep, and their soil textures are highly variable, depending on the local geology. Soils found on alluvial fans include clay loam and fine sandy loam. Soils on stream terraces are underlain by stratified sand, gravel, loamy, silty, or clayey sediments and, in some cases, buried paleosols. Typical soils that represent stream terraces are sandy clay loam and silt loam. Soils on floodplains and drainageways are generally very deep, with soil textures that are highly variable, depending on the local geology. Clay loam and fine-sand loam soils are found in drainageways, and fine sand and clay loam soils are found on floodplains.

## 3.5.4 Water Resources

### 3.5.4.1 Surface Waters

The Northwestern New Mexico Uranium Milling Region includes McKinley and the northern portion of Cibola County and a small portion western Bernalillo County. Average annual surface runoff, in terms of average annual flow per unit area of a watershed in the Northwestern New Mexico Uranium Milling Region, is generally less than 2.5 cm/yr [1 in\yr]. Watersheds in the Northwestern New Mexico Uranium Milling Region are Rio San Jose, Zuni, Chaco Canyon, Upper Puerco River,[1] Arroyo Chico, and a small portion of Rio Puerco (EPA, 2008) (Figure 3.5-8). The named uranium deposits shown in Figure 3.5-4 are listed with their corresponding watershed in Table 3.5-4. The unnamed uranium deposits northeast of Chaco Canyon are located in the Arroyo Chico and Rio Puerco watersheds. Historical and potential uranium milling sites are located in the Upper Puerco, Chaco, Arroyo Chico, and Rio San Jose watersheds. The Zuni River watershed does not contain any identified uranium deposits that are being considered for ISL uranium recovery. The Rio San Jose is the only watershed with perennial stream reaches within the area of potential uranium milling.

The Rio San Jose and associated tributaries drain the south-central portion of McKinley County and northeastern portion of Cibola County. The Rio San Jose flows into Rio Puerco east of the Northwestern New Mexico Uranium Milling Region. The state-designated uses of Rio San Jose and its tributaries are listed in Table 3.5-5 along with known impairments to these uses. Impairments to water quality within the Rio San Jose watershed include elevated nutrients, metals (aluminum), turbidity, temperature and sediment. Flow of the Rio San Jose is not gauged within the region.

The Rio Puerco drains a small portion of the east-central part of the Northwestern New Mexico Uranium Milling Region (Figure 3.5-8). The Rio Puerco flows southeast to the Rio Grande southeast of the Northwestern New Mexico Uranium Milling Region. The mainstem of the Rio Puerco is east of the Northwestern New Mexico Uranium Milling Region, and none of the tributaries of Rio Puerco are perennial within the Northwestern New Mexico Uranium Milling Region.

[1]The Rio Puerco watershed is located in north-central New Mexico and drains into the Rio Grande. The Puerco River watershed is located in west-central New Mexico and drains into the Little Colorado River in Arizona.

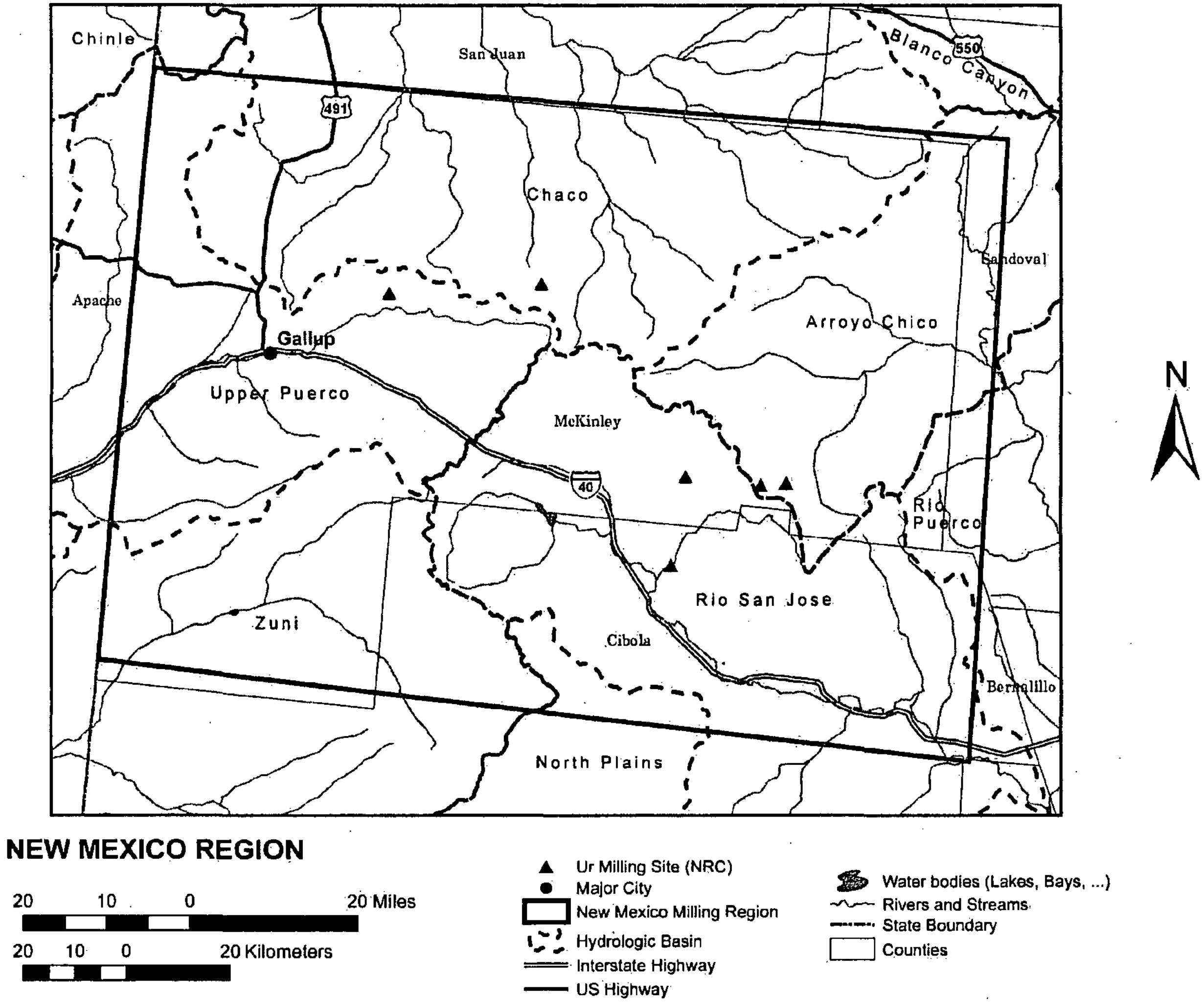



**Figure 3.5-8. Watersheds in the Northwestern New Mexico Uranium Milling Region**

**Table 3.5-4. Named Uranium Deposits in New Mexico and Corresponding Watersheds**

| Uranium Deposit | Watershed |
|---|---|
| Barnabe Montano | Rio San Jose |
| Marquez | Rio San Jose |
| Laguna | Rio San Jose |
| Grants | Rio San Jose |
| Smith Lake | Rio San Jose |
| Nose Rock | Chaco Canyon |
| Chaco Canyon | Chaco Canyon |
| Church Rock | Puerco River |
| Crownpoint | Chaco Canyon |

**Table 3.5-5. Primary Watersheds in New Mexico, Designated Uses, and Known Impairments**

| Watershed | Tributary or Reach | State-Designated Uses | Known Impairments |
|---|---|---|---|
| Rio San Jose | Bluewater Creek | Wildlife Habitat<br>Irrigation<br>Fish Culture<br>Domestic Water Supply<br>Cold Water Fishery<br>Primary Contact<br>Livestock Watering | Nutrients<br>Aluminum<br>Turbidity<br>Temperature<br>Sedimentation |
| | Bluewater Lake | Wildlife Habitat<br>Irrigation<br>Fish Culture<br>Domestic Water Supply<br>Cold Water Fishery<br>Primary Contact<br>Livestock Watering | None |
| | Rio Moquino | Wildlife Habitat<br>Irrigation<br>Fish Culture<br>Domestic Water Supply<br>Cold Water Fishery<br>Primary Contact<br>Livestock Watering | Temperature<br>Sedimentation |

**Table 3.5-5. Primary Watersheds in New Mexico, Designated Uses, and Known Impairments (continued)**

| Watershed | Tributary or Reach | State-Designated Uses | Known Impairments |
|---|---|---|---|
| | Rio Paquate | Wildlife Habitat<br>Irrigation<br>Fish Culture<br>Domestic Water Supply<br>Cold Water Fishery<br>Primary Contact<br>Livestock Watering | Selenium<br>Temperature<br>Sedimentation |
| | Rio San Jose | Wildlife Habitat<br>Livestock Watering | None |
| | Seboyeta Creek | Wildlife Habitat<br>Irrigation<br>Fish Culture<br>Domestic Water Supply<br>Cold Water Fishery<br>Primary Contact<br>Livestock Watering | None |
| Rio Puerco | No Perennial Reaches in New Mexico Region | | |
| Upper Puerco River | No Perennial Reaches in New Mexico Region | | |
| Arroyo Chico | No Perennial Reaches in New Mexico Region | | |
| Chaco | No Perennial Reaches in New Mexico Region | | |
| Zuni River | No Known Uranium Recovery Activities in Zuni Watershed | | |

The other watersheds within the area of potential uranium recovery of the Northwestern New Mexico Uranium Milling Region contain ephemeral streams that flow only after precipitation events. The only surface water features in these watersheds are springs and stock ponds. Many springs are present within the Northwestern New Mexico Uranium Milling Region in McKinley and Cibola Counties. These springs occur on the flanks of mountainous areas, such as the Chuska Mountains in the western portion of the region and the Mount Taylor area in the southeastern portion of the region as well as in the intermontane areas. These springs are fed by both local and regional aquifer systems (see Section 3.5.4.3).

### 3.5.4.2 Wetlands and Waters of the United States

Wetlands and other shallow aquatic habitats occupy only about 1–5 percent of the land surface in this region (USACE, 2006).

Within this region no digital data are available. However, hardcopy National Wetland Inventory Maps can be obtained from the U.S. Fish and Wildlife Service. In general, Waters of the United States in this region consist of ephemeral stream/arroyos with few perennial rivers. Bands of wetlands are concentrated along rivers and streams within this region. Seasonally emergent wetland areas may be found within woody habitat at high elevations. Within this region, springs and seeps often support small marshes (cienegas), oases, and other wetland types (USACE, 2006). Desert playas are intermittent shallow lakes that develop in the flat, lower portions of arid basins during the wet season. Most are unvegetated and may not contain water every year.

Waters of the United States and special aquatic sites that include wetlands would be expected to be identified and the impact delineated upon individual site selection. Based on impacts and consultation with each area, appropriate permits would be expected to be obtained from the local USACE district. Within this region, the state does not regulate wetlands; however, Section 401 state water quality certification is required for work in Waters of the United States.

### 3.5.4.3 Groundwater

Groundwater resources in the Northwestern New Mexico Uranium Milling Region are part of regional aquifer systems that extend well beyond the areas of uranium milling interest in this part of New Mexico. Uranium-bearing aquifers exist within these regional aquifer systems in the Northwestern New Mexico Uranium Milling Region. This section provides a general overview of the regional aquifer systems to provide context for a more focused discussion of the uranium-bearing aquifers in northwester New Mexico, including hydrologic characteristics, level of confinement, groundwater quality, water uses, and important surrounding aquifers.

#### 3.5.4.3.1 Regional Aquifer Systems

The Colorado Plateau aquifers underlie northwestern New Mexico and most parts of the Northwestern New Mexico Uranium Milling Region (Robson and Banta, 1995). The principal aquifers are present only in the San Juan Basin in northwest New Mexico. The geographical region in New Mexico underlain by the Colorado Plateaus aquifers is sparsely populated, and the quality and quantity of the groundwater pumped from these aquifers are suitable for most agricultural or domestic uses. The aquifers are typically composed of permeable sedimentary rocks of Permian to Tertiary ages.

Robson and Banta (1995) grouped the Colorado Plateau aquifers into four principal aquifers from shallowest to deepest: the Uinta-Animas aquifer, the Mesaverde aquifer, the Dakota-Glen Canyon aquifer system, and the Coconino-De Chelly aquifer. These four principal aquifers are hydraulically separated by relatively impermeable confining layers. The Mancos shale confining unit that underlies the Mesaverde aquifer and the Chinle-Moenkopi confining unit that underlies the Dakota-Glen Canyon aquifer system are the thickest confining layers. Among these four aquifer systems, the Mesaverde aquifer system (for water supplies) and the Dakota-Glen Canyon aquifer system (for water supplies and uranium milling) are the most important aquifer systems in the Northwestern New Mexico Uranium Milling Region.

**The Mesaverde Aquifer:** The Mesaverde aquifer is a regionally important aquifer for water supplies. It consists of sandstone, coal, siltstone, and shale of the Mesaverde Group in the San Juan Basin. The formations of the Mesaverde Group extensively interbedded with the Mancos Shale and, to a lesser extent, with the Lewis Shale. The thickness of the Mancos Shale typically ranges from 305 to 1,830 m [1,000 to 6,000 ft], and in general it forms a thick barrier to vertical and lateral groundwater flow. The maximum thickness of the Mesaverde aquifer is about 1,370 m [4,500 ft] in the southern part of San Juan Basin. The recharge to aquifer is by precipitation and discharge from aquifer is to streams, springs, and seeps; by upward movement across confining layers and into overlying aquifers; and by withdrawals. In general, water pumpage from the Mesaverde aquifer is small; therefore, water-level declines are usually localized. The altitude of the potentiometric surface ranges from 1,525 to 2,440 m [5,000 to 8,000 ft] in the San Juan Basin. In most parts of the basin, transmissivity of the Mesaverde aquifer is typically less than 4.65 $m^2$/day [50 $ft^2$/day]. However, where the aquifer is fractured, the local transmissivities could be 100 times higher.

The water quality in the Mesaverde aquifer is variable. The dissolved solids concentration ranges from about 1,000 to 4,000 mg/L [1,000 to 4,000 ppm] in parts of the San Juan Basin, which exceed EPA's Secondary Drinking Water Standard of 500 mg/L [500 ppm].

**Dakota-Glen Canyon Aquifer System:** Large depths to the water table or poor water quality make the aquifers of the Dakota-Glen Canyon aquifer system unsuitable for production in most parts of the Northwestern New Mexico Uranium Million Region. Where an aquifer is close to the land surface, however, it can be important source of water. The Dakota-Glen Canyon aquifer system is confined by the Mancos confining unit above and by the Chinle-Moenkopi confining unit below. The thickness of the Chinle-Moenkopi confining unit is typically 305 to 610 m [1,000 to 2,000 ft]. These confining units substantially limit the Dakota-Glen Canyon aquifer system's hydraulic connection with the overlying and underlying aquifers.

The Dakota-Glen Canyon aquifer system consists of four major aquifers: the Dakota aquifer (including the Dakota Sandstone and adjacent water-yielding rocks), the Morrison aquifer (including water-yielding rocks generally of the lower part of the Morrison Formation), the Entrada aquifer (including the Entrada Sandstone and the Preuss Sandstone), and the Glen Canyon aquifer (including the Glen Canyon Sandstone or Group and the Nugget Sandstone). The aquifer systems typically include confining units that separate these aquifers. At the regional scale, recharge areas, discharge areas, groundwater flow directions, and water quality are similar among these four aquifers.

The top of the Dakota aquifer is less than 610 m [2,000 ft] below the surface in the San Juan Basin. The transmissivity of the Dakota aquifer is poorly defined in the region. The Dakota aquifer is underlain by the Morrison Formation. In most parts of the basin, the relatively impermeable Morrison confining unit is present in the upper parts of the Morrison Formation. The middle and lower parts of the Morrison Formation forms the Morrison aquifer, but only the coarser-grained strata generally yields water. In the San Juan Basin, the Morrison aquifer includes two underlying water-yielding sandstone units: the Cow Springs and Junction Creek Sandstones. In most places, the Morrison aquifer is underlain by the relatively impermeable Curtis-Stump confining unit.

The Entrada aquifer underlies either the Curtis-Stump confining unit or the Morrison aquifer. The Entrada aquifer consists mainly of the Entrada Sandstone. In the western part of the Uinta Basin, the aquifer is composed of the Preuss Sandstone, which is an equivalent of the Entrada aquifer. In part of the basins, the Entrada aquifer directly overlies the Glen Canyon aquifer that consists of Wingate Sandstone, Kayente Formation, and the Navajo Sandstone. The Glen Canyon is the thickest and where fractured has relatively high transmissivities. The transmissivity of the Glen Canyon aquifer typically ranges from about 9.23 to 92.9 $m^2$/day [100 to 1,000 $ft^2$/day]. Groundwater flow in the Glen Canyon aquifer is toward major discharge areas along the San Juan Rivers. The depth to the top of the Glen Canyon aquifer is typically less than 610 m [2,000 ft]. The dissolved-solids concentration in the Glen Canyon aquifer is less than 1,000 mg/L [1,000 ppm].

3.5.4.3.2 Aquifer Systems In the Vicinity of Uranium Milling Sites

The underlying hydrogeological system in past and current areas of uranium milling interest in the Northwestern New Mexico Uranium Milling Region consists of a thick sequence of primarily sandstone aquifers and shale aquitards.

Areas of uranium milling interest at the Crownpoint, Unit 1, and Church Rock areas are underlain, from shallowest to deepest, by water-bearing layers in the Mesaverde Formation, the Dakota sandstone, the Morrison Formation (including the uranium-bearing Westwater Canyon aquifer), the Cow Springs Sandstone, and Entrada Sandstone. The Mesaverde Formation is regionally important for water supplies. The uranium-bearing Westwater Canyon aquifer at the active uranium milling sites is also important for water supplies in the milling region. Little information is available for the Cow Springs sandstone aquifer, but the existing data suggests that the Cow Springs aquifer underlying the Westwater Canyon aquifer contains good quality water (Hydro Resources, Inc., 1996). Although the Dakota sandstone at the town of Crownpoint is qualified as a drinking water supply according to EPA's National Primary Drinking Water Regulations, it is locally (e.g., in McKinley County) unused as a water supply because of its poor water quality (NRC, 1997).

3.5.4.3.3 Uranium-Bearing Aquifers

The most important uranium deposits in the Northwestern New Mexico Uranium Milling Region are hosted by the Westwater Canyon sandstone aquifer in the Morrison Formation (NRC, 1997; McLemore, 2007). The uranium-bearing sandstone aquifers in the Westwater Canyon aquifer and the Dakota sandstone near the town of Crownpoint must be exempted (Section 1.7.2) by EPA's UIC program (40 CFR § 144.3) before ISL operations begin.

**Hydrogeological characteristics:** The groundwater flow velocities in the Westwater Canyon aquifer at the Crownpoint site ranged from 3.9 m/yr [12.9 ft/yr] in the east to 2.4 m/yr [8 ft/yr] in the west side of the site. Transmissivity estimates for the Westwater Canyon aquifer range from 235 to 250 $m^2$/day [2,550 to 2,700 gal/day/ft]. The storage coefficient values ranged from $4.50 \times 10^{-5}$ to $1.39 \times 10^{-4}$ (NRC, 1997).

At Unit 1, the aquifers are the same as those at the Crownpoint site. The calculated average groundwater velocity is 1.5 m/yr [5 ft/yr] in the Westwater Canyon aquifer. In the Westwater Canyon aquifer, transmissivity ranges from 84 to 133 $m^2$/day [905 to 1,432 gal/day/ft], and the storage coefficient values range from $9.40 \times 10^{-5}$ to $1.60 \times 10^{-4}$ (NRC, 1997).

The aquifers located beneath the Church Rock site are similar to those beneath the Crownpoint and Unit 1 sites. The average groundwater flow velocity in the Westwater Canyon at Church Rock is 2.7 m/yr [8.7 ft/yr]. Transmissivity of the Westwater Canyon aquifer ranges from 86 to 123 $m^2$/day [926 to 1,326 gal/day/ft], and the storage coefficient ranges from $8.90 \times 10^{-5}$ to $4.13 \times 10^{-4}$ (NRC, 1997).

The average storage coefficient of the Westwater Canyon aquifer is on the order of $10^{-5}$–$0^{-4}$ at the Crownpoint, Unit 1, and Church Rock sites, indicating the confined nature of the production aquifer [typical storage coefficients for confined aquifers range from $10^{-5}$–$10^{-3}$ (Driscoll, 1986)].

**Level of confinement:** At the Crownpoint site, the Westwater Canyon aquifer is confined below by the Recapture Shale and confined above by the Brushy Basin Shale. The upper aquitard is about 80 m [260 ft] thick and is continuous at the site. The lower confinement unit consists entirely of shale and is continuous at the site. Aquifer tests revealed no significant vertical flow across the Recapture Shale and Brushy Basin Shale aquitards. At Unit 1, both the upper (Brushy Basin Shale) and lower (Recapture Shale) aquitards that confine the Westwater Canyon aquifer are continuous beneath Unit 1. No significant vertical flow across the aquitards was detected. At the Church Rock site, the upper aquitard above the Westwater Canyon aquifer (Brushy Basin Shale) is 4–9 m [13–28 ft] thick. The thickness of the lower aquitard (Recapture Shale) was reported to be 55 m [180 ft] thick (NRC, 1997).

**Groundwater quality:** At the Crownpoint site, the artesian uranium-ore bearing Westwater Canyon sandstone aquifer is a valuable resource for high-quality groundwater, which fits the definition of underground sources of drinking water in the EPA National Primary Drinking Water Regulations (NRC, 1997). The TDS concentrations in groundwater range from 281 to 3,180 mg/L [281 to 3,180 ppm] and average 773 mg/L [773 ppm]. The TDS levels in four town water wells ranged from 325 to 406 mg/L [325 to 406 ppm], which are lower than the EPA's Secondary Drinking Water Standard of 500 mg/L [500 mg/L]. Even though the town's water supply wells are completed in sandstones that contain uranium deposits, radionuclide concentrations in the Crownpoint public water supply are low. The uranium and radium-226 concentrations at the Crownpoint ISL site's monitoring wells were in the range of less than 0.001 to 0.007 mg/L [0.001 to 0.007 ppm] and 0.3 to 0.6 pCi/L, respectively {EPA's drinking water standard for uranium is 0.03 mg/L [0.03 ppm] and for radium-226 is 5.0 pCi/L} (NRC, 1997).

At the Unit 1 site, groundwater in the Westwater Canyon aquifer in general meets New Mexico drinking water quality standards, except for radium-226 and uranium concentrations. The average radium-226 concentration at the Unit 1 ISL site's monitoring wells is 10.3 pCi/L, which exceeds the EPA drinking water standard for radium-226 (5.0 pCi/L). The average uranium concentration at the Unit 1 site is about 2.0 mg/L [2 ppm], which is higher than at the Crownpoint site. The average TDS of 285.0 mg/L [285 ppm] was lower than the EPA drinking water standard of 500 mg/L [500 ppm] (NRC, 1997).

At the Church Rock site, the groundwater quality is generally good in Westwater Canyon aquifer and meets the New Mexico drinking water quality standards, except for radium-226 concentration. However, the average radium-226 concentration at the monitoring wells was 10.2 pCi/L, exceeding the EPA drinking water standard of 5.0 pCi/L for radium. The average uranium concentration was 0.01 mg/L [0.01 ppm]. The average TDS of 369.75 mg/L [369.75 ppm] was lower than the EPA drinking water standard of 500 mg/L [500 ppm] (NRC, 1997).

**Current groundwater uses:** Groundwater in the Northwestern New Mexico Uranium Milling Region area is in general suitable for drinking. Groundwater has been used for domestic supplies, especially in the Crownpoint and Unit 1 areas. Most of the wells in and near the Church Rock site either owned by Hydro Resources, Inc. or are private wells (NRC, 1997).

3.5.4.3.4 Other Important Surrounding Aquifers for Water Supply

The Dakota Sandstone at the town of Crownpoint is qualified as a drinking water supply according to EPA's National Primary Drinking Water Regulations. Little information is available for the Cow Springs aquifer, but the existing data suggest that Cow Springs aquifer underlying the Westwater Canyon aquifer contains good quality water (Hydrology Resources Inc., 1996).

## 3.5.5 Ecology

### 3.5.5.1 Terrestrial

**Northwestern New Mexico Flora**

According to EPA, the Northwestern New Mexico Uranium Milling Region contains two ecoregions: the Arizona/New Mexico Plateau and the Arizona/New Mexico Mountains (Figure 3.5-9). This regions and subregions are as follows. The Grants Uranium District in the region is located in the Semi Arid Tablelands, Conifer Woodlands, and Savannas ecoregions and near the San Juan/Chaco Tablelands and Mesas ecoregions.

The Arizona/New Mexico Plateau is a transitional region between shrublands and wooded higher relief tablelands of the Colorado Plateaus in the north, the lower less vegetated Mojave Basin and Range in the west, and forested mountain ecoregions that border the region on the northeast and south. The topography in the region changes from a few meters [feet] on plains and mesa tops to well over 305 m [1,000 ft] along tableland side slopes. This region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley (Griffith, et al., 2006).

The San Juan/Chaco Tablelands and Mesas ecoregion of plateaus, valleys, and canyons contains a mix of desert scrub, semidesert shrub-steppe, and semi-desert grasslands. Native vegetation found within the region include shadscale, fourwing saltbush (*Atriplex canescens*), mat saltbush, greasewood, mormon tea (*Ephedra* spp.), Indian ricegrass, alkali sacaton, galleta (*Pleuraphis jamesii)*, and blue and black gramas. Rocky Mountain juniper (*Juniperus scopulorum*), one-seed (*Juniperus monosperma*), and Utah junipers (*Juniperus osteosperma*) can be found on higher mesas (Griffith, et al., 2006).

The Semiarid Tablelands consists of mesas, plateaus, valleys, and canyons. This region contains areas of high and low relief plains. Grass, shrubs, and woodland cover the tablelands. The vegetation is not as sparse as that found in the San Juan/Chaco Tablelands to the north or the Albuquerque Basin to the east. Scattered junipers occur on shallow, stony soils and are dense in some areas. Pinyon-juniper woodland is also common in some areas. Fourwing saltbush, alkali sacaton, sand dropseed (*Sporobolus cryptandrus*), and mixed grama grasses are common species found in this region (Griffith, et al., 2006).

The Lava Malpais can be found in the south central portion of the region. The lava substrate has the ability to trap and retain moisture, allowing for a more mesophytic vegetation, such as stunted Douglas fir and ponderosa pine, to occur in some areas. Other species that are found in this region include grasses like blue grama and side oats grama (*Bouteloua curtipendula*) with shrubs of Apache plume (*Fallugia paradoxa*) and New Mexico olive (*Forestiera pubescens*) (Griffith, et al., 2006).

The Near-Rockies Valleys and Mesas ecoregion is a region comoised of mostly pinyon-juniper woodland, juniper savanna, and mesa and valley topography, with influences of higher elevation vegetation in drainages from the adjacent Southern Rockies. Other natural species that can be found in this region include one seed and Rocky Mountain junipers, Indian ricegrass, big sagebrush, sand dropseed, gallets, threeawns (*Aristida* spp.), blue grama, and rabbitbrush (Griffith, et al., 2006).

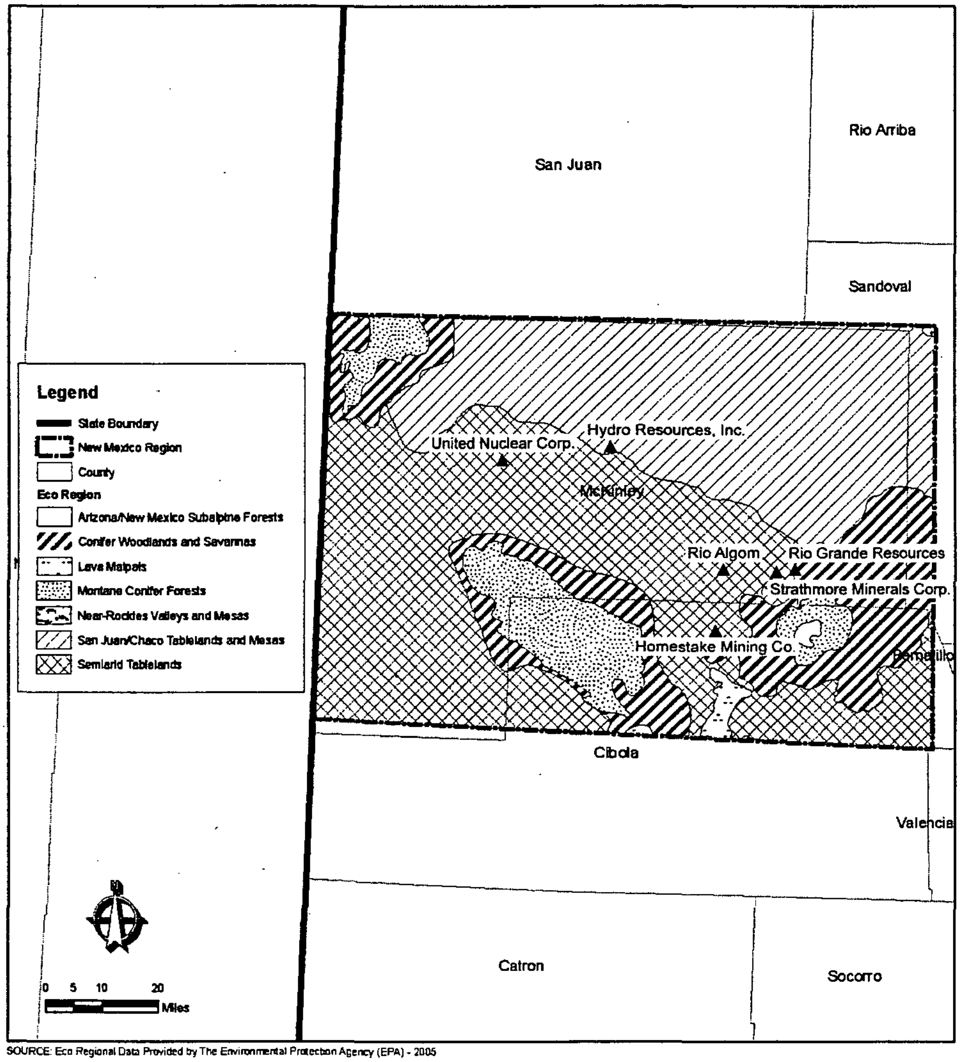



**Figure 3.5-9. Ecoregions for the Northwestern New Mexico Uranium Milling Region**

The Arizona/New Mexico Mountains region is distinguished from neighboring mountainous ecoregions by lower elevations and associated vegetation indicative of drier, warmer environments. Forests of spruce, fir, and Douglas fir, which are common in mountainous regions, are limited to the highest elevations in this region. Chaparral is common at lower elevations in some areas; pinyon-juniper and oak woodlands are found at lower and middle elevations. Higher elevations in the region are mostly covered with open to dense ponderosa pine forests. These mountains are the northern extent of some Mexican plant and animal species. Surrounded by deserts or grasslands, these mountains in New Mexico can be considered biogeographical islands (Griffith, et al., 2006).

The Montane Conifer Forests are found west of the Rio Grande at elevations from about 2,130 to 2,900 m [7,000 to 9,500 ft]. Ponderosa pine and Gambel oak are common, along with mountain mahogany and serviceberry (*Amelanchier alnifolia*). Some Douglas fir, southwestern white pine (*Pinus strobiformis*), and white fir (*Abies concolor*) occur in a few areas (Griffith, 2006). This region also includes mixed conifer/aspen stands. Seven different conifers can be found growing in the same region, and there are a number of common cold-deciduous shrub and grass species, including a few maple (*Acer* spp.), blueberry (*Vaccinium* ssp), gray alder (*Alnus incana*), kinnikinnick (*Arctostaphylos uva-ursi*), water birch (*Betula occidentalis*), redosier dogwood (*Cornussericea*), Arizona fescue (*Festuca arizonica*), fivepetal cliffbush (*Jamesia Americana*), creeping barberry (*Mahonia repens*), Oregon boxleaf (*Paxistima myrsinites*), Kuntze mallow ninebark (*Physocarpus malvaceus*), New Mexico locust (*Robinia neomexicana*), mountain snowberry, and Gambel oak (*Quercus gambelii*). Herbaceous species include fringed brome (*Bromus ciliatus*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*Carex rossii*), dryspike sedge (*Carex siccata*), screwleaf muhly, bluebunch wheatgrass, sprucefir fleabane (*Erigeron eximius*), Virginia strawberry (*Fragaria virginiana*), smallflowered woodrush (*Luzula parviflora*), sweetcicely (*Osmorhiza berteroi*), bittercress ragwort (*Packera cardamine*), western meadow-rue (*Thalictrum occidentale*), and Fendler's meadow-rue (*Thalictrum fendleri*) (New Mexico Department of Game and Fish, 2006).

The Conifer Woodlands and Savannas ecoregion is an area of mostly pinyon-juniper woodlands consisting of one-seed, alligator, and Rocky Mountain junipers with some ponderosa pine at higher elevations. It often intermingles with grasslands and shrublands consisting of blue grama, junegrass, gallet, and bottlebrush squirreltail (*Elymus elymoides*). In addition, some areas may have Gambel oak. Utah juniper and big sagebrush can be found in the Chuska Mountains. At lower elevations, yuccas and cactus can be found (Griffith, et al., 2006)

The Arizona/New Mexico Subalpine Forests occur west of the Rio Grande at the higher elevations, generally above about 2,900 m [9,500 ft]. The region includes parts of the Mogollon Mountains, Black Range, San Mateo Mountains, Magdalena Mountains, and Mount Taylor. Although there are some vegetational differences from mountain range to mountain range within the region, the major forest trees include Engelmann spruce, corkbark fir (*Abies lasiocarpa var. arizonica*), blue spruce (*Picea pungens*), white fir, and aspen. Some Douglas fir occurs at lower elevations (Griffith, et al., 2006).

**Northwestern New Mexico Fauna**

According to the Biota Information System of New Mexico (2007), more than 1,100 species of amphibians, reptiles, mammals, birds, invertebrates, and fish are found throughout the state. Bird fauna is diverse with more than 500 species. Mammal diversity is high compared to other southwestern states, with approximately 184 species. New Mexico has approximately 26 species of amphibians and over 100 species of reptiles.

Common mammals found within the Northwester New Mexico Uranium Milling Region include numerous myotis bat species, black bear, bobcat, numerous rodents, coyotes, bighorn sheep, Gunnison's prairie dogs, skunks, and squirrels. In addition, critical elk winter habitat and calving areas are located in the area (Figure 3.5-10). Currently, most of the proposed or existing ISL facilities are located within designated critical elk winter habitat. Most of the habitat in this region is found within the southern half of McKinley County and most of Cibola County. Common bird species found in the region include bluebirds, buntings, doves, ducks, cormorants (*Phalacrocorax* spp.), hummingbirds, jays, flycatchers, kingbirds, mockingbird, sparrows, and ravens. Raptor species include hawks such as the ferruginous hawk, red-tailed hawk, sharp shinned hawk, and Swainson's hawk; noted owl species found in the counties are the barn owl (*Tyto alba*), burrowing owl (*Athene cunicularia*), elf owl (*Micrathene whitneyi*), flammulated owl (*Otus flammeolus*), great horned owl (*Bubo virginianus*), pygmy owl (*Glaucidium* spp.), and Mexican spotted owl (*Strix occidentalis lucida*). The climax raptor found in the region is the golden eagle (Biota Information System of New Mexico, 2007).

Individual county listings can be obtained through the Biota Information System of New Mexico. A comprehensive listing of habitat types and species (with their scientific names) found within New Mexico are compiled as part of the Southwest Regional Gap Analysis Project (New Mexico State University, 2007).

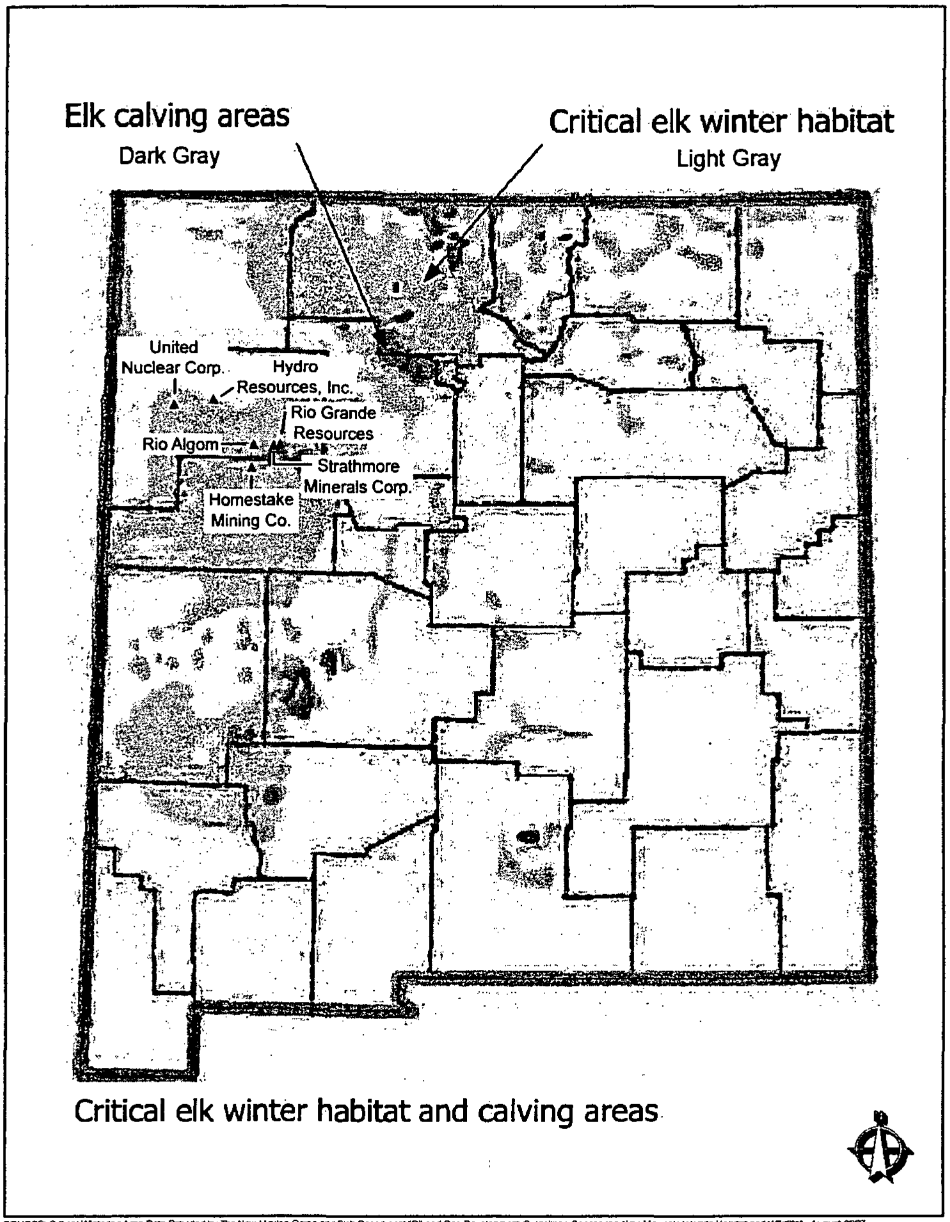
#### 3.5.5.2 Aquatic

There are approximately 161 different species of fish located within the state, with approximately 48 species found in the watersheds of the region (Table 3.5-6) (Biota Information System of New Mexico, 2007). The New Mexico Comprehensive Wildlife Conservation Strategy Plan indicates that the majority of the areas in which milling would occur lie within the Zuni, Rio Grande, and the lower portion of the San Juan watersheds (New Mexico Department of Game and Fish, 2006).

The Zuni watershed also encompasses the upper Puerco watershed. The Zuni watershed has an impacted water system due to settlement changes, overgrazing, and logging. The loss of vegetative cover led to increased erosion, gullying, head cutting, wide discharge fluctuations, and loss of water in the system (New Mexico Department of Game and Fish, 2006). Eight nonnative fish have been found in the watershed, with the green sunfish (*Lepomis cyanellus*), fathead minnow, and the plains killifish comparatively common and widespread. Several sport fish have been introduced to the system such as northern pike (*Esox lucius*), rainbow trout, and channel catfish. Crayfish (*Orconectes virilis*) have also been introduced into the system (New Mexico Department of Game and Fish, 2006).

Two fish, the roundtail chub (*Gila robusta*) and Zuni bluehead sucker (*Catostomus discobolus yarrowi*) and one crustacean (*Hyalella* spp.) have been identified as species of greatest conservation need (New Mexico Department of Game and Fish, 2006).

The Rio Grande watershed originates in the San Juan Mountains of Southern Colorado and flows south through the entire length of New Mexico. This waters shed also encompasses the Arroyo Chico, Rio San Jose and Rio Puerco watersheds as previously discussed. The aquatic habitats in the Rio Grande consist of reservoirs, marshes, and perennial streams (New Mexico Department of Game and Fish, 2006). Numerous species have been introduced into the Rio Grande Watershed. Common carp (*Cyprinus carpio*) are widespread and nonnative




SOURCE: Critical Wintering Area Data Provided by The New Mexico Game and Fish Department "Oil and Gas Development Guidelines Conserving New Mexico's Wildlife Habitat and Wildlife" - August 2007

**Figure 3.5-10. Elk Winter Habitat and Calving Areas for the Northwestern New Mexico Uranium Milling Region (Modified From New Mexico Department of Game and Fish, 2007)**

| Table 3.5-6. Native Fish Species Found in New Mexico | |
|---|---|
| **Common Name** | **Scientific Name** |
| Largemouth Bass | *Micropterus salmoides salmoides (NM)* |
| Smallmouth Bass | *Micropterus dolomieui* |
| Striped Bass | *Morone saxatilis* |
| White Bass | *Morone chrysops* |
| Bluegill | *Lepomis macrochirus* |
| Smallmouth Buffalo | *Ictiobus bubalus* |
| Black Bullhead | *Ameiurus melas* |
| Yellow Bullhead | *Ameiurus natalis* |
| Common Carp | *Cyprinus carpio* |
| Grass Carp | *Ctenopharyngodon idella* |
| River Carpsucker | *Carpiodes carpio carpio* |
| Blue Catfish | *Ictalurus furcatus* |
| Channel Catfish | *Ictalurus punctatus* |
| Chihuahua Catfish | *Ictalurus sp (NM)* |
| Flathead Catfish | *Pylodictis olivaris* |
| Chub Flathead | *Platygobio gracilis* |
| Gila Chub | *Gila intermedia* |
| Rio Grande Chub | *Gila pandora* |
| Roundtail Chub | *Gila robusta* |
| Black Crappie | *Pomoxis nigromaculatus* |
| White Crappie | *Pomoxis annularis* |
| Longfin Dace | *Agosia chrysogaster* |
| Longnose Dace | *Rhinichthys cataractae* |
| Speckled Dace | *Rhinichthys osculus (Gila pop.)* |
| Speckled Dace | *Rhinichthys osculus (Non-Gila pop.)* |
| Rainwater Killifish | *Lucania parva* |
| Fathead Minnow | *Pimephales promelas* |
| Loach Minnow | *Tiaroga cobitis* |
| Roundnose Minnow | *Dionda episcopa* |
| Rio Grand Silvery Minnow | *Hybognathus amarus* |
| Yellow Perch | *Perca flavescens* |
| Gizzard Shad | *Dorosoma cepedianum* |
| Threadfin Shad | *Dorosoma petenense* |
| Golden Shiner | *Notemigonus crysoleucas* |
| Red Shiner | *Cyprinella lutrensis* |
| Rio Grande Shiner | *Notropis jemezanus* |
| Spikedance | *Meda fulgida* |
| Central Stoneroller | *Campostoma anomalum* |
| Zuni Bluehead,Sucker | *Catostomus discobolus yarrowi (NM)* |
| Desert Sucker | *Catostomus clarki* |
| Rio Grande Sucker | *Catostomus plebeius* |
| Sonora Sucker | *Catostomus insignis* |
| White Sucker | *Catostomus commersoni* |
| Green Sunfish | *Lepomis cyanellus* |
| Brown Trout | *Salmo trutta* |
| Gila Trout | *Oncorhynchus gilae* |

| Table 3.5-6. Native Fish Species Found in New Mexico (continued) | |
|---|---|
| **Common Name** | **Scientific Name** |
| Rainbow Trout | *Oncorhynchus mykiss* |
| Western Mosquito Fish | *Gambusia affinis* |

salmonids, including rainbow trout, cutthroat subspecies (*O. clarki*) brook trout, and brown trout live in mountain streams. Kokanee salmon (*Oncorhynchus nerka*), rainbow trout, and brown trout are present in reservoirs. Warm/cool water fish include largemouth bass, smallmouth bass, walleye, northern pike, white bass (*Morone chryops*), crappie (*Pomoxis* spp.), and sunfishes (*Lepomis* spp.) (New Mexico Department of Game and Fish, 2006).

Eleven fish species have been designated as a species of greatest conservation need. The Mexican tetra (*Astyanax mexicanus*), speckled chub (*Macrhybopsis aestivalis*), Rio Grande shiner (*Notropis jemezanus*), blue sucker (*Cycleptus elongates*), and gray redhorse (*Moxostoma congestum*) have disappeared from key habitats in the Rio Grande watershed. The following fish are in conservation need: Rio Grande cutthroat trout, Rio Grande chub, Rio Grande sucker, smallmouth sucker, and blue catfish (New Mexico Department of Game and Fish, 2006).

Noted native fish species historically found within the watersheds associated with sites in the Grants Uranium District include blue catfish (*Ictalurus furcatus*), desert sucker (*catostomus clarki*), Gila chub (*Gila intermedia*), Gila topminnow (*Poeciliopis occidentalis*), Gila trout (*Oncorhynchus gilae*), loach minnow (*Rhinichthys cobitis*), Rio Grande sucker (*Catostomus plebeius*), Rio Grande silver minnow (*Hybognathus amarus*), Rio Grande shiner, Rio Grande cutthroat trout (*Ohcorhynchus clarki virgininalis*), Rio Grande chub (*Gila pandora*), roundtail chub, spikedace (*Meda fulgida*), smallmouth buffalo (*Ictiobus bubalus*), Sonora sucker (*Catostomus insignis*), and the Zuni bluehead sucker (Biota Information System of New Mexico, 2007).

The San Juan watershed that contains many first and second order streams found in the Chaco watershed within the milling region. The San Juan River Basin is the second largest of the three subbasins that comprise the Upper Colorado River Basin. The San Juan River Basin drains about 97,300 $km^2$ [38,000 $mi^2$] of southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah (U.S. Fish and Wildlife Service, 2006). At least eight native fish species—cutthroat trout, roundtail chub, Colorado pikeminnow, speckled dace, flannelmouth sucker, bluehead sucker, razorback sucker, and mottled sculpin—are located within the basin. Colorado pikeminnow, razorback sucker, and the bonytail chub are federally listed as endangered species, with New Mexico listing the roundtail chub as endangered. Noted non native fish found within the higher order streams in the watershed include red shiner, common carp, fathead minnow, plains killifish, whiter sucker, brown trout, rainbow trout, and channel catfish (New Mexico Department of Game and Fish, 2006).

#### 3.5.5.3 Threatened and Endangered Species

Federally listed threatened and endangered and species which are known to exist within habitats found within the region include the following:

- Bald Eagle, Delisted Monitored.
- Black-Footed Ferret, Extirpated.

- Mexican Spotted Owl (*Strix occidentalis lucida*), Critical Habitat Designated—Mexican spotted owls nest, roost, forage, and disperse in a diverse assemblage of biotic communities. Mixed-conifer forests are commonly used throughout most of the range which may include Douglas fir and/or white fir, with codominant species including southwestern white pine, limber pine, and ponderosa pine. The understory often contains the above coniferous species as well as broadleaved species, such as Gambel oak, maples, box elder, and/or New Mexico locust. In southern Arizona and Mexico, Madrean pine-oak forests are also commonly used. Spotted owls nest and roost primarily in closed-canopy forests or rocky canyons. They nest in these areas on cliff ledges, in stick nests built by other birds, on debris platforms in trees, and in tree cavities. In southern Utah, Colorado, and some portions of northern New Mexico, most nests are in caves or on cliff ledges in rocky canyons. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure, are typically uneven-aged and multistoried, and have high canopy closure. A wider variety of trees are used for roosting, but again Douglas fir is the most commonly used species (U.S. Fish and Wildlife Service, 2008)

- Pecos Puzzle Sunflower (*Helianthus paradoxus*)—This species is found in areas that have permanently saturated soils, including desert wetlands (cienegas) that are associated with springs, but may include stream and lake margins. When found around lakes, these lakes are usually natural cienega habitats that have been impounded (Center for Plant Conservation, 2008).

- South Western Willow Fly Catcher (*Empidonax traillii extimus*)—The southwestern willow flycatcher breeds in patchy to dense riparian habitats along streams, reservoirs, or other wetlands. Common tree or shrub species include willow, seep willow, boxelder, stinging nettle, blackberry, cottonwood, arrowweed, tamarisk (salt cedar), and Russian olive. Habitat characteristics vary across the subspecies' range. However, occupied sites usually consist of dense vegetation in the patch interior, or dense patches interspersed with openings, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still water, or saturated soil is present at or near breeding sites during non-drought years (U.S. Fish and Wildlife Service, 2008).

- Yellow Billed Cuckoo (*Coccyzus americanus*)—Discussed in Section 3.2.5.3.

- Zuni Bluehead Sucker (*Catostomus dicobolus yarrowi*), Candidate—More recent surveys (early to mid 1990s) determined the distribution of Zuni bluehead sucker in New Mexico to be limited mainly to the Río Nutria drainage upstream of the mouth of the Nutria Box Canyon. This included the mouth of Río Nutria box canyon, upper Río Nutria, confluence of Tampico Draw and Río Nutria, Tampico Spring, and Agua Remora. Definitive habitat associations for Zuni bluehead sucker have not been determined. Zuni bluehead sucker are primarily found in shaded pools and pool runs, about 0.3 to 0.5 m [1 to 1.5 ft] deep with water velocity less than 10 cm/s [4 in/s]. Zuni bluehead suckers were found over clean, hard substrate, from gravel and cobble to boulders and bedrock (New Mexico Department Game and Fish, 2004).

- Zuni Fleabane (*Erigeron rhizomatus)*—Zuni fleabane grows in selenium-rich red or gray detrital clay soils derived from the Chinle and Baca formations. Plants are found at elevations from 2,230-2,440 m [7,300–8,000 ft] in pinyon-juniper woodland. Zuni fleabane prefers slopes of up to 40°, usually with a north-facing aspect. Although the overall vegetative cover is usually high, there are few other competing plants on the steep easily erodible slopes that are Zuni fleabane's primary habitat. Zuni fleabane is found only in areas of suitable soils. These soils occur most extensively in the Sawtooth Mountains and in the northwestern part of the Datil Mountains in Catron County, New Mexico. There are 29 known sites in this area, which range in size from a fraction of an acre to about 105 ha [260 acres]. There are two sites on the northwest side of the Zuni Mountains in McKinley County, New Mexico, and one site in Apache County, Arizona (U.S. Fish and Wildlife Service, 2008).

- Rio Grande Silvery Minnow (*Hybognathus amarus*)—Currently, the Rio Grande silvery minnow is believed to occur only in one reach of the Rio Grande in New Mexico, a 280-km (174-mi) stretch of river that runs from Cochiti Dam to the headwaters of Elephant Butte Reservoir. Its current habitat is limited to about 7 percent of its former range. The Rio Grande silvery minnow uses only a small portion of the available aquatic habitat. In general, the species most often uses silt substrates in areas of low or moderate water velocity (e.g., eddies formed by debris piles, pools, and backwaters). The Rio Grande silvery minnow is rarely found in habitats with high water velocities, such as main channel runs, which are often deep and swift. The species is most commonly found in depths of less than 20 cm [7.9 in] in the summer and 31–40 cm [12.2–15.75 in] in the winter (U.S. Fish and Wildlife Service, 2007).

State-listed threatened and endangered species for the region include the following:

- American Marten (*Martes americana*)—The American marten is broadly distributed. It extends from the spruce-fir forests of northern New Mexico to the northern limit of trees in arctic Alaska and Canada. American martens live in mature, dense conifer forests or mixed conifer-hardwood forests. They prefer woods with a mixture of conifers and deciduous trees including hemlock, white pine, yellow birch, maple, fir and spruce. Especially critical is presence of many large limbs and fallen trees in the understory, known as coarse woody debris. These forests provide prey, protection and den sites (New Mexico Department of Game and Fish, 2008).

- Arctic Peregrine Falcon (*Falco peregrinus tundrius*)—Peregrine falcons live mostly along mountain ranges, river valleys, and coastlines. Historically, they were most common in parts of the Appalachian Mountains and nearby valleys from New England south to Georgia, the upper Mississippi River Valley, and the Rocky Mountains. Peregrines also inhabited mountain ranges and islands along the Pacific Coast from Mexico north to Alaska and in the Arctic tundra (U.S. Fish and Wildlife Service, 2008).

- Bald Eagle (*Haliaeetus leucocephalus*)—In New Mexico, migrating bald eagles can be found near rivers and lakes, where occasional tall trees provide lookout perches and night roosts. Reservoirs with sizable populations of migrating bald eagles include Ute, Conchas, Ft. Sumner, Santa Rosa, Elephant Butte, Caballo, Cochiti, El Vado, Heron, and Navajo (New Mexico Department of Game and Fish, 2008).

- Baird's Sparrow (*Ammodramus bairdii*)—Breeds in native mixed-grass and fescue prairie. Winters in grasslands; specific winter habitat requirements not well described. Baird's sparrow does not inhabit prairie lands where fire suppression and changes in natural grazing patterns have allowed woody vegetation to grow excessively. Some hayfields or pastures may support Baird's sparrow where native grasses occur in sufficient quantity, but generally cultivated land is a far inferior habitat relative to true prairie. Winters from southeast Arizona, southern New Mexico, and south Texas to north-central Mexico (Cornell Laboratory of Ornithology, 2008)

- Broadbilled Hummingbird (*Cynanthus latirostris*)—In the United States this hummingbird is found in riparian woodlands at low to moderate elevations. In Guadalupe Canyon, these woodlands are characterized by cottonwoods, sycamores, white oaks, and hackberries. Nests found in Guadalupe Canyon have been in a variety of trees, shrubs, and even forests (New Mexico Department of Game and Fish, 2004).

- Brown Pelican (*Pelecanus occidentalis*)—Brown pelicans nest on small, isolated coastal islands where they are safe from predators such as raccoons and coyotes. This is a potential migrant though the region (Texas Parks and Wildlife Department, 2007)

- Common black hawk (*Buteogallus anthracinus* )—Obligate riparian nester, dependent on mature, relatively undisturbed habitat supported by a permanent flowing stream. Streams less than 30 cm [12 in] deep of low to moderate gradient with many riffles, runs, pools, and scattered boulders or lapped with branches provide ideal hunting conditions (Public Employees for Environmental Responsibility, 2008).

- Costa's Hummingbird (*Calypte costae*)—Occurs mainly in Southern California, Arizona, Baja California, and western Mexico, but also extends into Nevada, extreme southeastern Utah, and southeastern New Mexico. Habitats occupied by Costa's hummingbirds include Sonoran desert scrub, the Mojave Desert, California chaparral, California coastal scrub, and the Cape deciduous forest of Baja California (Audubon Society, 2007).

- Gray Vireo (*Vireo vicinior*)—Gray vireo breeds in some of the hottest, driest areas of the American Southwest, favoring dry thorn scrub, chaparral, and pinyon-juniper and oak-juniper scrub, in arid mountains and high plains scrubland. This species forages in thickets, taking most of its prey from leaves, twigs, and branches of small trees and bushes. Its diet on the breeding grounds consists of a variety of arthropods, including large grasshoppers, cicadas, and caterpillars. Winter diet differs based on locality—birds found in western Texas are primarily insectivorous, while those wintering in southern Arizona and adjacent northern Mexico feed mainly on fruit (Audubon Society, 2007).

- Interior Least Tern (*Sterna antillarum athalassos*)—Discussed in Section 3.3.5.3.

- Jemez Mountains Salamander (*Plethodon neomexicanus*)—Native to north-central New Mexico, this species has been found in various localities in the Jemez Mountains in Sandoval, Los Alamos, and Rio Arriba counties. This salamander typically lives on shady, wooded sites at elevations of about 2,300 to 2,900 m [7,500 to 9,500 ft]. In these habitats, characterized by coniferous trees, salamanders spend much of their time under and in fallen logs. Old, stabilized talus slopes, especially those with a good covering of damp soil and plant debris, are important types of cover for this species (New Mexico Department of Game and Fish, 2008).

- Meadow Jumping Mouse (*Zapus hudsonius*)—Jumping mice are nocturnal, and in New Mexico this species occurs in moist habitats dominated by damp and rich vegetation. The meadow jumping mouse inhabits areas with streams, moist soil, and lush streamside vegetation consisting of grasses, sedges, and forbs. Such habitats are in the Jemez Mountains and in the edges of permanent ditches and cattail stands in the Rio Grande Valley (New Mexico Department of Game and Fish, 2008).

- Neotropic cormorant (*Phalacrocorax brasilianus)*—This cormorant is found from southern New Mexico to southern Louisiana and southward through Central America and the Caribbean to South America. Neotropic cormorants also may wander northward to the Bernalillo area and westward to the Gila Valley. This bird is rare in southern Hidalgo County, the area near Alamogordo, and in the lower Pecos Valley from Bitter Lake National Wildlife Refuge southward (New Mexico Department of Game and Fish, 2008).

- Peregrine Falcon (*Falco peregrines*)—In New Mexico the breeding sites of peregrine falcons are on cliffs in wooded and forested habitats, with large "gulfs" of air nearby in which these predators can forage (New Mexico Department of Game and Fish, 2008).

- Rio Grande Shiner (*Notropis jemezanus*)—The Rio Grande shiner is found in the Rio Grande drainage, from just above the mouth to the Pecos River (north in Pecos River to Sumner Lake, New Mexico) and (formerly) Rio Grande, New Mexico (where now extirpated). It is absent from large sections of the Rio Grande and Pecos Rivers in western Texas; occurs in Rio San Juan, Rio Salado, and Rio Conchos, Mexico; common in the lower Rio Grande, and is less common elsewhere. It can be found in runs and flowing pools of large open weedless rivers and large creeks with bottom of rubble, gravel, and sand, often overlain with silt (NatureServe, 2008).

- Spotted Bat (*Euderma maculatum)*—The rarity of this bat and the diverse habitats in which it has been seen have caused confusion about its preferences. Some have been captured in pine forests at high elevations 2,400–2,700 m [8,000–9,000 ft]; others came from a pinyon pinejuniper association; and still others from desert scrub areas. Spotted Bats are known only from about 20 locations in western and southern New Mexico (New Mexico Department of Game and Fish, 2008).

- Southwestern Willow Flycatcher—previously described in this section as a federally listed species.

- Wrinkled Marsh Snail (*Stagnicola caperata*)—The wrinkled marsh snail occurs in such habitats as vegetated ditches, marshes, streams, and ponds, that are typically seasonally dry. Such a site is occupied by the New Mexico population in the Jemez Mountains, where the habitat is a shallow pond at 2,600 m [8,500 ft] elevation. The species also occurs in areas of perennial water, including the former population at Bitter Lake National Wildlife Refuge (USACE, 2007).

- Zuni Bluehead Sucker—previously described in this section as a federally listed species.

## 3.5.6 Meteorology, Climatology, and Air Quality

### 3.5.6.1 Meteorology and Climatology

Temperature in New Mexico is influenced more by elevation than latitude. Mean annual temperatures range from 17 °C [64 °F] in the southeast to less than 4 °C [40 °F] in the high mountains and northern valleys (National Climatic Data Center, 2005). New Mexico typically experiences variations between daytime and nighttime temperatures. Table 3.5-7 identifies two climate stations located in the Northwestern New Mexico Uranium Milling Region. Climate data for these stations are found in the National Climatic Data Center's Climatography of the United States No. 20 Monthly Station Climate Summaries for 1971–2000 (National Climatic Data Center, 2004). This summary contains climate data for 4,273 stations throughout the United States and some territories. Table 3.5-8 contains temperature data for two stations in the Northwestern New Mexico Uranium Milling Region.

The precipitation and snow that New Mexico receives comes from both the Pacific Ocean to the west and the Gulf of Mexico to the southeast. Average annual precipitation ranges from 25 cm [10 in] to more than 50 cm [20 in] at higher elevations (National Climatic Data Center, 2005). In summer, the source of precipitation is usually brief, but often intense thunderstorms. For most of the state, 30 to 40 percent of the year's annual moisture falls in July and August. Typically, New Mexico does not experience widespread floods. Heavy thunderstorms can cause local flash floods. Heavy rains or rain in conjunction with snowmelt can cause large rivers to flood.

Table 3.5-8 contains precipitation data for two stations in the Northestern New Mexico Uranium Milling Region. The wettest month for both stations identified in Table 3.5-8 is August and, based on the snow depth data, snowpack melting usually occurs earlier in the summer (National Climatic Data Center, 2004). One of the stations is in Cibola County and the other is in McKinley County. Data from the National Climatic Data Center's Storm Events Database from 1950 to 2007 indicate that the majority of thunderstorms in Cibola and McKinley Counties occurs somewhat evenly between May and September (National Climatic Data Center, 2007).

**Table 3.5-7. Information on Two Climate Stations in the Northwestern New Mexico Uranium Milling Region***

| Station (Map Number) | County | State | Longitude | Latitude |
|---|---|---|---|---|
| Grants Milan AP | Cibola | New Mexico | 107°54W | 35°10N |
| McGaffey 5 SE | McKinley | New Mexico | 108°27W | 35°20N |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.

**Table 3.5-8. Climate Data for Stations in the Northwestern New Mexico Uranium Milling Region***

| | | Grants Milan AP | McGaffey 5 SE |
|---|---|---|---|
| Temperature (°C) † | Mean—Annual | 10.4 | 5.9 |
| | Low—Monthly Mean | −0.6 | −4.5 |
| | High—Monthly Mean | 22.1 | 17.2 |
| Precipitation (cm) ‡ | Mean—Annual | 27.6 | 51.6 |
| | Low—Monthly Mean | 1.1 | 1.7 |
| | High—Monthly Mean | 5.3 | 7.0 |
| Snowfall (cm) | Mean—Annual | 23.9 | 136 |
| | Low—Monthly Mean | 0 | 0 |
| | High—Monthly Mean | 7.4 | 26.9 |

*National Climatic Data Center. "Climatography of the United States No. 20: Monthly Station Climate Summaries, 1971–2000." Asheville, North Carolina: National Oceanic and Atmospheric Administration. 2004.
†To convert Celsius (°C) to Fahrenheit (°F), multiply by 1.8 and add 32.
‡To convert centimeters (cm) to inches (in), multiply by 0.3937.

In winter, the precipitation usually falls as snow in the mountains; however, the precipitation in the valleys can be either rain or snow. Table 3.5-9 contains snowfall data for two stations in the Northwestern New Mexico Uranium Milling Region.

As an example, Figure 3.5-11 shows a wind rose for Gallup, New Mexico, for 1991. Winds are predominantly from the west southwest and southwest. Wind speeds are depicted in knots where 1 knot is approximately equal to 0.51 m/s [1.7 ft/s]. Wind roses such as these should be obtained for the actual location of the facility for preferably a period of time of 1 year or longer. This data can be used for dispersion estimates.

The pan evaporation rates for the Northwestern New Mexico Uranium Milling Region range from about 114 to 152 cm [45 to 60 in] (National Weather Service, 1982). Pan evaporation is a technique that measures the evaporation from a metal pan typically 121 cm [48 in] in diameter and 25 cm [10 in] tall. Pan evaporation rates can be used to estimate the evaporation rates of other bodies of water such as lakes or ponds. Pan evaporation rate data are typically available only from May to October. Freezing conditions often prevent collection of quality data during the other part of the year.

### 3.5.6.2 Air Quality

The general air quality general description for the Northwestern New Mexico Uranium Milling Region would be similar to the description in Section 3.2.6 for the Wyoming West Uranium Milling Region.

**Table 3.5-9. U.S. Environmental Protection Agency Class I Prevention of Significant Deterioration Areas in New Mexico and Arizona***

| New Mexico | Arizona |
|---|---|
| Bandelier Wilderness | Chiricahua National Monument Wilderness |
| Bosque del Apache Wilderness | Chiricahua Wilderness |
| Carlsbad Caverns National Park | Galiuro Wilderness |
| Gila Wilderness | Grand Canyon National Park |
| Pecos Wilderness | Mazatzal Wilderness |
| Salt Creek Wilderness | Mount Baldy Wilderness |
| San Pedro Parks Wilderness | Petrified Forest National Park |
| Wheeler Peak Wilderness | Pine Mountain Wilderness |
| White Mountain Wilderness | Saguaro Wilderness |
| | Sierra Ancha Wilderness |
| | Superstition Wilderness |
| | Sycamore Canyon Wilderness |

*Modified from Code of Federal Regulations. "Prevention of Significant Air Deterioration of Air Quality." Title 40—Protection of the Environment, Part 81. Washington, DC: U.S. Government Printing Office. 2005.

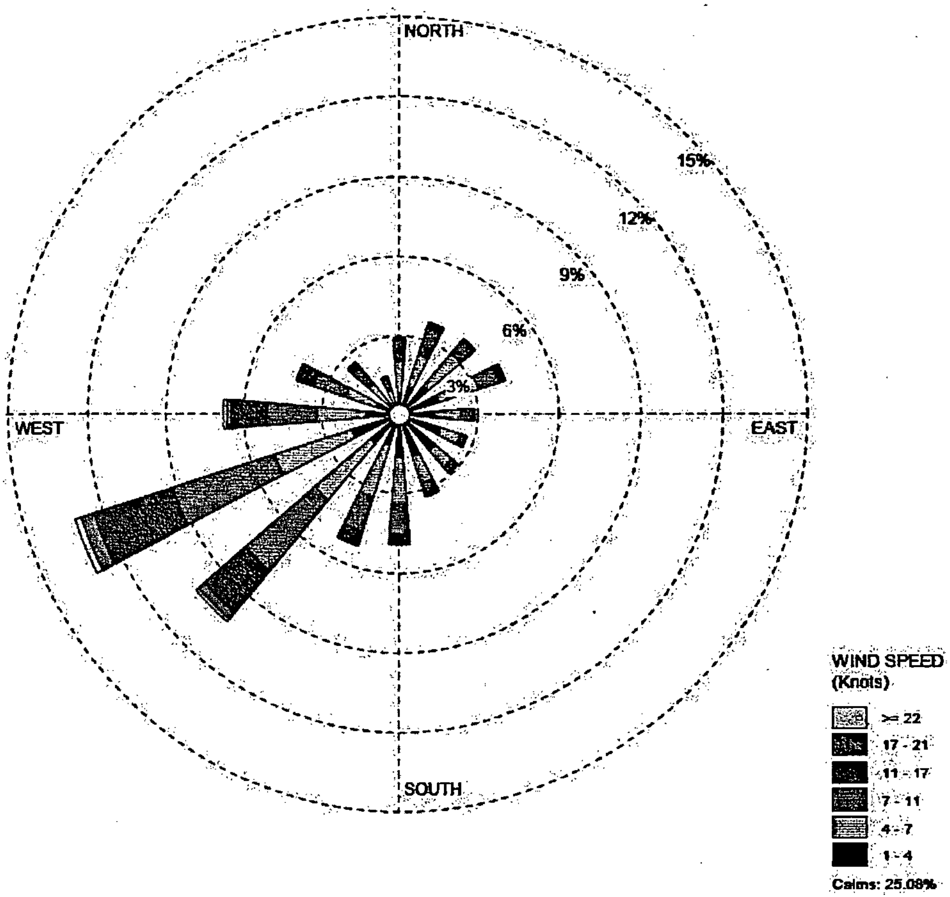



**Figure 3.5-11. Wind Rose for Gallup, New Mexico, Airport for 1991 (New Mexico Environmental Department, 2007)**

As described in Section 1.7.2.2, the permitting process is the mechanism used to address air quality. If warranted, permits may set facility air pollutant emission levels, require mitigation measures, or require additional air quality analyses. Except for Indian Country, New Source Review permits in New Mexico are regulated under the EPA-approved State Implementation Plan. For Indian Country in New Mexico, the New Source Review permits are regulated under 40 CFR 52.21 (EPA, 2007a).

State implementation plans and permit conditions are based in part on federal regulations developed by the EPA. The NAAQS are federal standards that define acceptable ambient air concentrations for six common nonradiological air pollutants: nitrogen oxides, ozone, sulfur oxides, carbon monoxide, lead, and particulates. In June 2005, EPA revoked the 1-hour ozone standard nationwide in all locations except certain Early Action Compact Areas. None of the 1-hour ozone Early Action Compact Areas are in New Mexico. States may develop standards that are stricter or supplement the NAAQS. New Mexico has a more restrictive standard for carbon monoxide throughout the state and for sulfur dioxide in a small area around the city of Hurley. This area around Hurley is not within the Northwestern New Mexico Uranium Milling Region. New Mexico also has a nitrogen dioxide standard with a 24-hour averaging time (New Mexico Environment Department, 2002).

Prevention of Significant Deterioration requirements identify maximum allowable increases in concentrations for particulate matter, sulfur dioxide, and nitrogen dioxide for areas designated as attainment. Different increment levels are identified for different classes of areas and Class I areas have the most stringent requirements.

The Northwestern New Mexico Uranium Milling Region air quality description focuses on two topics: NAAQS attainment status and Prevention of Significant Deterioration classifications in the region.

Figure 3.5-12 identifies the counties in and around the Northwestern New Mexico Uranium Milling Region that are partially or entirely designated as nonattainment or maintenance for NAAQS at the time this GEIS was prepared (EPA, 2007b). The Northwestern New Mexico Uranium Milling Region covers portions of New Mexico and borders Arizona. All of the area within this milling region is classified as attainment. Portions of two counties in New Mexico are not in attainment: Bernalillo County (central New Mexico) and Doña Ana County (south central New Mexico). The city of Albuquerque in Bernalillo County is designated as maintenance for carbon monoxide. The northwest part of Bernalillo County is only several kilometers [miles] from the Northwestern New Mexico Uranium Milling Region border; however, Albuquerque is about 50 km [31 mi] from this border. The city of Anthony in Doña Ana County is designated as nonattainment for $PM_{10}$. The Sunland Park area of Doña Ana County was designated as nonattainment for the 1-hour ozone standard until the EPA revoked the standard in 2005. Several counties in southern Arizona, including one that borders New Mexico, are not in attainment. However, the one Arizona county (Apache County) that borders the Northwestern New Mexico Uranium Milling Region is in attainment.

Table 3.5-9 identifies the Prevention of Significant Deterioration Class I areas in New Mexico and Arizona. The Class I areas in and around the Northwestern New Mexico Uranium Milling Region are shown in Figure 3.5-13. There are no Class I areas in the Northwestern New Mexico Uranium Milling Region.

### 3.5.7 Noise

The existing ambient noise levels for undeveloped rural areas in the Northwestern New Mexico Uranium Milling Region would be similar to those described in Section 3.2.7 for the Wyoming West Uranium Milling Region (up to 38 dB). The largest communities in the region include Gallup with a population of more than 20,000; Grants with a population of about 9,000; and Zuni Pueblo (about 6,400) (see Section 3.5.10). Urban noise levels in these communities and the smaller surrounding population centers would be similar to those (up to about 78 dB) for other urban areas (Washington State Department of Transportation, 2006).

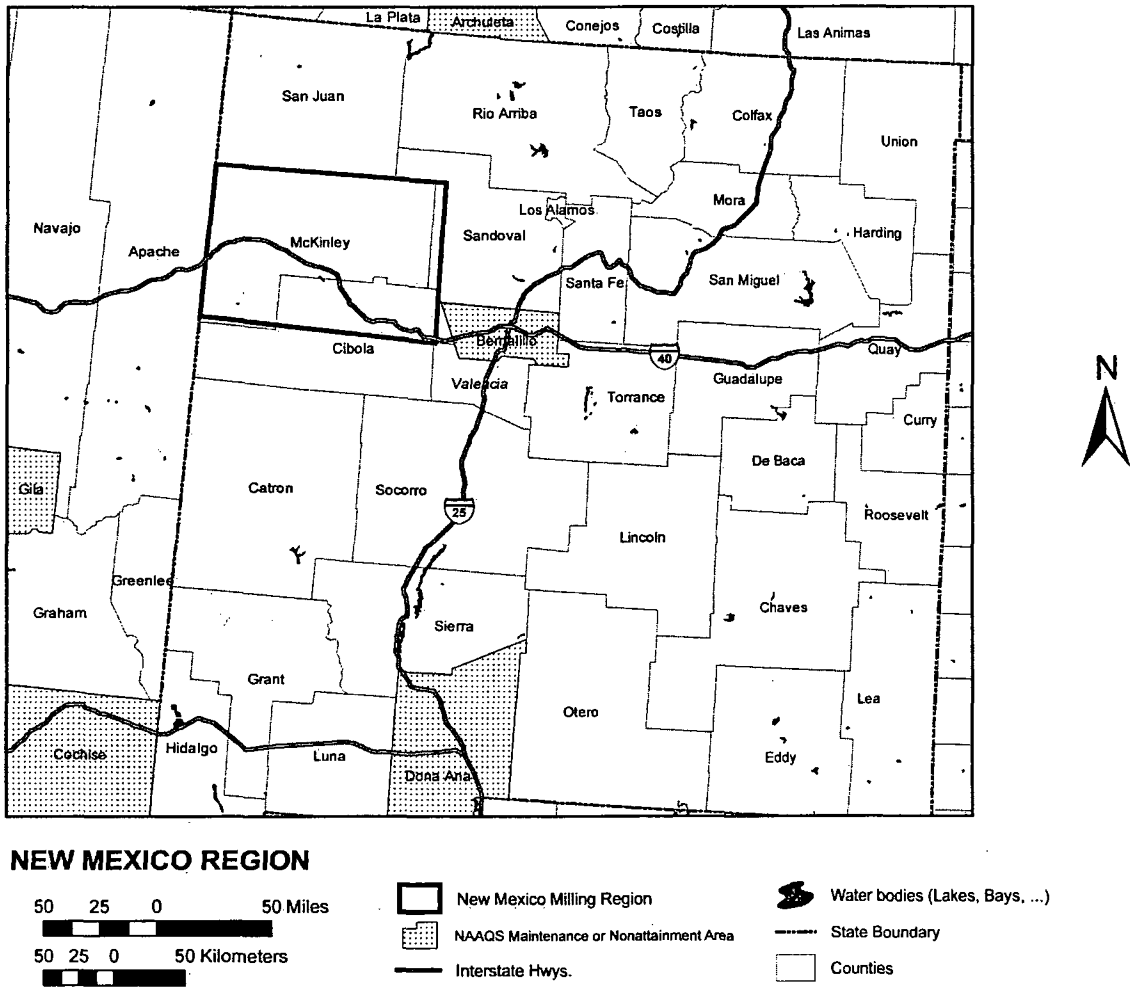



**Figure 3.5-12. Air Quality Attainment Status for the Northwestern New Mexico Uranium Milling Region and Surrounding Areas (EPA, 2007a)**

As described in Section 3.5.2, two major highways cross the Northwestern New Mexico Uranium Milling Region: Interstate 40 runs east west and U.S. Highway 491 runs north from Gallup. There are also several state undivided highways, but the area is only sparsely served by paved roads. Traffic counts for Interstate 40 are higher than those reported for Interstate-80 in Wyoming, with annual average daily traffic reported at about 16,500 just east of the New Mexico/Arizona line (New Mexico Department of Transportation, 2007). Traffic counts for U.S. Highway 491 are less, with annual average daily traffic of about 9,700 north of Gallup (New Mexico Department of Transportation, 2007). This suggests that ambient noise levels near these highways might be higher than the levels measured for Interstate-80 (Wyoming Department of Transportation, 2005; Federal Highway Administration, 2004; see also Section 3.2.7).

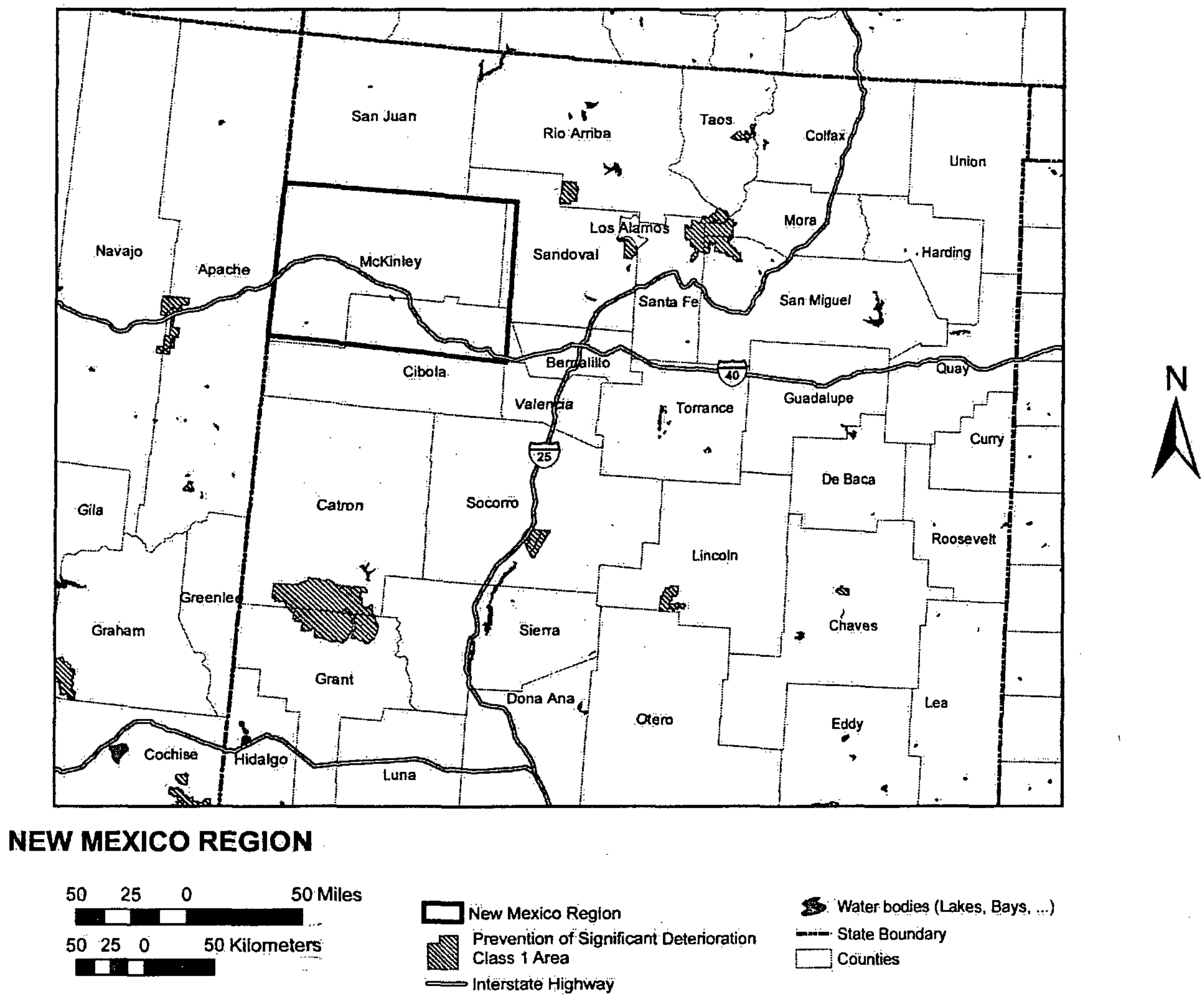



**Figure 3.5-13. Prevention of Significant Deterioration Class I Areas in the Northwestern New Mexico Uranium Milling Region and Surrounding Areas (40 CFR Part 81)**

The potential uranium projects in the region are more than 8 km [5 mi] from Interstate 40, and ambient noise levels would not be affected by highway noise. In some cases, such as at Crownpoint, the proposed facility would be located close to a small community, and the ambient noise levels would be expected to be slightly higher. Areas of special sensitivity to potential noise impacts could include areas of special significance to the Native American culture in the region (see Section 3.5.8).

### 3.5.8 Historical and Cultural Resources

The New Mexico SHPO is responsible for the oversight of federal and state historic preservation compliance laws, regulations, and statutes. The Cultural Properties Act (Sections 16-6 through 18-6-23, New Mexico Statutes Annotated 1978) was enacted in 1969 and amended several times in the ensuing years. It established the State Historic Preservation Division and Cultural Properties Review Committee, which issues permits for survey and excavation on state lands, and for the excavation of burials. Burial excavation permits are specifically required by the Unmarked Burial Statute (18-6-11.2, 1989) and the Marked Burial Statute (30-12-12, 1989) for human remains found on state or private land; whereas the NAGPRA applies to federal lands. The Reburial Grounds Act (18-6-14, 2006) provides for the designation of reburial areas for unclaimed human remains. The Cultural Properties Act also requires that state agencies provide the New Mexico SHPO with the opportunity to participate in planning activities that would affect properties on the State Register of Cultural Properties or the National Register of Historic Places. The Prehistoric and Historic Sites Preservation Act of 1969 (Sections 18-8-1 through 18-8-8, NMSA 1978) prohibits the use of state funds that would adversely affect sites on the state or national registers, unless the state agency demonstrates that there is no feasible or prudent alternative. The Cultural Properties Protection Act (Sections 18-6A-1 through 18-6A-6, New Mexico Statutes Annotated 1978) enacted in 1993 encourages state agencies to consult with the New Mexico SHPO in order to develop programs that will identify cultural properties and ensure that they will not be inadvertently damaged or destroyed. Lastly, Executive Order No. 2005-003 recognizes the sovereignty of Native American tribes in the state of New Mexico and provides that state agencies should conduct tribal consultation on the protection of culturally significant places and the repatriation of human remains and cultural items. Information on the New Mexico SHPO can be found at the following link: <http://www.nmhistoricpreservation.org>.

The U.S. government and the State of New Mexico recognize the sovereignty of certain Native American tribes. These tribal governments have legal authority for their respective reservations. Executive Order 13175 requires executive branch federal agencies to undertake consultation and coordination with Native American tribal governments on a government-to-government basis. NRC, as an independent federal agency, has agreed to voluntarily comply with Executive Order 13175.

In addition, the NHPA provides these tribal groups with the opportunity to manage cultural resources within their own lands under the legal authority of a THPO. The THPO therefore replaces the New Mexico SHPO as the agency responsible for the oversight of all federal and state historic preservation compliance laws. Both the Navajo Nation and Zuni Pueblo have a recognized THPO program. Other tribes have historic and cultural preservation offices that are not recognized as THPOs, but they should be consulted where they exist (see appended New Mexico tribal consultation list for Cibola and McKinley Counties).

The Navajo Nation has passed the Natural Resources Protection Act of 2005, which is designed to "ensure that no further damage to the culture, society, and economy of the Navajo Nation occurs because of uranium mining within the Navajo Nation ..." An insight into the effects of uranium exploration on traditional Navajo life is provided in the recent publication (Udall, et al., 2007). The Navajo Nation Code also states that "the six culturally significant mountains...Tsoodzil...must be respected, honored and protected for they, as leaders, are the foundation of the Navajo Nation (Navajo Nation, 2005, pp. 22–23)." *Tsoodzil* (Turquoise Mountain) is the Navajo word for Mount Taylor, some 24 km [15 mi] north of Grants, New Mexico, and in Navajo tradition, marks the southern boundary of the Navajo Dinetah or traditional homeland.

### 3.5.8.1 New Mexico Historic and Cultural Resources

McKinley and Cibola Counties are rich in cultural resources. In fact, the first highway salvage archaeological excavations in the nation were conducted along old Route 66 in this vicinity during the 1950s. Archaeological compliance work continues through the 21st century in respect to a variety of economic activities, including highway construction, energy development, tourism at the national monuments, and the realignment of military installations. Cultural resource overviews and Class II surveys of the region have therefore been provided by several federal agencies; however, they date to the 1980s when most of the energy-related development was initiated. The San Juan Basin Regional Uranium Study was certainly one of the most important of these studies (Broster and Harrill, 1982; Dulaney and Dosh, 1981; Plog and Wait, 1979; Powers, et al., 1983; Tainter and Gillio, 1980).

Interstate 40 passes through Albuquerque, Grants, and Gallup, acting as a primary east-west link across the region. New Mexico State Road 491 heads north from Gallup to Shiprock and the Four-Corners area. Lastly, Grants is connected to Chaco Canyon National Monument by way of State Road 371. A variety of archaeological projects have therefore been conducted in respect to highway-related compliance work (e.g., Damp, et al., 2002; Gilpin, 2007).

McKinley and Cibola Counties have been a major focus of energy development activities, including coal, uranium, and natural gas pipeline projects. The McKinley Coal Mine and the Laguna uranium mine represent two examples of extensive surface mining operations (Allen and Nelson, 1982; Kelley, 1982). In addition, the ENRON and El Paso pipeline projects have crosscut the region to supply the west with natural gas from sources in northwest New Mexico (Winter, 1994).

Three national monuments are located within the Northwestern New Mexico Uranium Milling Region: Chaco Canyon, El Morro, and El Malpais. Although Chaco Canyon is situated to the north of Grants, New Mexico, in San Juan County, several outlying components of Chaco National Monument are present in Cibola and McKinley Counties including the Red Mesa Valley group east of Gallup, the Cebolleta Mesa Group, Puerco of the West Group, and portions of the South Chaco Slope Group (Marshall, et al., 1979; Powers, et al., 1983). El Morro and El Malpais National Monuments are also located near Grants (Powers and Orcutt, 2005a; Murphy, et al., 2003).

Fort Wingate is a closed military installation that has been extensively surveyed for cultural resources. The former Army munitions depot is located south of Interstate 40 between Gallup and Grants. These lands contain numerous archaeological sites and have ancestral ties to both Zuni Pueblo and the Navajo Nation (Schutt and Chapman, 1997; Perlman, 1997).

A total of 21,625 archaeological sites have been recorded in McKinley and Cibola Counties as of this writing. A single Class II sample survey identified an average density of 6 sites/km$^2$ [15 sites/mi$^2$] for the southern San Juan Basin (Dulaney and Dosh, 1981); however, site densities as high as 12 sites/km$^2$ [30 sites/mi$^2$] were identified on Cebolleta Mesa (Broster and Harrill, 1982). Table 3.5-10 provides a summary of sites recorded by time period for McKinley and Cibola Counties, and Figure 3.5-14 illustrates the distribution of these sites across the counties. However, this distribution only includes those areas that have been systematically surveyed for cultural resources. Together these resources represent over 10,000 years of human land-use in the region. The following is a brief review of the Native American occupation of the area.

| Table 3.5-10. Number of Recorded Sites by Time Period and County | | |
|---|---|---|
| | County | |
| Period | McKinley | Cibola |
| Paleoindian | 18 | 34 |
| Archaic | 426 | 359 |
| Ancestral Pueblo | 8,211 | 2,742 |
| Historic Pueblo | 575 | 290 |
| Navajo | 4,476 | 378 |
| Other Historic | 518 | 1,057 |
| Undetermined | 2,822 | 2,331 |
| Total* | 15,040 | 6,585 |
| *Note: Because many sites include multiple temporal components, the total number of sites presented above does not reflect the total number of components (occupations) that might exist at each site. | | |

**Paleoindian (ca. 10,000 to 6000 B.C.)**

The Paleoindian occupation of the region is primarily represented by the presence of isolated projectile points with a few campsites (Figure 3.5-15). Clovis (10,000–9,000 B.C.), Folsom (9,000–8,000 B.C.) and Late Paleoindian (8,000–6,000 B.C.) points have been identified at various locations across the landscape. The Clovis inhabitants presumably hunted a range of large animal species including mammoth, whereas Folsom hunters focused on migratory bison herds and Late Paleoindian hunters on bison, with other animal and plant species (Amick, 1994; Broster and Harrill, 1982; Judge, 2004; Stanford, 2005).

**Archaic (ca. 6,000 B.C to A.D. 400)**

The Archaic occupation of the region is characterized by the presence of numerous temporary campsites (Figure 3.5-16). Early Archaic (6,000–4,000 B.C.) and Middle Archaic (4,000–2000 B.C.) sites appear to be less common than those occupied during the Late Archaic (2000 B.C.–A.D. 400); however, this may be a product of differential preservation and the exposure of subsurface deposits, rather than differences in the degree to which these groups occupied the area. Early and Middle Archaic groups gathered a variety of plant species while hunting medium- to small-sized game. In contrast, domesticated maize first appeared in New Mexico by 2100 B.C., probably as a supplement to gathered plant foods, with the first evidence of simple irrigation perhaps as early as 1000 B.C. (Damp, et al., 2002; Huber and Van West, 2005; Simmons, 1986; Vierra, 2008).

**Ancestral Puebloan (ca. A.D. 400 to 1540)**

For many years, archaeologists referred to the prehistoric culture that arose in the San Juan Basin after the Archaic period as the "Anasazi," a word borrowed from the Navajo that means "old people" or "enemy ancestors" (Kantner, 2004). Although this term continues to be widely used among archaeologists and the public alike, many contemporary Pueblo people find the use of Anasazi to be offensive. Although controversy about this issue continues (Kantner, 2004; Riggs, 2005), archaeologists and government agencies increasingly use the term "Ancestral Puebloan" in place of Anasazi, a practice that is followed here.

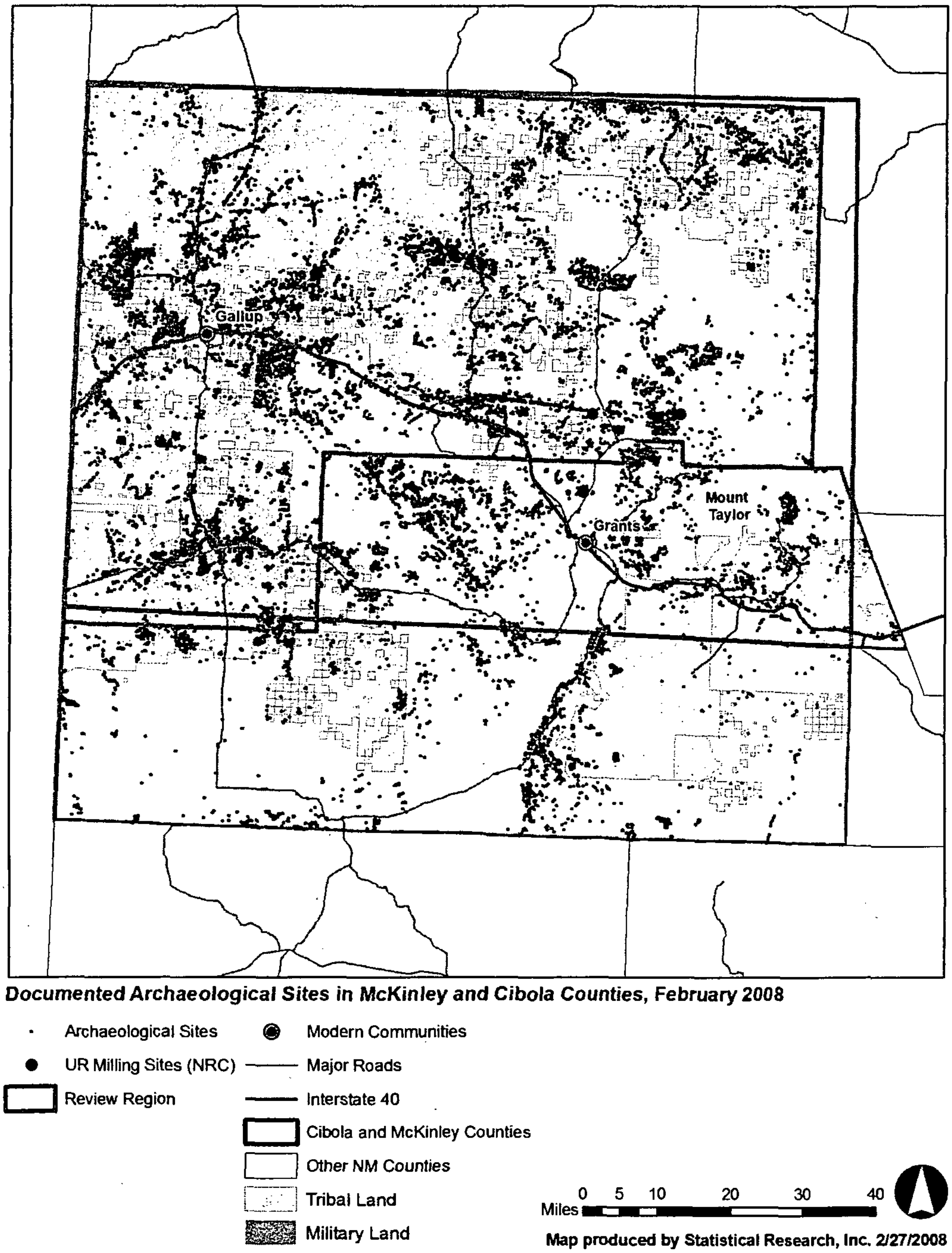



**Figure 3.5-14. Distribution of Recorded Archaeological Sites in McKinley and Cibola Counties, New Mexico**

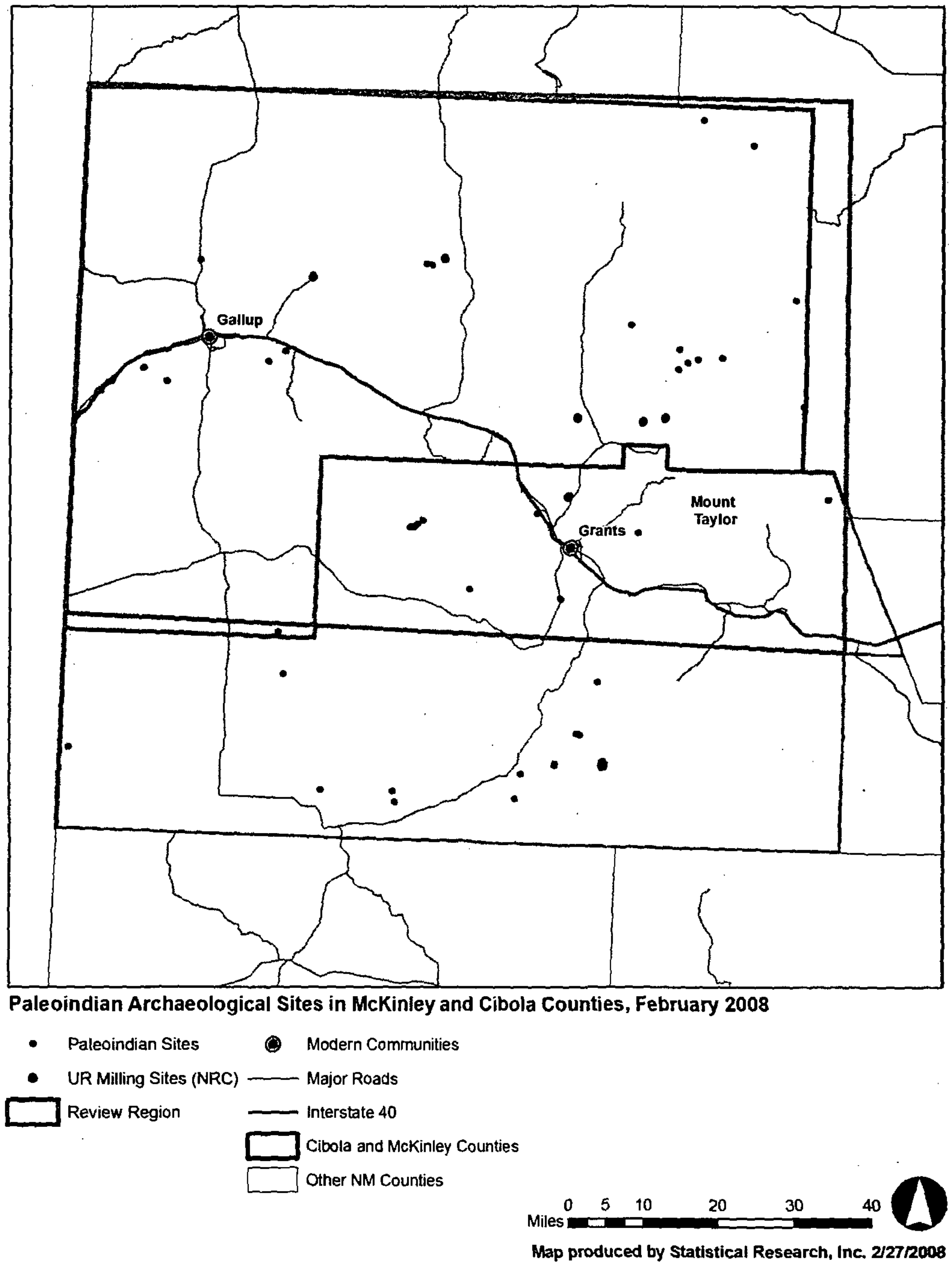



**Figure 3.5-15. Paleoindian Sites**

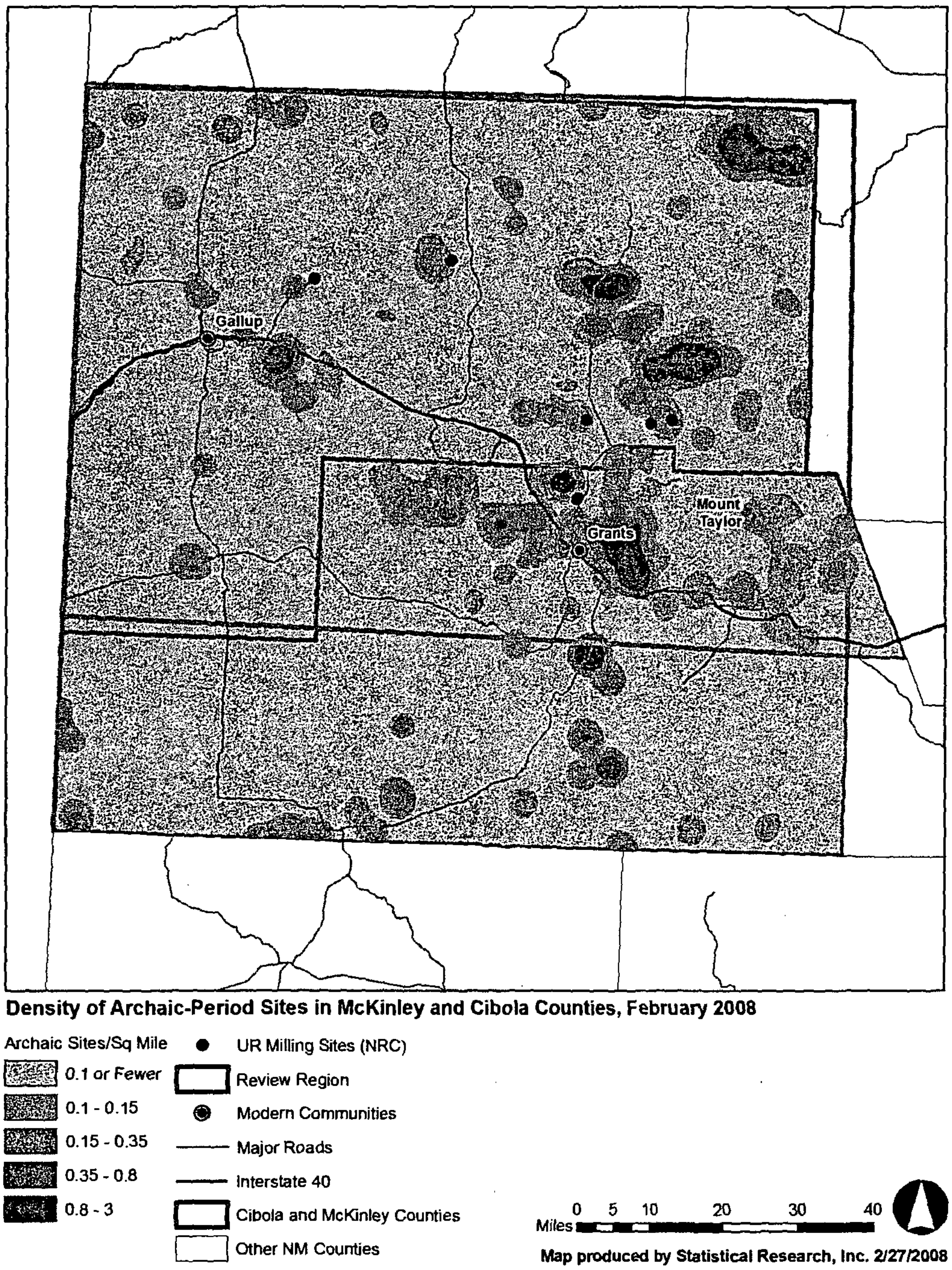



**Figure 3.5-16. Distribution of Archaic-Period Sites**

The Ancestral Puebloan period appears to have emerged directly from the preceding Archaic period and begins with the initial appearance of pottery and the bow and arrow, more elaborate pit structure architecture, and the more intensive use of maize agriculture. Although a number of chronological sequences for this period have been proposed for the region, the two major sequences currently in use are the Cebolleta Mesa and Pecos Chronologies (Kidder, 1927) (Table 3.5-11, Figure 3.5-17).

**Basketmaker II (ca. 500 B.C. to A.D. 400)**

Basketmaker II (or Late Archaic) represents a continuation of the previous hunting and gathering lifestyle. However, important changes in subsistence and social organization were occurring with a growing dependence on the cultivation of maize. Recent excavations in the region have documented habitation sites with houses, storage pits, and refuse areas. High water table farming adjacent to playa settings appears to have been an important niche for early maize cultivation, with numerous storage features having been discovered in these contexts. In addition, the earliest evidence of water diversion through irrigation channels is also represented. Lastly, important changes in technology were also occurring, including the use of ceramic containers and the bow and arrow (Damp, et al., 2002; Kearns, et al., 1998; Vierra, 1994, 2008).

**Basketmaker III (ca. A.D. 400 to 700)**

In comparison to the preceding Late Archaic period, Basketmaker III material culture is characterized by the introduction of the bow and arrow and fired ceramic vessels. Basketmaker III sites in the San Juan region also featured larger and more elaborate pit habitation structures, larger villages, and evidence for increased trade and greater reliance on agriculture, including both corn and beans (Reed, 2000b). Although Basketmaker III sites have been identified throughout McKinley and Cibola Counties, these sites typically date to the later portion of this time period and transition gradually into Pueblo I occupations, with few major cultural differences between them (Tainter and Gillio, 1980). In general, Basketmaker III sites are fairly rare in most of the McKinley/Cibola region compared to other areas to the north and west (Cordell, 1979; Orcutt, et al., 2005, Powers and Orcutt, 2005b; Schutt and Chapman, 1997; Tainter and Gillio, 1980). In McKinley County, however, many sites that became important during the later Pueblo II period were initially occupied at this time (Powers, et al., 1983).

**Table 3.5-11. Cebolleta Mesa and Pecos Chronologies**

| Cebolleta Mesa Sequence | Dates B.C./A.D. | Pecos Classification |
|---|---|---|
| — | Ca. 500 B.C.–A.D. 500 | Basketmaker II |
| Lobo Period | ?–700 A.D. | Basketmaker III |
| White Mound Phase | 700–800 | Basketmaker III/Pueblo I |
| Kiatuthlana Phase | 800–870 | Pueblo I |
| Red Mesa Phase | 850–950 | Early Pueblo II |
| Cebolleta Phase | 950–1100 | Pueblo II |
| Pilares Phase | 1100–1200 | Pueblo III |
| Kowina Phase | 1200–1400 | Pueblo III to IV |
| Cubero Phase | 1400–1540 | Late Pueblo IV |
| Acoma Phase | 1540–present | Pueblo V/Historic Pueblo |

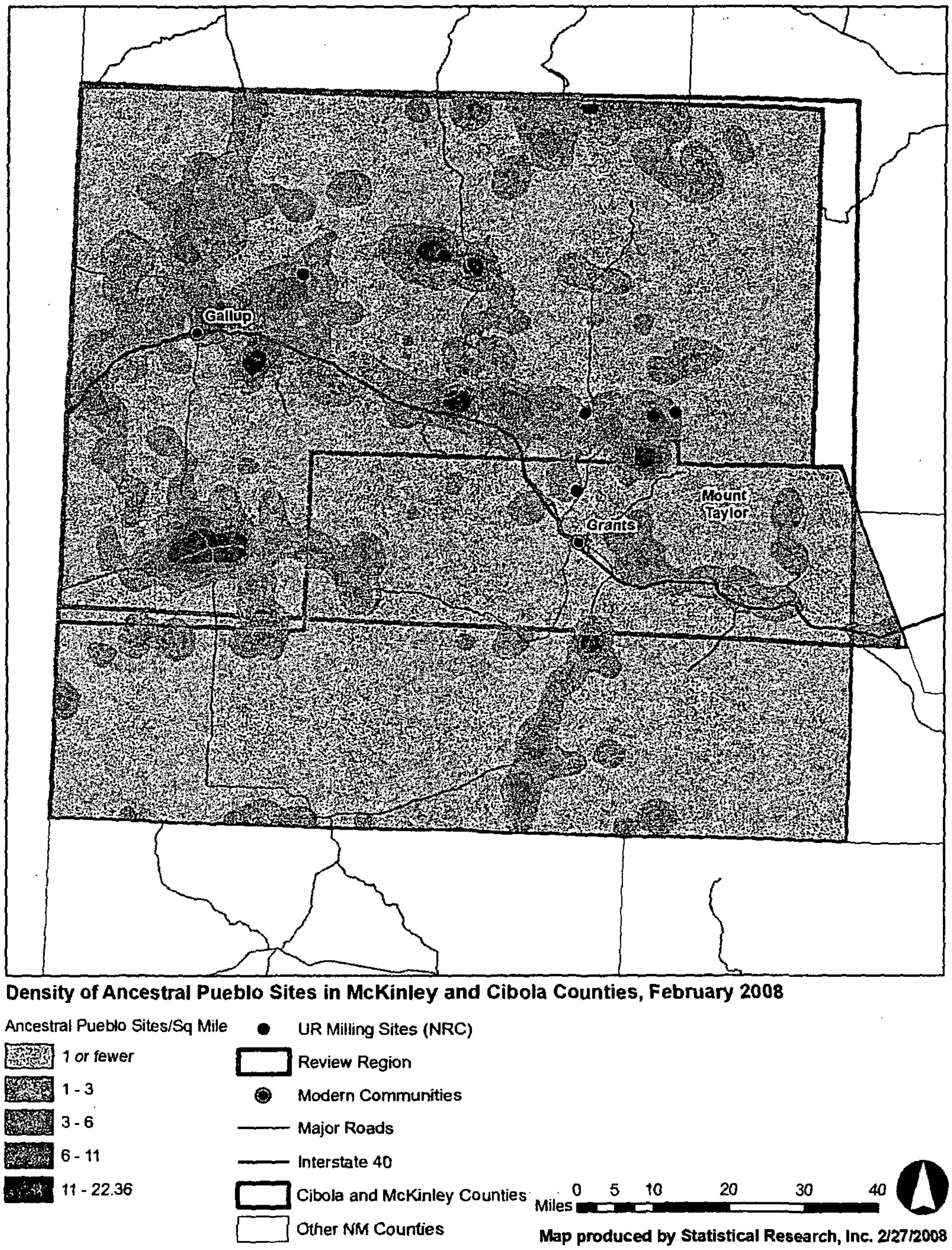



**Figure 3.5-17. Distribution of Ancestral Puebloan Sites**

**Pueblo I (ca. A.D. 700 to 900)**

The Pueblo I period is distinguished from the Basketmaker III period by the first appearance of painted black-on-white pottery. Although a shift away from living in subterranean pit structures and into aboveground rooms is also typically part of the Basketmaker III/Pueblo I transition (Reed, 2000a), pithouses remained the dominant structure type in much of McKinley and Cibola Counties until fairly late in the Pueblo I period, with small surface rooms primarily used for storage (Schutt and Chapman, 1997; Tainter and Gillio, 1980). Small aboveground pueblos constructed from masonry or jacal (wattle-and-daub) began to be used for habitation in some areas by the end of the Pueblo I period (Schutt and Chapman, 1997). Kivas—subterranean structures with a specialized ceremonial function—also made their first appearances during this period (Schutt and Chapman, 1997). Although Pueblo I-period sites are not particularly common in McKinley and Cibola Counties, they are more numerous than Basketmaker III sites and represent the first substantial Ancestral Puebloan occupations in many areas (Schachner and Kilby, 2005; Schutt and Chapman, 1997; Tainter and Gillio, 1980).

**Pueblo II (ca. A.D. 900 to 1100)**

The Pueblo II period represents a considerable change in Ancestral Puebloan culture throughout the Four Corners region, including the present study area (Powers, et al., 1983; Schutt and Chapman, 1997; Tainter and Gillio, 1980). Blocks of contiguous, aboveground masonry rooms become the primary focus of occupation, with belowground structures increasingly shifting to a predominantly ceremonial function (Powers and Orcutt, 2005b; Schutt and Chapman, 1997). Sites are often much larger than in the preceding Pueblo I period, and populations increase steeply throughout McKinley and Cibola Counties: in many areas, populations during Pueblo II reach a peak that is not exceeded during the prehistoric period (Tainter and Gillio, 1980).

This period also marks the development of the Chacoan regional system, an event with major repercussions for the entire Four Corners region (Kantner and Mahoney, 2000; Noble, 2004; Powers, et al., 1983). Beginning around A.D. 850, Ancestral Puebloan peoples living in Chaco Canyon, located just north of McKinley County (Judge, 2004; Powers, et al., 1983; Windes, 2004), began constructing a series of elaborate, carefully planned, multistory masonry structures today known as "great houses" (Windes, 2004). Although rooted in the Puebloan architecture of previous periods, the great houses were larger than contemporary structures anywhere else in the Puebloan world (Mills, 2002b). By the mid-13th century, when major construction ceased, at least 18 great houses had been constructed in and around the canyon, the largest reaching 4 or more stories and incorporating hundreds of rooms and an elaborate, decorative core-and-veneer masonry style (Judge, 2004; Mahoney and Kantner, 2000; Mills, 2002b).

Nor was great house construction limited to Chaco Canyon. Starting at about A.D 950, great houses began to be built beyond the canyon at numerous locations throughout the San Juan Basin. More than 200 great houses with Chacoan-style architecture and features have been identified to date across an area stretching from eastern Arizona and southern Colorado to the edges of the Jemez Mountains and the foothills of Mount Taylor. Outlier sites in McKinley and Cibola Counties include Casamero, Kin Nizhoni, and Village of the Great Kivas (Mahoney and Kantner, 2000; Marshall, et al., 1979). Southern and eastern areas near Acoma and Laguna are less clearly part of the Chaco system, exhibiting clear differences from sites in the San Juan Basin (Tainter and Gillio, 1980), but outliers may exist in these areas as well (Powers and Orcutt, 2005b). Outlying great houses are typically located among much smaller and less elaborate masonry pueblos and are often accompanied by distinctive structures including extremely large "great kivas" and Chacoan roads. These roads are intentionally constructed trails that typically measure 8 to 12 m [26 to 39 ft] in width and incorporate raised beds, borders, gates, stairways, and other features (Mahoney and Kantner, 2000; Mills, 2002b; Powers and Orcutt, 2005b). Their function is not well understood, but recent studies suggest they may link ceremonially and ritually important features of the Chacoan landscape (Kantner, 1997; Van Dyke, 2004).

The function and meaning of Chacoan great houses are not well understood, but most evidence suggests they were not simply residential structures. Excavated great houses in Chaco Canyon typically contain few rooms with cooking hearths and very little household trash, leading some archaeologists to suggest that even the largest structures never housed more than 100 permanent residents (Mills, 2002b). Most archaeologists now believe these structures served some sort of public function, perhaps as part of a ceremonial system centered around Chaco itself. However it functioned, Chaco's far-reaching influence served to funnel trade goods into the canyon. Recent studies of ceramic and lithic artifacts, wooden roof beams, and even foodstuffs like corn from great houses in the canyon suggest that many of these goods were brought in from far-flung areas such as the Chuska Mountains in eastern Arizona, the Mesa Verde area in southern Colorado, and the Mount Taylor region (Cordell, 2004; Mills, 2002b; Toll, 2004).

**Pueblo III (ca. A.D. 1100 to 1300)**

Great house construction within Chaco Canyon itself ceased by about A.D. 1130, and most of the canyon's occupants appear to have moved elsewhere by the late 12th century (Judge, 2004; Mills, 2002b). Many factors probably contributed to the demise of Chaco, but a series of major droughts that afflicted the region throughout much of the 12th century may have had a particularly influential role (Mills, 2002b). Beyond Chaco Canyon, however, many great house communities remained occupied throughout the 1100s, retaining many aspects of their Chacoan origins but incorporating new and distinctly different features as well (Mills, 2002b). Perhaps spurred by drought, populations declined throughout much of McKinley and Cibola Counties (Kintigh, 1996; Roney, 1996; Tainter and Gillio, 1980). New settlements founded during this period were frequently larger and more compact than the great house communities of the preceding period as populations aggregated in areas more conducive to conserving and managing water (Kintigh, 1996). Populations in some areas appear to have recovered and stabilized somewhat by the early 13th century (Powers and Orcutt, 2005a; Roney, 1996). The process of abandonment and aggregation began to accelerate again by the late 1200s, however, as renewed drought increasingly pushed Pueblo populations into relatively well-watered areas along the Zuni River to the west and the Rio San Jose to the east (Kintigh, 1996; Roney, 1996; Tainter and Gillio, 1980).

**Pueblo IV (ca. A.D. 1300 to 1540)**

The settlement reorganization that began during the Pueblo III period continued during Pueblo IV. By A.D. 1400, most of the Four Corners region was abandoned, with remnant populations concentrated in the Zuni and Rio San Jose areas and at the Hopi mesas in Arizona (Huntley and Kintigh, 2004; Kintigh, 1996; Roney, 1996). The number of sites present in these areas continued to drop as populations aggregated in large villages, but the compactly laid-out pueblos that remained were often extremely large, with several including more than 1,000 rooms (Huntley and Kintigh, 2004). By the late Pueblo IV period, the vast majority of Puebloan people in west-central New Mexico were at least part-time residents of one of these large pueblos; the smaller habitation sites that characterized earlier periods were virtually absent in many areas (Huntley and Kintigh, 2004; Roney, 1996). These newly aggregated large villages shared many similarities across the region: settlements typically consisted of blocks of contiguous rooms arranged around plaza areas used for domestic activities and public rituals. At larger sites, these roomblocks were often two or more stories tall. Sites were also frequently located in highly defensive locations, especially early in the period (Huntley and Kintigh, 2004; Roney, 1996; Tainter and Gillio, 1980).

**Historic Pueblo (post A.D. 1540)**

By the mid-16th century, Puebloan groups occupied no more than 10 villages in west-central New Mexico: 6 to 9 Zuni-speaking pueblos arrayed along the lower Zuni River and its tributaries south of modern Gallup (Huntley and Kintigh, 2004) and the single Keres-speaking village of Acoma, located on a mesa top in eastern Cibola county along the Rio San Jose (Adams and Duff, 2004) (Figure 3.5-18). The first contact between these villages and the Spanish came in 1539, when a small expedition led by Franciscan friar Marcos de Niza and the former slave Esteban entered the Zuni region; de Niza returned abruptly to Mexico when Esteban was killed (Ferguson and Hart, 1985; Spicer, 1962). The much larger expedition of Francisco Vasquez de Coronado fought a battle with the Zuni in July 1540 outside the village of Hawikuh and stopped briefly at Acoma on its way to the Rio Grande valley (Ferguson and Hart, 1985; Flint and Flint, 2005). More sustained contact with the Spanish empire came in 1598, when both the Zuni and Acoma areas were formally subjugated by the expedition of Juan de Oñate (Spicer, 1962).

Franciscan missions were established at both Zuni and Acoma in 1629, but the distance between Zuni and the center of Spanish power along the Rio Grande allowed the Zuni to retain a degree of cultural and religious independence (Ferguson and Hart, 1985; Spicer, 1962). Franciscan missions at Acoma and the Zuni villages of Hawikuh and Halona operated until the Pueblo Revolt of 1680, when the Spanish were driven from New Mexico for a dozen years, but missionization in the Zuni region continued only sporadically after the Spanish reconquest in the late 1600s. At both Acoma and Zuni, however, European infectious diseases and the economic demands of the colonizers decimated Puebloan populations: at Zuni, the six or more villages inhabited at contact dwindled to three by 1680, and only one village, the present pueblo of Zuni, was reoccupied after the reconquest (Mills, 2002a). To the east, Acoma remained the only village along the Rio San Jose until 1697, when the pueblo of Laguna was established by a group of Acoma dissidents and refugees from other villages after the Spanish reconquest (Ellis, 1979).

More benign aspects of colonialism included new economic opportunities afforded by the food crops and domesticated animals brought by the Spanish. Sheepherding, in particular, began at both Zuni and Acoma as early as the mid-17th century, and by the mid-18th century, the Zunis grazed more than 15,000 sheep across an area extending as far as 112 km [70 mi] from the central pueblo itself (Ferguson and Hart, 1985; Schutt and Chapman, 1997). Small, temporary campsites associated with sheepherding and agriculture are among the most common historic period Puebloan archaeological sites from the 1600s into the 20th century (Ferguson, 1996; Schutt and Chapman, 1997).

**Navajo (ca. 1700 to present)**

With the exception of the areas just discussed, much of the northern Southwest, including northwestern New Mexico, was abandoned by Ancestral Puebloan groups during the

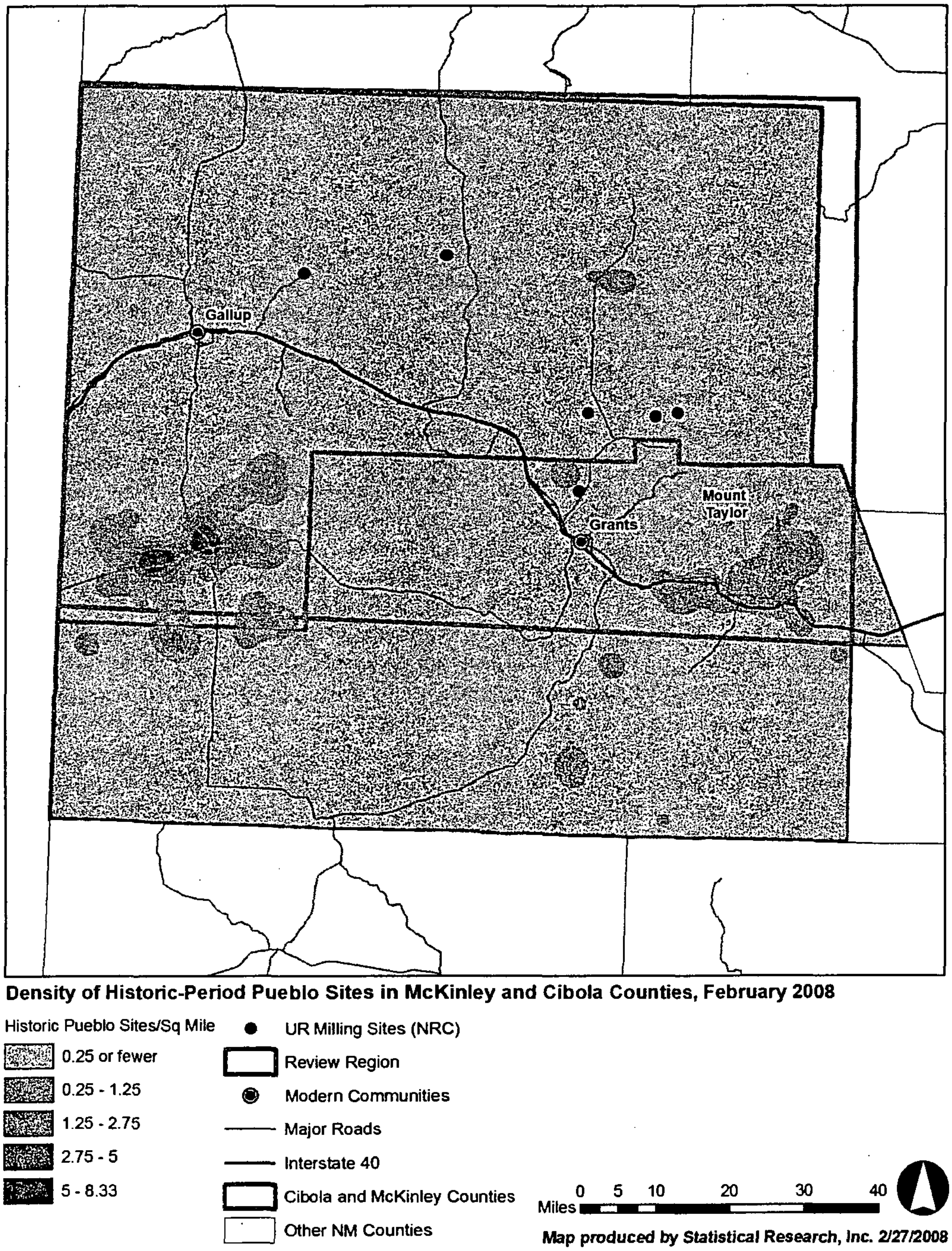



**Figure 3.5-18. Distribution of Historic Pueblo Sites**

14th century, followed by the expansion of Athabaskan hunter-gatherers into these vacated areas, perhaps as early as the late 15th century (Dean, et al., 1994; Towner, 1996). The Athabaskan-speaking groups are believed to have been the ancestors of today's Navajo and Apachean groups in the Southwest. The ancestral Navajo groups subsequently adopted maize cultivation and later moved south into the southern San Juan Basin by the 1700s (Figure 3.5-19). The 18th century Navajo migration southward was due to several factors including conflict with the Comanches and Utes, drought, and disease outbreaks. Records of Navajo baptisms at the Cebolleta Mission occur after 1749, with Navajo raids on local settlers and Laguna Pueblo Indians being reported in the late 1700s (Brugge, 1968; Correll, 1976; Reeve, 1959). This conflict continued through the 1800s, although the Navajos in the Mount Taylor (Tsoodzil) area were also involved in trade relations with both local Spanish and Pueblo Indians. Nonetheless, in 1864 all the Navajos residing in the region were forcibly moved to Fort Sumner in eastern New Mexico. By 1868 the Navajos were allowed to return to their lands within a newly designated reservation. The arrival of the railroad during the 1880s provided them with a market for wool blankets and jewelry. However, this was a mixed blessing, with pressures on the Navajo households to produce market items, versus subsistence self-sufficiency. Ultimately, Navajos expanded into more marginal areas that could not sustain the growing economic markets, with the long-term result being the partitioning of landholdings into smaller family-owned tracts, the overgrazing of these tracts, and a shift toward wage-earning jobs (Kelley, 1986).

### 3.5.8.2 National Register of Historic Properties and State Registers

Table 3.5-12 includes a summary of sites in the Northwestern New Mexico Uranium Milling Region that are listed on the New Mexico State and/or NRHP. Most of the sites are located in McKinley County, and the locations of many of the archaeological sites are not identified to reduce the likelihood of vandalism. Historic sites are located in the communities of Grants, Gallup, and Crownpoint, all of which are close to potential uranium ISL milling locations.

### 3.5.8.3 New Mexico Tribal Consultation

There are 22 Native American Pueblos and tribes located within the state of New Mexico. Most of these groups are situated along the Rio Grande valley corridor from Albuquerque to Taos, with several additional groups being represented in the northwest and southern parts of the state. Five tribes have reservation lands within McKinley and Cibola Counties, consisting of Acoma Pueblo, Laguna Pueblo, Zuni Pueblo, the Navajo Nation and the Ramah Navajo Tribe. These counties lie in the northwestern section of the state, along the southern periphery of the San Juan Basin. The region is characterized by mesas and open grasslands, which are bounded by the Chuska Mountains, Zuni Mountains, and Mount Taylor rising to heights of over 2,950 m [9,700 ft]. The Continental Divide bisects the area with drainages flowing toward the north, west, and east. Silko provides an insight into the Pueblo perspective of this environment when she states that "there is no high mesa edge or mountain peak where one can stand and not immediately be part of all that surrounds. Human identity is linked with all the elements of Creation" (Silko, 1990, pp. 884–885).

Traditional cultural properties are places of special heritage value to contemporary communities because of their association with cultural practices and beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (Parker and King, 1998; King, 2003). Religious places are often associated with prominent topographic features like mountains, peaks, mesas, springs and lakes (Silko, 1990). In addition,

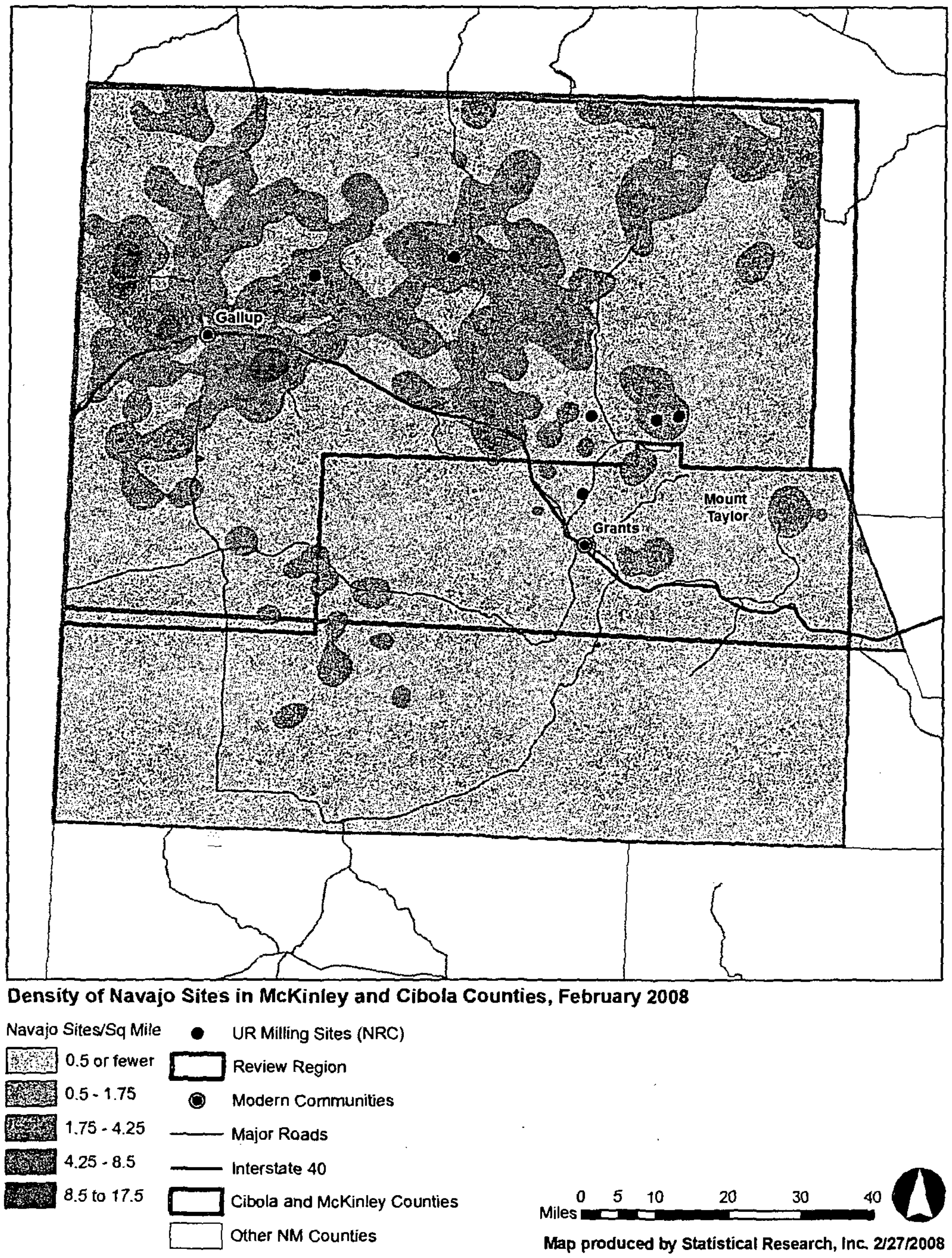



**Figure 3.5-19. Distribution of Navajo Archaeological Sites**

| Table 3.5-12. National Register Listed Properties in Counties Included in the Northwestern New Mexico Uranium Milling Region | | | |
|---|---|---|---|
| **County** | **Resource Name** | **City** | **Date Listed YYYY-MM-DD** |
| Cibola | Bowlin's Old Crater Trading Post | Bluewater | 2006-03-21 |
| Cibola | Candelaria Pueblo | Grants | 1983-03-10 |
| Cibola | Route 66 Rural Historic District: Laguna to McCarty's | Cubero | 1994-01-13 |
| Cibola | Route 66, State Maintained from McCarty's to Grants | Grants | 1997-11-19 |
| Cibola | Route 66, State Maintained from Milan to Continental Divide | Continental Divide | 1997-11-19 |
| McKinley | Andrews Archeological District | Prewitt | 1979-05-17 |
| McKinley | Archaeological Site # LA 15278 (Reservoir Site; CM 100) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,780 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,781 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,782 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,784 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,785 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,786 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 45,789 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,000 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,001 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,013 (CM101) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,014 (CM 102) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,015 (CM 102A) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,016 (CM 103) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,017 (CM 104) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,018 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,019 (CM 105) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,020 (CM 106) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,021 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,022 (CM 107) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,023 (CM 118) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,024 (CM 108) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,025 (CM 109) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,026 (CM 108) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,027 (CM 111) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,028 (CM 112) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,030 (CM 114) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,031 (CM 115) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,033 (CM 117) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,034 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,036 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,037 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,038 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,044 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,071 (CM 148) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,072 (CM 94) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,074 (CM 181) | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,077 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,080 | Pueblo Pintado | 1985-08-02 |
| McKinley | Archaeological Site # LA 50,035 | Pueblo Pintado | 1985-10-09 |

| Table 3.5-12. National Register Listed Properties in Counties Included in the Northwestern New Mexico Uranium Milling Region (continued) | | | |
|---|---|---|---|
| County | Resource Name | City | Date Listed YYYY-MM-DD |
| McKinley | Ashcroft—Merrill Historic District | Ramah | 1990-07-27 |
| McKinley | Bee Burrow Archeological District | Seven Lakes | 1984-12-10 |
| McKinley | Casa de Estrella Archeological Site | Crownpoint | 1980-10-10 |
| McKinley | Chaco Culture National Historical Park | Thoreau | 1966-10-15 |
| McKinley | Chief Theater | Gallup | 1988-05-16 |
| McKinley | Cotton, C.N., Warehouse | Gallup | 1988-01-14 |
| McKinley | Cousins Bros. Trading Post | Chi Chil Tah | 2006-03-22 |
| McKinley | Dalton Pass Archeological Site | Crownpoint | 1980-10-10 |
| McKinley | Drake Hotel | Gallup | 1988-01-14 |
| McKinley | El Morro Theater | Gallup | 1988-05-16 |
| McKinley | El Rancho Hotel | Gallup | 1988-01-14 |
| McKinley | Fort Wingate Archeological Site | Fort Wingate | 1980-10-10 |
| McKinley | Fort Wingate Historic District | Fort Wingate | 1978-05-26 |
| McKinley | Grand Hotel | Gallup | 1988-05-25 |
| McKinley | Greenlee Archeological Site | Crownpoint | 1980-10-10 |
| McKinley | Halona Pueblo | Gallup | 1975-02-10 |
| McKinley | Harvey Hotel | Gallup | 1988-05-25 |
| McKinley | Haystack Archeological District | Crownpoint | 1980-10-10 |
| McKinley | Herman's, Roy T., Garage and Service Station | Thoreau | 1993-11-22 |
| McKinley | Lebanon Lodge No. 22 | Gallup | 1989-02-14 |
| McKinley | Log Cabin Motel | Gallup | 1993-11-22 |
| McKinley | Manuelito Complex | Manuelito | 1966-10-15 |
| McKinley | McKinley County Courthouse | Gallup | 1989-02-15 |
| McKinley | Palace Hotel | Gallup | 1988-05-16 |
| McKinley | Peggy's Pueblo | Zuni | 1994-08-16 |
| McKinley | Redwood Lodge | Gallup | 1998-02-13 |
| McKinley | Rex Hotel | Gallup | 1988-01-14 |
| McKinley | Route 66, State Maintained from Iyanbito to Rehobeth | Rehobeth | 1997-11-19 |
| McKinley | Southwestern Range and Sheep Breeding Laboratory Historic District | Fort Wingate | 2003-05-30 |
| McKinley | State Maintained Route 66—Manuelito to the Arizona Border | Mentmore | 1993-11-22 |
| McKinley | Upper Kin Klizhin Archeological Site | Crownpoint | 1980-10-10 |
| McKinley | U.S. Post Office | Gallup | 1988-05-25 |
| McKinley | Vogt, Evon Zartman, Ranch House | Ramah | 1993-02-04 |
| McKinley | White Cafe | Gallup | 1988-01-14 |

shrines are present across the landscape to denote specific culturally significant locations where an individual can place offerings (Ellis, 1974a,b; Perlman, 1997; Rands, 1974a,b). Ancestral villages also represent culturally significant places where the ancestors of these contemporary communities once resided in the distant past, and these villages are sometimes linked to Pueblo migration stories (Ellis, 1974a,b). In addition, specific resource collecting areas may have significance for maintaining traditional lifeways (Ferguson and Hart, 1985; Perlman, 1997; Rands 1974a,b). Lastly, pilgrimage trails with trail markers provide a link to all these areas across the broad ethnic landscape (Ferguson and Hart, 1985; Fox, 1994; Parsons, 1918; Sedgwick, 1926).

The area of McKinley and Cibola Counties only composes a small portion of the lands considered to be affiliated with traditional land-use activities. For example, the Navajo Nation bounds their traditional lands by the four culturally significant mountains: Hesperus Peak, Blanca Peak, Mount Taylor, and the San Francisco Peaks, which are located in Colorado, New Mexico, and Arizona, respectively (Linford, 2000). Zuni Pueblo recognizes a shrine that is situated more than 240 km [150 mi] away at Bandelier National Monument near Los Alamos, New Mexico (Ferguson and Hart, 1985). On the other hand, Mount Taylor is significant to nearby Acoma and Laguna Pueblos for its role in their traditional origin myth where the Gambler held captive the Rainclouds until released by Sun Youth and Old Grandmother Spider (Sterling, 1942; Silko, 1990).

Information on traditional land use and the location of culturally significant places is often protected information within the community (e.g., King, 2003). Therefore, the information presented on religious places is limited to those that are identified in the published literature and is therefore restricted to a few highly recognized places on the landscape within McKinley and Cibola counties. Various documents pertaining to the Indian land claims also provide background information on local history and traditional land use (Ellis, 1974a,b; Minge, 1974; Rands, 1974a,b; Jenkins, 1974).

Linford's (2000) statement on the relation between mythology and place names is relevant to all traditional communities when he states that "a location's religious significance is more obscure, usually ascribed through it's [sic] association with, or mention in, one or more of the stories that are the foundation of Navajo ceremonies" (Kelley and Francis, 1994; Holt, 1981; Ortiz, 1992; Silko, 1990). The list of religious places provided in Table 3.5-13 is most often associated with traditional stories that recount the community's heritage through oral traditions. Ellis (1974a,b) and Rand (1974a,b) do, however, provide a list of shrines that are associated with Laguna and Acoma Pueblos, and Ferguson and Hart (1985) list religious sites associated with Zuni Pueblo.

On June 14, 2008, the New Mexico Cultural Properties Review Committee accepted an emergency listing of the Mount Taylor traditional cultural property to the State Register of Cultural Properties (Los Angeles Times, 2008). The nomination was submitted by Acoma Pueblo, Hopi Tribe, Laguna Pueblo, the Navajo Nation, and Zuni Pueblo. The boundaries of the traditional cultural property have been tentatively set to include the summit and surrounding mesas above 2,440 m [8,000 ft], with the boundary dropping down to 2,224 m [7,300 ft] in the area of Horace Mesa. This application was specifically initiated to protect culturally sensitive sites that may be impacted by proposed uranium mining activities. The nominating group has 1 year to complete the final nomination to the state register; however, during this time, the traditional property is given the full status of being listed. Also in 2008, the USFS has determined that Mount Taylor is eligible for listing in the NRHP as a traditional cultural property.

If the listing of Mount Taylor is approved and NRC receives a license application for the Mount Taylor area, NRC regulations require that the application be reviewed. Under applicable NRC regulations, if an ISL license application is received, consultation and site-specific review of the application will be undertaken according to NEPA, NHPA, and NRC regulations. Appendix D summarizes the NHPA process that would occur should a license application be received.

The New Mexico Historic Preservation website suggests that the following Pueblo and tribal groups should be contacted for consultation associated with activities in McKinley and Cibola Counties: Acoma Pueblo, Hopi Tribe, Isleta Pueblo, Laguna Pueblo, Mescalero Apache Tribe, Navajo Nation, Sandia Pueblo, White Mountain Apache Tribe and Zuni Pueblo. This list was generated from the Pueblo and American land claims, Historic Preservation Division ethnographic study, the National Park Service's Native American Consultation database and groups that directly contacted Historic Preservation Division requesting to be notified of potential

| Table 3.5-13. Known Culturally Significant Places in McKinley and Cibola Counties | | |
|---|---|---|
| **Place** | **Affiliated Tribe** | **Reference** |
| Bandera Crater | Zuni | Ferguson and Hart (p. 127)* |
| Cerro del Oro | Laguna | Parsons†, Rands (p. 68)‡ |
| Chuska Mountains (various locations) | Navajo | Linford (p. 194)§ |
| Correo Snake Pit | Acoma and Laguna | Ellis (p. 92) ‖, Parsons†, Rands (p. 8)¶ |
| Dowa Yalanne | Zuni | Ferguson and Hart (p. 124)* |
| El Malpais | Navajo | Linford (p. 204)§ |
| El Morro | Zuni | Ferguson and Hart (p. 127)* |
| Hosta Butte | Navajo | Linford (p. 218)§ |
| Ice Caves | Zuni | Ferguson and Hart (p. 125)* |
| Mount Taylor Shrines | Acoma<br>Laguna<br>Zuni | Parsons (p. 185) #, Rands (p. 97)¶,<br>Ellis (p. 92)‖, Ferguson and Hart (p. 126)* |
| Mount Taylor:<br>Kaweshtima<br>Tsiipiya<br>T'se pina<br>Tsoodzil<br>Dewankwi<br>Kyabachu Yalanne | <br>Acoma<br>Hopi<br>Laguna<br>Navajo<br>Zuni | Application for Register. New Mexico State Register of Cultural Properties, June 14, 2008 (Los Angeles Times**). New Mexico State Historic Preservation Office. |
| Pueblo Pintado | Navajo | Linford (p. 247)§ |
| Red Lake | Navajo | Linford (p. 250)§ |
| Springs | Acoma<br>Laguna<br>Zuni | Rands (p. 97)¶, White (pp. 45–47)††,<br>Ellis (p. 92)‖, Ferguson and Hart (pp. 125–132)* |
| Zuni Salt Lake | Laguna<br>Zuni<br>Navajo | Rands (p. 68)‡, Ferguson and Hart (p. 126)*,<br>Linford (p. 284)§ |
| Zuni Mountains (various locations) | Zuni | Ferguson and Hart (pp. 125, 132)* |

*Ferguson, T.J. and E. Hart. *A Zuni Atlas.* Norman, Oklahoma: University of Oklahoma Press. 1985.
†Parsons, E.C. "War God Shrines of Laguna and Zuni." *American Anthropologist.* Vol. 20. pp. 381–405. 1918.
‡Rands, R. *Laguna Land Utilization: Pueblo Indians IV.* New York City, New York: Garland Publishing. 1974.
§Linford, L. *Navajo Places: History, Legend and Landscape.* Salt Lake City, Utah: University of Utah Press. 2000.
‖Ellis, F.H. *Archaeologic and Ethnologic Data: Acoma-Laguna Land Claims.* New York City, New York: Garland Publishing, Inc. 1974.
¶Rands, R. *Acoma Land Utilization: Pueblo Indians III.* New York City, New York: Garland Publishing. 1974.
#Parsons, E.C. "Notes on Acoma and Laguna." *American Anthropologist.* pp. 162–186. 1918.
**Los Angeles Times. "Tribes Get Mt. Taylor Listed as Protected." Los Angeles Times, June 15, 2008. <http://articles.latimes.com/2008/jun/15/nation/na-mountain 15>
††White, L.A. *The Acoma Indians.* Forty-Seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. Washington, DC: Smithsonian Institution. 1932.

activities in these areas. The Pueblo and tribal contact information provided in Table 3.5-14 was obtained from the State of New Mexico, Indian Affairs Department website at <http://www.iad.state.nm.us/ pueblogovandtribaloff.html>.

| Table 3.5-14. 2008 Pueblo and Tribal Government Contacts for McKinley and Cibola Counties, New Mexico | | |
|---|---|---|
| **Affiliated Tribe** | **Contact** | **Address** |
| Acoma Pueblo | Governor<br>Chandler Sanchez | Pueblo of Acoma<br>P.O. Box 309<br>Acoma, NM 87034<br>(505) 552-6604/6605 |
| Acoma Pueblo | Director<br>Teresa Pasqual, | Pueblo of Acoma Historic Preservation Office<br>PO Box 309<br>Acoma, NM 87034<br>(505) 552-5170 |
| Hopi Tribe | Chairman<br>Benjamin Nuvamsa | Hopi Tribe<br>P.O. Box 123<br>Kykotsmovi, AZ 86039<br>(928) 734-3000 |
| Hopi Tribe | Leigh Kuwanwisiwma | Hopi Cultural Preservation Office<br>The Hopi Tribe<br>P.O. Box 123<br>Kykotsmovi, AZ 86039<br>(928) 734-6636 P<br>(928) 734-3613 EX611 Leigh<br>(928) 734-3629 Fax |
| Jemez Pueblo | Governor<br>Paul Chinana | Jemez Pueblo<br>P.O. Box 100<br>Jemez Pueblo, NM 87024<br>(505) 834-7359 |
| Jicarilla Apache Nation | President<br>Levi Pesata | Jicarilla Apache Nation<br>P.O. Box 507<br>Dulce, NM 507<br>(505) 759-3242 |
| Isleta Pueblo | Governor<br>Robert Benavides | Pueblo of Isleta<br>P.O. Box 1270<br>Isleta Pueblo, NM 87022<br>(505) 869-3111/6333 |
| Laguna Pueblo | Governor<br>John Antonio, Sr. | Pueblo of Laguna<br>P.O. Box 194<br>Laguna Pueblo, NM 87026<br>(505) 552-6654/6655/6598 |
| Mescalero Apache Tribe | President<br>Carleton Naiche-Palmer | Mescalero Apache Tribe<br>P.O. Box 227<br>Mescalero, NM 88340<br>(505) 464-4494 |
| Navajo Nation | President<br>Joe Shirley, Jr. | Navajo Nation<br>P.O. Box 9000<br>Window Rock, AZ 86515<br>(928) 871-6352/6357 |

| Table 3.5-14. 2008 Pueblo and Tribal Government Contacts for McKinley and Cibola Counties, New Mexico (continued) | | |
|---|---|---|
| **Affiliated Tribe** | **Affiliated Tribe** | **Affiliated Tribe** |
| Navajo Nation | Alan Downer | Tribal Preservation Officer<br>Navajo Nation Historic Preservation Department<br>P.O. Box 4950<br>Window Rock, AZ 86515<br>(928) 871-6437 |
| Sandia Pueblo | Governor<br>Robert Montoya | Pueblo of Sandia<br>481 Sandia Loop<br>Bernalillo, NM 87004<br>(505) 867-3317 |
| White Mountain Apache | Mr. Ramon Riley | White Mountain Apache Tribe<br>P.O. Box 507<br>Fort Apache, AZ 85926 |
| Zuni Pueblo | Governor<br>Norman Cooeyate | Pueblo of Zuni<br>P.O. Box 339<br>Zuni, NM 87327<br>(505) 782-7022 |
| Zuni Pueblo | Kurt Dongoske | Office of Heritage and Historic Preservation<br>Pueblo of Zuni<br>P.O. Box 339<br>Zuni, New Mexico 87327-0339<br>(928) 782-4814 P<br>(928) 782-2393 F |

#### 3.5.8.4 Traditional Cultural Landscapes

Although archaeology and cultural resources management have historically focused on archaeological sites and artifact finds, past and present human interactions with their natural surroundings extend beyond the material traces of past human behavior. As a result, archaeologists and resource managers alike are increasingly focusing on the concept of traditional *cultural landscapes* as a broader, more accurate perspective on the way humans conceive of and use their environments. A cultural landscape is not the same as a natural "environmen"; rather, it is produced by a cultural group's interaction with their environment. In simple terms, a cultural landscape is what results as members of a particular human group "project culture onto nature" (Crumley and Marquardt, 1990) by interacting with, modifying, and conceptualizing their natural surroundings over time (Anschuetz, et al., 2001).

The notion of a cultural landscape includes the physical evidence of a group's interactions with the natural world, but is not limited to quantifiable material resources or patterns. A landscape perspective also incorporates the significance of particular places or landmarks for a group's histories, traditional stories, or religious beliefs (Anschuetz, 2007; Anschuetz, et al., 2001; Basso, 1996). Particular locations may serve as reminders of traditional beliefs or ways of life, or be venerated as supernatural beings in their own right. To quote a recent summary, a landscape perspective encompasses a "community's intimate relationships with the land and its resources in every aspect of its material life, including economy, society, polity, and recreation" (Anschuetz, 2007).

Understanding the importance of traditional cultural landscapes, then, means being aware of many overlapping dynamics of a culture's relationships with its environment. A landscape perspective must also take into account the overlapping, diverse cultural landscapes of many different cultures. In west-central New Mexico, for instance, a survey of cultural landscapes would include the distinct, extensive territories formerly used by the Zunis for economic activities ranging from farming and herding to gathering medicinal plants or collecting raw materials for stone tools (Ferguson and Hart, 1985). It would also recognize the culturally significant springs, caves, and shrines dotting the world as conceived by the Keres people of Laguna and Acoma, or the culturally significant peaks at the four cardinal directions delineating this world's boundaries (Snead and Preucel, 1999; White, 1932). Similar culturally significant landmarks recognized by the Navajo form part of yet another traditional landscape perspective, as described previously. Finally, the roads and ruins of the ancient inhabitants of Chaco Canyon figure in the traditional histories of Zuni, Acoma, and Navajo alike, but also serve as clues to illuminate the traditional landscapes of the Chacoans themselves. Like their modern descendents, the ancient Chacoans seem to have placed importance on astronomical alignments, the cardinal directions, and prominent peaks, mesas, and other landmarks (Van Dyke, 2004).

In summary, then, the distribution of archaeological sites, artifacts, and other physical markers of human activity are only one dimension of the processes in which past human groups used and conceptualized their surroundings. The traditional cultural landscapes of west-central New Mexico's indigenous groups include a wide variety of landmarks, traditional use areas, and other important features, many of which retain importance for contemporary groups. These traditional landscapes are increasingly recognized by agencies and archaeologists alike and play an expanding role in historic preservation and cultural resource management decision making.

### 3.5.9 Visual/Scenic Resources

Based on the BLM Visual Resource Handbook (BLM, 2007a–c), the Grants Uranium District in the Northwestern New Mexico Uranium Milling Region is located in the Colorado Plateau physiographic province (BLM, 2007a). The Farmington and Albuquerque field offices of the BLM have classified most of the region as VRM Class III and IV (BLM, 2003, 2000). There are no VRM Class I VRM areas, and most of the Class II areas are located just north of Interstate 40. As described in NRC (1997), the primary viewers in the San Juan Basin and Grants Uranium District are likely to be Native American residents living on and near a proposed ISL facility (see Section 3.5.8). For this reason, their aesthetic sense at the landscape scale is important. In general, Native American thought is "integrative and comprehensive. It does not separate intellectual, moral, emotional, aesthetic, economic, and other activities, motivations, and functions" (Norwood and Monk, 1987). For both the Navajo and Zuni, moral good tends to be equated with aesthetic good: that which promotes or represents human survival and human happiness tends to be experienced as "beautiful." The landscape is beautiful by definition because the Holy People designed it to be a beautiful, harmonious, happy, and healthy place (Norwood and Monk, 1987). Native Americans have not created an abstract category for unspecified vistas; the emphasis is on specific mountains, specific trees, and specific colors of the soil (Norwood and Monk, 1987). References to the visual quality of a given area may be more meaningful when linked to an identifiable place and not to more generalized landscapes.

Natural and scenic attractions within the Grants Uranium District in the Northwestern New Mexico Uranium Milling Region are minimal. Regionally, the Chaco Culture National Historic Park, El Malpais National Monument (BLM, 2000), El Morro National Monument, and the Red

Rock State Park, among other features, attract tourists for scenic, historic, and cultural features (see Section 3.5.1). Near Gallup and south of Interstate 40, the USFS categorizes the visual quality objectives within the Cibola National Forest as predominantly (about 75 percent) in the Modification and Maximum Modification class (USFS, 1985), with some areas such as the Mount Taylor district in the San Mateo Mountains having high scenic integrity (USFS, 2007). In addition, in June 2008 (Los Angeles Times, 2008), the New Mexico Cultural Properties Review Committee approved listing the Mount Taylor traditional cultural property in the State Register of Cultural Properties (see Section 3.5.8.3). With the exception of major highways such as Interstate 40 and U.S. Highway 491, area roads are used mostly for local travel. The urban areas such as Gallup, Crownpoint, and Grants tend to dominate visual resources near these cities and towns (NRC, 1997).

The resource management plan for the Farmington field office of the BLM provides a VRM classification for the public lands in the Northwestern New Mexico Uranium Milling Region (BLM, 2003) (Figure 3.5-20). The visual context is also an important component of the cultural resource values of the Chacoan Outliers, Native American Use and Sacred Areas of Critical Environmental Concern, and additional traditional cultural properties (BLM, 2003). The approximately 2 million ha [5 million acres] of regional public lands and subsurface mineral resources BLM administers in the Farmington field office have a relatively small amount (about 13 percent) of VRM Classes I and II viewsheds associated with wilderness areas, wilderness study areas, specially designated areas, and special management areas. As categorized by BLM, the visual landscape in northwestern New Mexico is dominated by VRM Class IV (55 percent) and Class III (32 percent). The natural state has been considerably modified by human activities and structures associated with oil and gas development, including gas wells, pipelines, and the accompanying access roads. There are no Class I areas within the Northwestern New Mexico Uranium Milling Region. Areas categorized as Class II include locations where scenic vistas (from major highways), riverfronts, and high places are important because of associated sightseeing and recreational value (BLM, 2003).

Specific VRM Class II locations identified by BLM within and near the region include the Cabezon Peak, Cañon Jarido, Elk Springs, Ignacio Chavez, Jones Canyon, and La Lena special management areas and the Empedrado wilderness study areas (BLM 2003) at the eastern edge of the Northwestern New Mexico Uranium Milling Region. The USFS also identifies Corral Canyon and the western edge of the San Pedro Mountains in the La Jara area of the Santa Fe National Forest just to the east of the Northwestern New Mexico Uranium Milling Region as areas where recreation and timber are to be managed to preserve visual resource value (USFS, 2007). These Class II resource areas are adjacent to the Grants Uranium District, but the closest potential uranium ISL facility to these resource areas is about 16 km [10 mi]. A Class II area associated with the Chaco Culture National Historic Park is north of the Northwestern New Mexico Uranium Milling Region and extends into the region about 50 km [30 mi] north of the nearest potential uranium recovery facility (Figure 3.5-20). BLM National Conservation Areas, adjacent to the El Malpais National Monument and about 3 km [2 mi] south of Grants, are also identified as Class II. Two potential facilities are located near San Mateo Mesa about 16 km [10 mi] northwest of Mount Taylor. In addition, two of the proposed facilities are located within about 3–8 km [2–5 mi] of the borders of the Navajo Nation (Figure 3.5-20). Current indications from industry are that these would be developed as conventional milling operations (NRC, 2008).

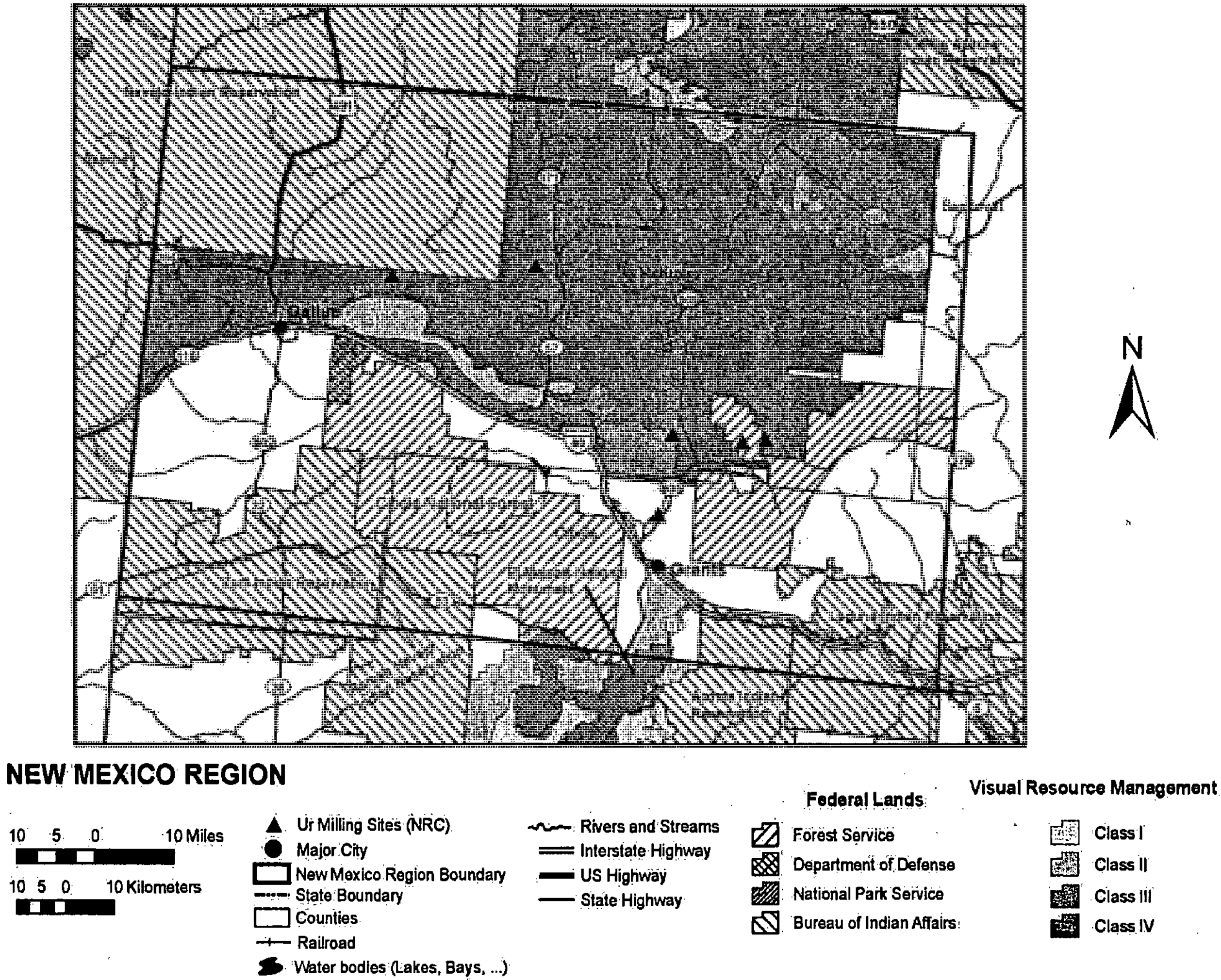



**Figure 3.5-20. BLM Visual Resource Classifications for the Northwestern New Mexico Uranium Milling Region (BLM, 2003, 2000)**

### 3.5.10 *Socioeconomics*

For the purpose of this GEIS, the socioeconomic description for the Northwestern New Mexico Uranium Milling Region includes communities within the region of influence for potential ISL facilities in the Grants Uranium District. These include communities that have the highest potential for socioeconomic impacts and are considered the affected environment. Communities that have the highest potential for socioeconomic impacts are defined by (1) proximity to an ISL facility {generally within about 48 km [30 mi]}; (2) economic profile, such as potential for income growth or destabilization; (3) employment structure, such as potential for job placement or displacement; and (4) community profile, such as potential for growth or destabilization to local emergency services, schools, or public housing. The affected environment consists of counties, towns, CBSAs, and Native American communities (reservation land) (Table 3.5-15). A CBSA, according to the U.S. Census Bureau, is a collective term for both metro and micro areas ranging from a population of 10,000 to 50,000 (U.S. Census Bureau, 2008). The following subsections describe areas most likely to have implications with regard to socioeconomics. In some subsections, Metropolitan Areas are also discussed. A Metropolitan Area is greater than 50,000 and a town has less than 10,000 in population (U.S. Census Bureau, 2008).

#### 3.5.10.1 Demographics

Demographics are based on 2000 U.S. Census data on population and racial characteristics of the affected environment (Table 3.5-16). Figure 3.5-21 illustrates the populations of communities within the Northwestern New Mexico Uranium Milling Region. Most 2006 data compiled by the U.S. Census Bureau is not yet available for the geographic area of interest.

Based on review of Table 3.5-16, the most populated county is Sandoval County and the most sparsely populated county is Cibola County. The largest populated town/CBSAs in the Northwestern New Mexico Uranuim Milling Region is Gallup. The county with the largest percentage of non-minorities is Sandoval County with a white population of 65.1 percent. The town/CBSAs with the largest percentage of non-minorities is Grants with a white population of 56.2 percent. The largest minority-based county is McKinley County with a white population of

**Table 3.5-15. Summary of Affected Environment Within the Northwestern New Mexico Uranium Milling Region**

| Counties Within New Mexico | Towns Within New Mexico | CBSAs Within New Mexico | Native American Communities Within New Mexico |
|---|---|---|---|
| Cibola | Grants | Gallup | Acoma Indian Reservation |
| McKinley | | | Tohajiilee Indian Reservation |
| Sandoval | | | Laguna Indian Reservation |
| | | | Navajo Nation Indian Reservation |
| | | | Ramah Navajo Indian Reservation |
| | | | Zuni Indian Reservation |

**Table 3.5-16. 2000 U.S. Bureau of Census Population and Race Categories of the Northwestern New Mexico Uranium Milling Region***

| Affected Environment | Total Population | White | African American | Native American | Some Other Race | Two or More Races | Asian | Hispanic Origin† | Native Hawaiian and Other Pacific Islander |
|---|---|---|---|---|---|---|---|---|---|
| New Mexico | 1,819,046 | 1,214,253 | 34,343 | 173,483 | 309,882 | 66,327 | 19,255 | 765,386 | 1,503 |
| *Percent of total* | | 66.8% | 1.9% | 9.5% | 3.6% | 3.6% | 1.1% | 42.1% | 0.1% |
| Cibola County | 25,595 | 10,138 | 246 | 10,319 | 3,952 | 828 | 98 | 8,555 | 14 |
| *Percent of total* | | 39.6% | 1.0% | 40.3% | 15.4% | 3.2% | 0.4% | 33.4% | 0.1% |
| McKinley County | 74,798 | 12,257 | 296 | 55,892 | 4,095 | 1,882 | 344 | 9,276 | 32 |
| *Percent of total* | | 16.4% | 0.4% | 74.7% | 5.5% | 2.5% | 0.5% | 12.4% | 0.0% |
| Sandoval County | 89,908 | 58,512 | 1,535 | 14,634 | 11,118 | 3,117 | 894 | 26,437 | 98 |
| *Percent of total* | | 65.1% | 1.7% | 16.3% | 12.4% | 3.5% | 1.0% | 29.4% | 0.1% |
| Gallup | 20,274 | 8,106 | 219 | 7,404 | 2,985 | 1,187 | 289 | 6,699 | 19 |
| *Percent of total* | | 40.1% | 1.1% | 36.6% | 14.8% | 5.9% | 1.4% | 33.1% | 0.1% |
| Grants | 8,806 | 4,947 | 143 | 1,054 | 2,184 | 386 | 81 | 4,611 | 11 |
| *Percent of total* | | 56.2% | 1.6% | 12.0% | 24.8% | 4.4% | 0.9% | 52.4% | 0.1% |

*U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other races would total more than 100 percent).

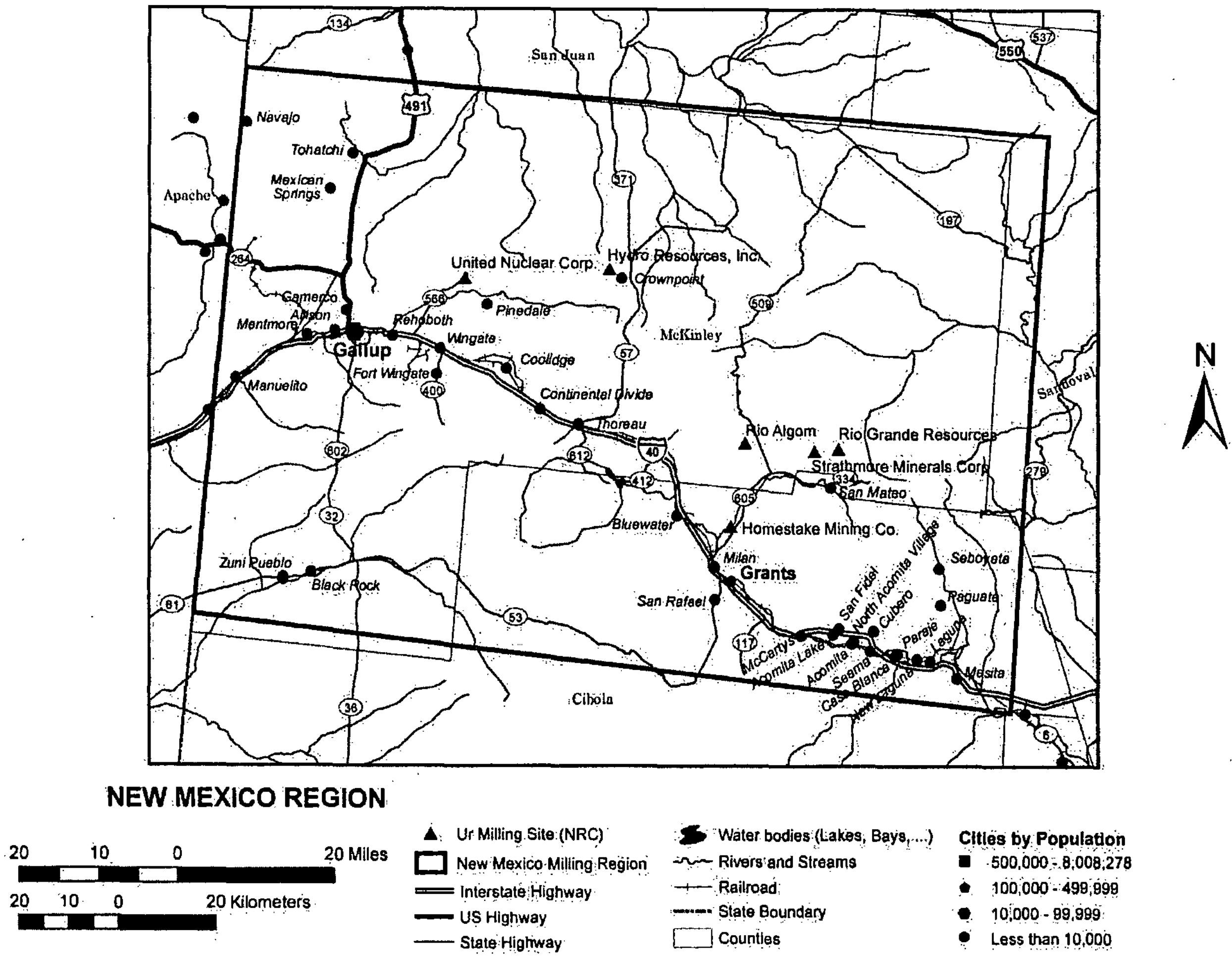



**Figure 3.5-21. Northwestern New Mexico Uranium Milling Region With Population**

only 16.4 percent. The largest minority-based town is Gallup with a white population of 40.1 percent.

Although not listed in Table 3.5-16, total population counts based on 2000 U.S. Census Bureau data (U.S. Census Bureau, 2008) for the Native American communities (reservation land) that would be affected are

- Acoma Indian Reservation: 2,802
- Tohajiilee Indian Reservation: 1,649
- Laguna Indian Reservation: not available
- Navajo Nation Indian Reservation: 173,987 [Includes Arizona, Utah, and New Mexico (131,166 were reported as living in Arizona]
- Ramah Navajo Indian Reservation: 2,167
- Zuni Indian Reservation: 7,758

### 3.5.10.2 Income

Income information from 2000 U.S. Census data including labor force, income, and poverty levels for the affected environment is collected at the state and county levels. Data collected from a state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than 48 km [30 mi]} for income opportunities or may be a workforce needed to fulfill specialized positions (if a local workforce is unavailable or unspecialized). Data collected from a county level is generally the same affected environment discussed previously in Table 3.5-15 and also includes information on Native American communities in the Northwestern New Mexico Uranium Milling Region. State-level information is provided in Table 3.5-17, and county data is listed in Table 3.5-18.

For the region surrounding the Northwestern New Mexico Uranium Milling Region, the state with the largest labor force population is Arizona. The community with the largest labor force is Albuquerque, New Mexico {144 km [90 mi] from the nearest potential ISL facility}, and the smallest community labor force is Grants, New Mexico {8 km [5 mi] from the nearest potential ISL facility}. The community with the highest per capita income is Santa Fe, New Mexico {96 km [60 mi] from the nearest potential ISL facility} and the lowest per capita income population is Silver City, New Mexico {161 km [100 mi] from the nearest potential ISL facility}. Outside of tribal lands, the community with the highest percentage of individuals and families below poverty levels is Grants, New Mexico.

The county with the largest labor force population in the Northwestern New Mexico Uranium Milling Region is Sandoval County, and the county with the smallest labor force population is Cibola County. The county with the highest per capita income is Sandoval County, and the lowest per capita income county is McKinley County. The county with the highest percentage of individuals and families below the poverty level is McKinley County (Table 3.5-18).

### 3.5.10.3 Housing

Housing information from the 2000 U.S. Census data is provided in Table 3.5-19.

The availability of housing within the immediate vicinity of the proposed ISL facilities is somewhat limited. The majority of housing is available in larger populated areas such as Gallup

| Table 3.5-17. U.S. Bureau of Census State Income Information for the Northwestern New Mexico Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 years and over)** | **Median Household Income In 1999** | **Median Family Income In 1999** | **Per Capita Income In 1999** | **Families Below Poverty Level In 2000** | **Individuals Below Poverty Level In 2000** |
| Arizona | 2,387,139 | $40,558 | $46,723 | $20,275 | 128,318 | 698,669 |
| New Mexico | 834,632 | $34,133 | $39,425 | $17,261 | 68,178 | 328,933 |
| Albuquerque, New Mexico | 232,320 | $38,272 | $46,979 | $20,884 | 11,285 | 59,641 |
| *Percent of total†* | 66.2% | NA‡ | NA | NA | 10.0% | 13.5% |
| Farmington, New Mexico | 18,204 | $37,663 | $42,605 | $18,167 | 1,328 | 5,910 |
| *Percent of total* | 65.0% | NA | NA | NA | 12.9% | 16.0% |
| Flagstaff, Arizona | 30,822 | $37,146 | $48,427 | $18,637 | 1,255 | 8,751 |
| *Percent of total* | 73.7% | NA | NA | NA | 10.6% | 17.4% |
| Gallup, New Mexico | 8,941 | $34,868 | $39,197 | $15,789 | 804 | 4,079 |
| *Percent of total* | 61.9% | NA | NA | NA | 16.6% | 20.8% |
| Grants, New Mexico | 3,801 | $30,652 | $33,464 | $14,053 | 446 | 1,810 |
| *Percent of total* | 58.3% | NA | NA | NA | 19.4% | 21.9% |
| Rio Rancho, New Mexico | 25,964 | $47,169 | $52,233 | $20,322 | 521 | 2,619 |
| *Percent of total* | 67.9% | NA | NA | NA | 3.7% | 5.1% |

| Table 3.5-17. U.S. Bureau of Census State Income Information for the Northwestern New Mexico Uranium Milling Region* (continued) | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **2000 Labor Force Population (16 years and over)** | **Median Household Income in 1999** | **Median Family Income in 1999** | **Per Capita Income in 1999** | **Families Below Poverty Level in 2000** | **Individuals Below Poverty Level in 2000** |
| Santa Fe, New Mexico | 34,033 | $40,392 | $49,705 | $25,454 | 1,425 | 7,439 |
| *Percent of total* | 66.8% | NA | NA | NA | 9.5% | 12.3% |
| Silver City, New Mexico | 4,249 | $25,881 | $31,374 | $13,813 | 483 | 2,237 |
| *Percent of total* | 52.5% | NA | NA | NA | 17.7% | 21.9% |

*Source: U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007, 25 February 2008, and 15 April 2008).
†Percent of total based on a population of 16 years and over.
‡NA—not applicable.

**Table 3.5-18. U.S. Bureau of Census County Income Information for the Northwestern New Mexico Uranium Milling Region***

| Affected Environment | 2000 Labor Force Population (16 years and over) | Median Household Income In 1999 | Median Family Income In 1999 | Per Capita Income In 1999 | Families Below Poverty Level In 2000 | Individuals Below Poverty Level In 2000 |
|---|---|---|---|---|---|---|
| Cibola County, New Mexico | 9,848 | $27,774 | $30,714 | $11,731 | 1,365 | 6,054 |
| *Percent of total* | 53.0% | NA | NA | NA | 21.5% | 24.8% |
| McKinley County, New Mexico | 26,498 | $25,005 | $26,806 | $9,872 | 5,303 | 26,664 |
| *Percent of total* | 53.4% | NA | NA | NA | 31.9% | 36.1% |
| Sandoval County, New Mexico | 41,599 | $44,949 | $48,984 | $19,174 | 2,130 | 10,847 |
| *Percent of total* | 63.0% | NA | NA | NA | 9.0% | 12.1% |

*Source: U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).
†Percent of total based on a population of 16 years and over.
‡NA—not applicable.

| Table 3.5-19. U.S. Bureau of Census Housing Information for the Northwestern New Mexico Uranium Milling Region* | | | | | | |
|---|---|---|---|---|---|---|
| **Affected Environment** | **Single Family Owner-Occupied Homes** | **Median Value in Dollars** | **Median Monthly Costs With a Mortgage** | **Median Monthly Costs Without a Mortgage** | **Occupied Housing Units** | **Renter-Occupied Units** |
| New Mexico | 339,888 | $108,100 | $929 | $228 | 677,971 | 200,908 |
| Cibola County | 3,742 | $62,600 | $654 | $179 | 8,327 | 1,873 |
| McKinley County | 10,235 | $57,000 | $841 | $140 | 21,476 | 5,840 |
| Sandoval County | 21,873 | $115,400 | $979 | $233 | 31,411 | 5,097 |
| Gallup | 2,922 | $97,000 | $933 | $4,245 | 6,807 | 2,682 |
| Grants | 1,634 | $64,700 | $697 | $210 | 3,160 | 1,024 |

* U.S. Census Bureau. "American FactFinder." <http://factfinder.census.gov/home/saff/main.html?_lang=en> (18 October 2007 and 25 February 2008).

{24 km [15 mi] to the nearest potential ISL facility}, Grants {8 km [5 mi] to nearest potential ISL facility}, Albuquerque {144 km [90 mi] to the nearest potential ISL facility}, and Rio Rancho {161 km [100 mi] to the nearest potential ISL facility}. There are approximately 20 housing units, including manufactured housing parks or residential neighborhoods in this region (MapQuest, 2008).

Temporary housing such as apartments, lodging, and trailer camps within the immediate vicinity of the Grants Uranium District ISL facilities is not as limited. The majority of apartments is available in larger populated areas such as Gallup, Grants, Belen, Los Lunas, and Albuquerque with approximately 75 apartment complexes (MapQuest, 2008). There are 19 hotels/motels along major highways or towns near the ISL facilities. In addition to apartments and lodging, there are three trailer camps also located near potential ISL facilities (along major roads or near towns) (MapQuest, 2008).

### 3.5.10.4 Employment Structure

Employment structure from the 2000 U.S. Census data including employment rate and type is based on data collected at the state and county levels. Data collected at the state level also include information on towns, CBSAs, or Metropolitan Areas and consider an outside workforce. An outside workforce may be a workforce willing to commute long distances {greater than [48 km [30 mi]} for employment opportunities or may be a workforce needed to fulfill specialized positions (if local workforce is unavailable or unspecialized). Data collected from a county level are generally the same affected environment previously discussed in Table 3.5-15 and also include information on Native American communities.

Based on review of state information, the state in the vicinity of the Northwestern New Mexico Uranium Milling Region with the highest percentage of employment is Arizona.

The county with the highest percentage of employment is Sandoval County, and the county with the highest unemployment rate is McKinley County. Native American communities (Navajo Nation, Zuni, and Laguna Reservations) report unemployment rates of 60 percent or more, much greater than the state unemployment levels of 3.4 percent (Arizona) to 4.4 percent (New Mexico) Table 3.5-20.

#### 3.5.10.4.1 State Data

##### 3.5.10.4.1.1 Arizona

The state of Arizona has an employment rate of 57.2 percent and unemployment rate of 3.4 percent. The largest sector of employment is management, professional, and related occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

<u>Flagstaff</u>

Flagstaff has an employment rate of 69.8 percent and an unemployment rate slightly higher than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 30.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.5.10.4.1.2 New Mexico

The State of New Mexico has an employment rate of 55.7 percent and unemployment rate of 4.4 percent. The largest sector of employment is management, professional, and related occupations. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Albuquerque

Albuquerque has an employment rate of 61.8 percent and an unemployment rate lower than that of the state at 3.8 percent. The largest sector of employment is management, professional, and related occupations at 38.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Gallup

Gallup has an employment rate of 57.1 percent and an unemployment rate slightly higher than that of the state at 4.8 percent. The largest sector of employment is management, professional, and related occupations at 38.9 percent. The largest type of industry is educational, health, and social services at 31.5 percent. The largest class of worker is private wage and salary workers at 65.2 percent (U.S. Census Bureau, 2008).

Grants

Grants has an employment rate of 51.9 percent and an unemployment rate higher than that of the state at 6.2 percent. The largest sector of employment is management, professional, and related occupations at 30.0 percent. The largest type of industry is educational, health, and social services at 23.6 percent. The largest class of worker is private wage and salary workers at 61.3 percent (U.S. Census Bureau, 2008).

Farmington

Farmington has an employment rate of 60.4 percent and an unemployment rate slightly higher than that of the state at 4.5 percent. The largest sector of employment is management, professional, and related occupations at 30.2 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Rio Rancho

Rio Rancho has an employment rate of 64.3 percent and an unemployment rate slightly higher than that of the state at 3.2 percent. The largest sector of employment is management, professional, and related occupations at 34.5 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

Santa Fe

Santa Fe has an employment rate of 63.7 percent and an unemployment rate much lower than that of the state at 3.0 percent. The largest sector of employment is management, professional, and related occupations at 43.0 percent. The largest type of industry is educational, health, and social services. The largest class of worker is private wage and salary workers (U.S. Census Bureau, 2008).

3.5.10.4.2 County Data

Cibola County, New Mexico

Cibola County has an employment rate of 46.8 percent and an unemployment rate relatively higher than that of the state at 6.1 percent. The largest sector of employment is management, professional, and related occupations at 29.6 percent. The largest type of industry is educational, health, and social services at 27.4 percent. The largest class of worker is private wage and salary workers at 58.4 percent (U.S. Census Bureau, 2008).

McKinley County, New Mexico

McKinley County has an employment rate of 44.2 percent and an unemployment rate relatively higher than that of the state at 9.2 percent. The largest sector of employment is management, professional, and related occupations at 32.4 percent. The largest type of industry is educational, health, and social services at 32.4 percent. The largest class of worker is private wage and salary workers at 55.9 percent (U.S. Census Bureau, 2008).

Sandoval County, New Mexico

Sandoval County has an employment rate of 58.8 percent and an unemployment rate lower than that of the state at 3.9 percent. The largest sector of employment is management, professional, and related occupations at 36.0 percent. The largest type of industry is educational, health, and social services at 17.4 percent. The largest class of worker is private wage and salary workers at 73.6 percent (U.S. Census Bureau, 2008).

Native American Communities

Information on labor force and poverty levels for the affected Native American communities within the Northwestern New Mexico Uranium Milling Region is based on 2003 Bureau of Indian Affairs data and is provided in Table 3.5-20 (U.S. Department of the Interior, 2003).

### 3.5.10.5 Local Finance

Local finance such as revenue and tax information for the affected environment is provided next and in Tables 3.5-21 to 3.5-23.

New Mexico

Sources of revenue for the State of New Mexico come from income, mineral extraction, and property taxes. Personal income tax rates for New Mexico range from 1.7 percent to 5.3 percent. New Mexico does not have a sales tax and instead has a 5 percent gross receipts tax. Combined gross receipts tax rates throughout the state range from 5.125 to 7.8125 percent. Net taxable values for affected counties in New Mexico are presented in Table 3.5-21 (New Mexico Taxation and Revenue Department, 2008).

| Table 3.5-20. Employment Structure of Native American Communities Within the Affected Environment of the Northwestern New Mexico Uranium Milling Region* | | | | |
|---|---|---|---|---|
| Affected Areas | 2003 Labor Force Population | Unemployed as Percent of Labor Force | Employed Below Poverty Guidelines | |
| Acoma Indian Reservation | NR† | NR | NR | NR |
| Canoncito Indian Reservation | NA‡ | NA | NA | NA |
| Laguna Indian Reservation | 828 | 81% | NR | NR |
| Navajo Nation Indian Reservation (Eastern Navajo Agency) | 2,664 | 74% | 62 | 2% |
| Ramah Navajo Indian Reservation | NR | NR | NR | NR |
| Zuni Indian Reservation | 1,591 | 64% | 110 | 7% |

* U.S. Department of the Interior. "Affairs American Indian Population and Labor Force Report 2003." <http://www.doi.gov/bia/labor.html>. Washington, DC: U.S. Department of the Interior, Bureau of Indian Affairs, Office of Tribal Affairs. 2003.
†NR—Not reported by tribes.
‡NA—not available.

| Table 3.5-21. Net Taxable Values for Affected Counties Within New Mexico for 2006* | | | |
|---|---|---|---|
| Affected Counties | Residential | Nonresidential | Total |
| Cibola County | $88,563,082 | $145,457,203 | $234,020,285 |
| McKinley County | $219,073,850 | $410,061,159 | $629,311,981 |
| Sandoval County | $1,631,727,293 | $449,148,142 | $6,755,265 |

*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department. (18 October 2007 and 25 February 2008).

| Table 3.5-22. Percent Change in Tax Values From 2005 to 2006 for the Affected Counties Within New Mexico* | | | |
|---|---|---|---|
| Affected Counties | Residential | Nonresidential | Total |
| Cibola County | 3.0 percent | 3.6 percent | 3.4 percent |
| McKinley County | 4.1 percent | 4.0 percent | 4.0 percent |
| Sandoval County | 18.8 percent | 8.7 percent | 16.5 percent |

*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department. (18 October 2007 and 25 February 2008).

| Table 3.5-23. Percent Distribution of New Mexico Property Tax Obligations Within Affected Counties for 2006* | | | | | |
|---|---|---|---|---|---|
| **Affected Counties** | **State** | **County** | **Municipal** | **School District** | **Other** |
| Cibola County | 4.4 percent | 34.4 percent | 9.8 percent | 34.4 percent | 17 percent |
| McKinley County | 3.9 percent | 32.3 percent | 10.9 percent | 31.6 percent | 21.1 percent |
| Sandoval County | 4.8 percent | 26.6 percent | 19.7 percent | 39.7 percent | 9.1 percent |

*New Mexico Taxation and Revenue Department. "2006 Property Tax Facts." <http://www.tax.state.nm.us/pubs/taxresstat.htm>. Santa Fe, New Mexico: New Mexico Taxation and Revenue Department (18 October 2007 and 25 February 2008).

Percentages and sources of revenue for 2006 were counties at 32.3 percent, municipalities at 14.3 percent, school districts at 30.0 percent, conservancy districts at 0.1 percent, state debt service at 4.8 percent, health facilities at 8.8 percent, and higher education at 9.7 percent. Total tax values for the affected counties within New Mexico follow. Percentage change in net taxable values from 2005 to 2006 for the affected counties is provided in Table 3.5-22 (New Mexico Taxation and Revenue Department, 2008).

New Mexico imposes ad valorem production and ad valorem production equipment taxes in lieu of property taxes on mineral extraction properties. Taxes are levied monthly on all owners and are imposed on products below the wellhead, such as oil and gas (New Mexico Taxation and Revenue Department, 2000.) Equipment is also levied against the operator of the property. In 2000, ad valorem production and production equipment taxes totaled approximately $43.4 million. Of this total, 83 percent came from the oil and gas production tax. How revenues are distributed in a particular county is determined by property tax rates imposed at the county level.

Percentage distribution of New Mexico property tax obligations for 2006 within the affected counties is listed in Table 3.5-23. Information on local finance for the CBSAs of Gallup and town of Grants is presented next.

Gallup

Sources of revenue for Gallup consist of gross receipts taxes, compensating taxes, corporate income taxes, franchise taxes, property taxes, severance taxes, and workers' compensation taxes. The largest tax revenues are gross receipts at a rate of 7.6 percent and property tax ranging from 4.7 percent to 7.4 percent. Revenue from gross receipts totaled $115,031,909 as of 2004 (City of Gallup Economic Development Center, 2007).

Grants

Sources of revenue for Grants consist of gross receipts taxes and property taxes (New Mexico Economic Development, 2008).

Native American Communities

The Acoma Indian Reservation's largest sources of revenue come from the Sky City Casino and big game hunting. Specific financial information including tax revenue is not available (Acoma New Mexico, 2007).

The Tohajiilee Indian Reservation receives revenue from local retail and gaming. Specific financial information including tax revenue is not available (Division of Economic Development of the Navajo Nation, 2006).

The Laguna Indian Reservation receives revenue from local retail and gaming. Specific financial information including tax revenue is not available (New Mexico Tourism Department, 2008).

The largest source of revenue for the Navajo Nation Indian Reservation comes from internal and external revenue. Internal revenue is referred to as General Fund revenues and consists of mining and taxes. Mining is the largest source of internal revenue. Taxes are the second largest sources of internal revenue and in 2005 accounted for $75.0 million (Division of Economic Development of the Navajo Nation, 2006). Taxes include business gross receipts. This tax could be levied on uranium production within the Navajo Reservation if production is determined to occur on the reservation (NRC, 1997). External sources of revenue consist of Federal, State, Private and other funds, and are mostly in the form of grants (Division of Economic Development of the Navajo Nation, 2006).

The Ramah Navajo Indian Reservation is one of 110 chapters that make up the larger Navajo Nation. The Ramah Navajo take no assistance from the Navajo Nation. The majority of revenue comes from federal funding because this group does not have a single, sustainable economic development program that generates significant income (Ramah Navajo Chapter, 2003).

The majority of revenue for the Zuni Indian Reservation comes from federal grants, such as the Community Services Block Grant. Other sources of income include local taxes such as sales tax from gross receipts (Pueblo of Zuni, 2008).

### 3.5.10.6 Education

Based on review of the affected environment, the county with the largest number of schools is McKinley County and the county with the smallest number of schools is Cibola County. The town/CBSA with the largest number of schools is Gallup, and the town/ CBSA with the smallest number of schools is Grants. The Native American community with the largest number of schools is the Navajo Nation, and the Native American community with the smallest number of schools is the Tohajiilee Indian Reservation.

Grants

Grants has 2 elementary schools, 1 middle school, 1 high school, 3 private academies, and 1 public school, with a total of approximately 2,414 students (Localschooldirectory.com, 2008).

Gallup

Gallup has 33 public schools and 2 parochial schools, with a total of approximately 8,013 students. (City of Gallup Economic Development Center, 2007).

Cibola County

Public education in Cibola County is operated by Grants/Cibola County Schools, which is based in Grants, New Mexico. There are 7 elementary schools, 1 middle school, 1 middle-high school, and 1 high school, with a total of approximately 3,698 students. The majority of schools provide bus services (Grants-Cibola County Schools, 2007).

McKinley County

Public education in the McKinley County education system is operated by the Gallup-McKinley County School District, which serves students from Gallup and surrounding areas of McKinley County. There are 36 public and private elementary, middle, and high schools within the county, with a total of approximately 13,840 students. The majority of schools provides bus services (Greatschools, 2007).

Sandoval County

Sandoval County has a total of 11 elementary schools, 6 middle schools, and 5 high schools, with a total of approximately 8,580 students. The majority of schools provides bus services (Publicschoolreview.com, 2008).

Native American Communities

The Acoma Indian Reservation has the Sky City Community School located at Acoma Pueblo. The total number of students is approximately 275. Information as to whether this school provides bus services is not available (Public Schools Report, 2007).

The Tohajiilee Indian Reservation has one school that is located within the Tohajiilee Indian Reservation. Specific information pertaining to school population or bus services is not available (Tohajiilee Chapter, 2008).

The Laguna Indian Reservation has one elementary school, one middle school, one high school, and one academy. Specific information pertaining to school population or bus services is not available (Lat-Long.com, 2008).

The Navajo Nation Indian Reservation has over 150 public, private, and Bureau of Indian Affairs schools serving students from kindergarten through high school. There are over 10,000 students. Information as to whether these schools provide bus services is not available (Division of Economic Development of the Navajo Nation, 2008).

The Ramah Navajo Indian Reservation school system is operated by the Ramah Navajo School Board and the Ramah Navajo Chapter. It has an Indian-controlled contract school located in Pine Hill, New Mexico. It accommodates almost 600 students from elementary through $12^{th}$ grade. Information as to whether this school provides bus services is not available (Ramah Navajo Chapter, 2003).

The Zuni Indian Reservation has 2 elementary schools, 1 middle school, and 2 high schools, with a total of approximately 2,000 students. Information as to whether these schools provide bus services is not available (Zuni Pueblo Public School District, 2008).

#### 3.5.10.7 Health and Social Services

Health Care Facilities

The majority of health care facilities is located within populated areas of the affected environment. The closest health care facilities within the vicinity of the ISL facilities are located in Gallup, Zuni, Rio Rancho, and Albuquerque and total approximately 50 facilities (MapQuest, 2008). These consist of hospitals, clinics, emergency centers, and medical services. There are 13 hospitals located within or proximate of this region: Gallup (1), Zuni (1), Rio Rancho (1), and Albuquerque (greater than10).

Local Emergency

Local police within the affected environment are within the jurisdiction of each county. There are 12 police, sheriff, or marshal's offices within the region: Cibola County (3), McKinley County (3), and Sandoval County (6) (Usacops, 2008).

Fire departments within the affected area are comprised at the town, CBSA, or city level. There are 24 fire departments within the milling region: Grants (4), Gallup (13), and Albuquerque (7) (50states, 2008).

### 3.5.11 Public and Occupational Health

#### 3.5.11.1 Background Radiological Conditions

For a U.S. resident, the average total effective dose equivalent from natural background radiation sources is approximately 3 mSv/yr [300 mrem/yr] but varies by location and elevation (National Council of Radiation Protection and Measurements, 1987). In addition, the average American receives 0.6 mSv/yr [60 mrem/yr] from man-made sources including medical diagnostic tests and consumer products (National Council of Radiation Protection and Measurements, 1987). Therefore, the total from natural background and man-made sources for the average U.S. resident is 3.6 mSv/yr [360 mrem/yr]. For a breakdown of the sources of this radiation, see Figure 3.2-22.

Background dose varies by location primarily because of elevation changes and variations in the dose from radon. As elevation increases so does the dose from cosmic radiation and hence the total dose. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. The amount of radon in the soil/bedrock depends on the type, porosity, and moisture content. Areas that have types of soils/bedrock like granite and limestone have higher radon levels that those with other types of soils/bedrock (EPA, 2006).

The total effective dose equivalent is the total dose from external sources and internal material released from licensed operations. Doses from sources in the general environment (such as terrestrial radiation, cosmic radiation, and naturally occurring radon) are not included in the dose calculation for compliance with 10 CFR Part 20, even if these sources are from technologically enhanced naturally occurring radioactive material, such as preexisting radioactive residues from prior mining (Atomic Safety and Licensing Board, 2006).

For the Northwestern New Mexico Uranium Milling Region, the average background rate including natural and man-made sources for the state of New Mexico is used, which is 3.15 mSv/yr [315 mrem/yr] (EPA, 2006). This average background rate in New Mexico is lower than the U.S. average rate of 3.6 mSv/yr [360 mrem/yr] primarily because average annual radon dose is less for New Mexico {1.32 mSv/yr [132 mrem/yr] versus the national average of 2 mSv/yr [200 mrem/yr]}. The background contribution from cosmic radiation is slightly higher for New Mexico versus the U.S. average {0.47 mSv/yr [47 mrem/yr] versus the national average of 0.27 mSv/yr [27 mrem/yr]}. The remaining contributors to background dose (terrestrial radiation, internal radiation, and man-made) are similar for New Mexico {1.36 mSv [136 mrem/yr]} and the U.S. average {1.33 mSv/yr [133 mrem/yr]}. The combination of these differences results in a decrease from the national average of about 0.45 mSv [45 mrem/yr].

#### 3.5.11.2 Public Health and Safety

Public health and safety standards are the same regardless of a facility's location. Therefore, see Section 3.2.11.2 for further discussion of these public health and safety standards.

#### 3.5.11.3 Occupational Health and Safety

Occupational health and safety standards are the same regardless of facility's location. Therefore, see Section 3.2.11.3 for further discussion of these occupational health and safety standards.

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