3.0 Affected Environment

3.1 Uses of Adjacent Lands

The information in this section provides data relevant to describe the major land uses nears Proposed Action Area (PAA).

The PAA straddles the western county border between Custer and Fall River, South Dakota. Land within the PAA is predominantly privately owned (97.5 percent) and the remaining 2.5 percent is managed by the Bureau of Land Management (BLM). Plate 3.1-1 shows the surface use agreements in the vicinity of the PAA.

3.1.1 Land Use

Land use within the proposed project boundary primarily consists of agriculture related to grazing, as well as hunting and historical mining. A 2.0-kilometer review area is not available for the PAA because the four counties in the study area do not utilize zoning or land use plans outside of urban areas. There is no commercial crop production within the permit area, although approximately 388.79 acres of land are irrigated in Sec. 32, T 6S, R. 1E along Beaver Creek. The majority of agricultural production is related to grazing. Most land serves as grazing land for cattle that are sold as food, as well as a small number of horses.

According to the United States Department of Agriculture's (USDA) 2002 census, Custer County generated $11,536,000 and Fall River County generated $49,003,000 from the sale of livestock, poultry and their products. The results from the 2007 Census will not be available until February 4, 2009. According to the National Agriculture Statistics Service, in 2008 (USDA, 2008) the two counties had a combined total 78,000 head of cattle (No data was available for poultry, pig, or sheep inventories). Table 3.1-1 shows the 2008 livestock inventory for Custer and Fall River Counties.

Table 3.1-1: 2008 Livestock Inventory for Custer and Fall River Counties

Type of Livestock	Number Custer County	Number Fall River County	Percent of Total (Custer and Fall River combined)
Beef Cows	17,000	45,000	22/58%
All Cattle and Calves – excluding Beef Cows	1,000	15,000	1/19%
Sheep and Lamb	N/A	N/A	N/A
Hogs and Pigs	N/A	N/A	N/A
Total Animals	18,000	60,000	100%

Source: USDA 2008.

Recreation lands are present in Custer, Fall River and Pennington counties within a 50-mile radius of the PAA (Table 3.1-2). Major attractions include Mount Rushmore National Memorial and Wind Cave National Park which are set in the backdrop of the Black Hill National Forest. Within the PAA or within the surrounding 2.0 kilometers there are no recreation lands present because most of the land is private with a small portion (240 acres) belonging to the BLM.

Recreational use within the PAA is limited primarily to large game hunting. Within the PAA, hunting is currently open to the public on approximately 5,689 acres. Approximately 240 acres are owned by the Bureau of Land Management (BLM); the South Dakota Game Fish and Parks (SDGFP) lease around 3,069 acres annually of privately owned land and currently designate this acreage as walk-in hunting areas.

Table 3.1-2: Recreational Areas within 50 Miles of the PAA

Name of Recreational Facility	Managing Agency	Distance From PAA (miles)
Mount Rushmore National Memorial	U.S. Department of the Interior	44.0
Jewel Cave National Monument	U.S. Department of the Interior	23.0
Buffalo Gap National Grassland	U.S. Forest Service	3.0
Custer State Park	South Dakota Department of Game, Fish and Parks	35.0
Wind Cave National Park	U.S. Department of the Interior	29.0
Black Hills National Forest	U.S. Forest Service	0.25
Angostura State Recreation Area	South Dakota Department of Game, Fish and Parks	29.0
George S. Mickelson Trail	South Dakota Department of Game, Fish and Parks	17.0

Source: Google Earth (20 June, 2008)

Table 3.1-3 lists the distance to the nearest resident from the PAA according to 22.5-degree sectors centered on the 16 cardinal compass points. The nearest resident is 0.9 miles to the west south-west of the PAA.

Table 3.1-3: Distance to Nearest Resident from the Center of the Proposed Project

Sector	Distance from Project Center	
	Miles	Km
N	7.2	11.6
NNE	8.3	13.3
NE	6.7	10.8
ENE	13.1	21.1
E	6.8	11.0
ESE	10.7	17.3
SE	7.5	12.1
SSE	5.9	9.4
S	0.9	1.4
SSW	3.4	5.5
SW	21.0	33.7
WSW	1.7	2.7
W	20.3	32.6
WNW	6.2	10.0
NW	3.5	5.6
NNW	4.2	6.7

Data from US Census Bureau, 2000 Census

3.1.1.1 Aesthetics

The PAA is located within the Great Plains physiographic province on the edge of the Black Hills Uplift. The vegetation is a mix of short grasses and shrubs typical of semi-arid steppe land along with Ponderosa Pine forest toward the Black Hills. The color of the landscape varies from light brown and green to dark green with wildflowers in the springtime to light brown to golden during the later drier months. The human influence on the area is minor with most of the area being used for grazing activities and associated facilities (e.g., fences and stock wells). The area's infrastructure includes the Burlington Northern Rail Road (BNRR) that runs north through Edgemont towards Newcastle, Country Road 6463 that parallels the BNRR to the town of Dewey and overhead electricity lines and several gravel access roads.

3.1.1.2 Transportation and Utilities

The PAA generally will be accessed north from Edgemont along County Road 9. To the east U.S. Highway 18 connects Edgemont with Hot Springs and to the north State Highway 89 connects Edgemont with Custer City. Annual Average Daily Traffic (AADT) counts on U.S. Highway 18 between Edgemont and the junction with State Highway 89 is 2,000 vehicles (SDDOT 2007). The AADT count on State Highway 89 between Custer City and the junction with U.S Highway 18 is 515 vehicles (SDDOT 2007).

3.1.1.3 Fuel Cycle Facilities

The NRC provides a list of all of the source material facilities operating in the United States which include uranium mills and fuel cycle facilities. According to the NRC website there are no fuel cycle facilities within 50 miles of the PAA. The closest fuel cycle facility is the AREVA NP, Inc. uranium fuel fabrication in Richland, Washington. Also in Eunice, New Mexico the Louisiana Energy Services fuel cycle facility is currently under construction (NRC, 2008).

There are no Resource Material Licenses for in situ uranium projects within 50 miles of the PAA. The nearest operational in situ facility is the Crow Butte ISL facility, SUA-1534, in Darrow County, near Crawford, Nebraska (NRC, 2008).

3.2 Transportation

3.2.1 Highways

The main highway that will be used to access the proposed project site is U.S. Highway 18, which connects Edgemont with Hot Springs, and highways U.S. 385 and S.D. 79 to the east, which connect to U.S. Highway 85 to the west of the PAA in the State of Wyoming.

3.2.2 Railroads

The Burlington Northern Santa Fe Railroad (BNSF) runs through the proposed PAA in a northwest-southeast direction. The BNSF is used for shipping coal from mining operations in the Powder River Basin of Wyoming and Montana. It is also used to transport many other agricultural, consumer, and industrial products. Powertech (USA) does not anticipate using the BNSF as a transportation option for any of the proposed project operations.

3.3 Geology, Soils, and Seismology

Proposed action is located in the Great Plains Physiographic province on the southwestern flank of the Black Hills uplift in southwestern South Dakota. To the west of the PAA is the Powder River Basin of Wyoming. The regional geologic map of this region is shown in Figure 3.3-1.

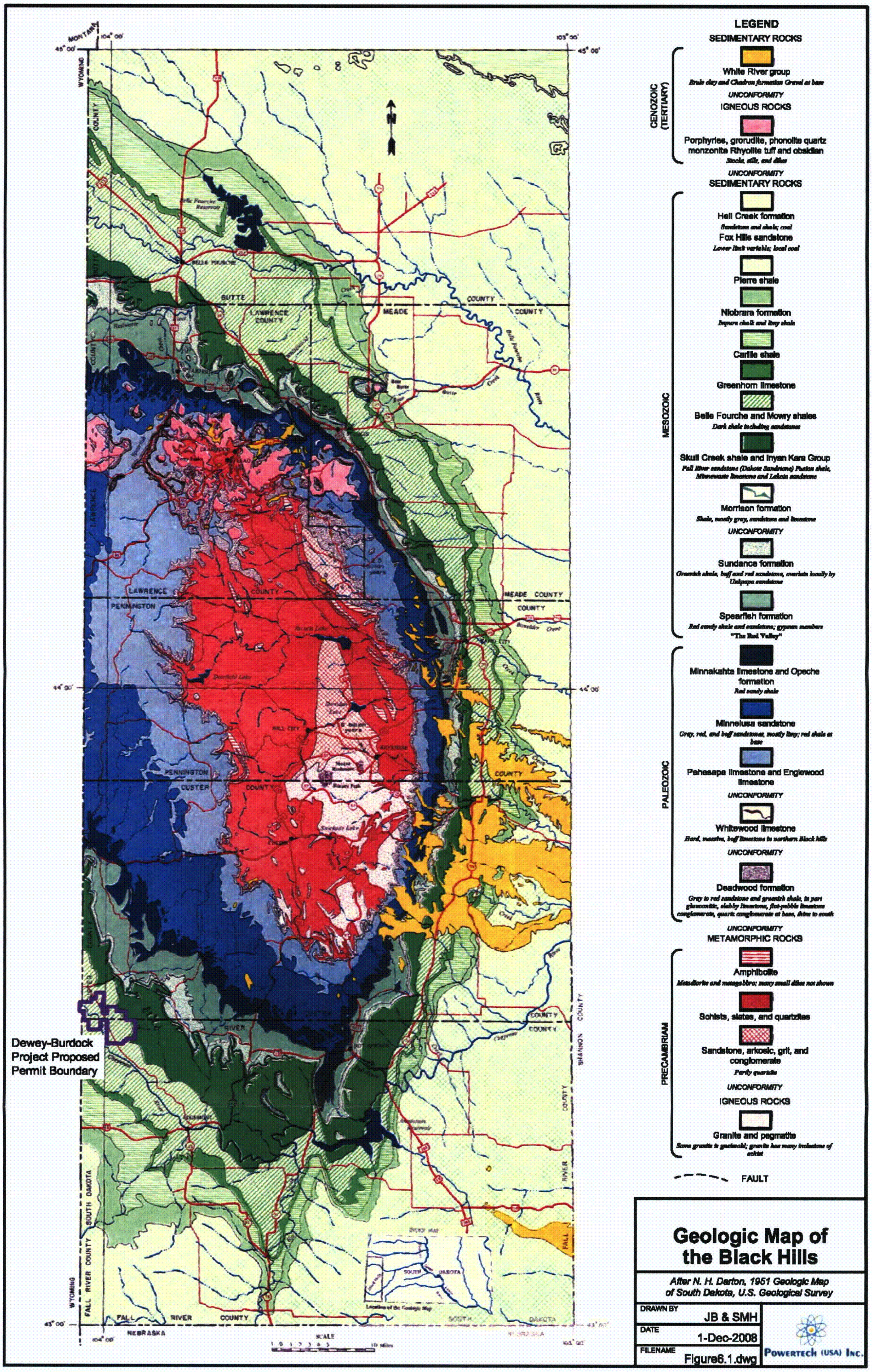

Figure 3.3-1: Geologic Map of the Black Hills

3.3.1.1 Regional Structure

The dominant structural feature in this region is the Black Hills Uplift. This uplift is of Laramide age (65 million years ago) and is an elongate northwest trending dome about 125 miles long and 60 miles wide. Igneous and metamorphic Precambrian-age rocks are exposed in the core of the uplift and are surrounded by outward-dipping Paleozoic and Mesozoic rocks that form cuestas and hogbacks around the core of the uplift. Folds constitute the major structural features in the Black Hills. In early Cretaceous time minor deformation along concealed northeast trending structures of Precambrian age affected the courses of the northwest flowing streams and their tributaries, thereby influencing the location of the fluvial sandstone deposits of the Inyan Kara Group.

3.3.1.2 Regional Stratigraphy

The oldest rocks in the region are Precambrian metamorphic rocks and granites. These form the core of the Black Hills Uplift and are exposed at the surfaced of this structural feature. Overlying these crystalline rocks are 2000-3000 feet of Paleozoic sediments. This sedimentary sequence contains several regional aquifers, to include the Deadwood Formation of Cambrian age, the Mississippian Madison Limestone and the Pennsylvanian/Permian-age Minnelusa Formation. See Figure 3.3-2 for a stratigraphic column of the Black Hills.

ERATHEM	SYSTEM	ABBREVIATION FOR STRATIGRAPHIC INTERVAL	STRATIGRAPHIC UNIT	THICKNESS IN FEET	DESCRIPTION
CENOZOIC	QUATERNARY & TERTIARY (?)	QTac	UNDIFFERENTIATED ALLUVIUM AND COLLUVIUM	0-50	Sand, gravel, boulder, and clay.
		Tw	WHITE RIVER GROUP	0-300	Light colored clays with sandstone channel fillings and local limestone lenses.
	TERTIARY	Tui	INTRUSIVE IGNEOUS ROCKS	--	Includes rhyolite, latite, trachyte, and phonolite
MESOZOIC	CRETACEOUS	Kps	PIERRE SHALE	1,200-2,700	Principal horizon of limestone lenses giving teepee buttes. Dark-gray shale containing scattered concretions. Widely scattered limestone masses, giving small teepee buttes. Black fissile shale with concretions.
			NIOBRARA FORMATION	[1]80-300	Impure chalk and calcareous shale.
			CARLILE SHALE: Turner Sandy Member; Wall Creek Member	[1]350-750	Light-gray shale with numerous large concretions and sandy layers. Dark-gray shale
			GREENHORN FORMATION	225-380	Impure slabby limestone. Weathers buff. Dark-gray calcareous shale, with thin Orman Lake limestone at base.
			GRANEROS GROUP: BELLE FOURCHE SHALE	150-850	Gray shale with scattered limestone concretions. Clay spur bentonite at base.
			GRANEROS GROUP: MOWRY SHALE	125-230	Light-gray siliceous shale. Fish scales and thin layers of bentonite.
			GRANEROS GROUP: MUDDY SANDSTONE / NEWCASTLE SANDSTONE	0-150	Brown to light-yellow and white sandstone.
			GRANEROS GROUP: SKULL CREEK SHALE	150-270	Dark-gray to black siliceous shale.
		Kik	INYAN KARA GROUP: FALL RIVER FORMATION	10-200	Massive to thin-bedded, brown to reddish-brown sandstone.
			INYAN KARA GROUP: LAKOTA FM: Fuson Shale; Minnewaste Limestone; Chilson Member	10-190; 0-25; 25-485	Yellow, brown, and reddish brown massive to thinly bedded sandstone, pebble conglomerate, siltstone, and claystone. Local fine-grained limestone and coal.
	JURASSIC	Ju	MORRISON FORMATION	0-220	Green to maroon shale. Thin sandstone.
			UNKPAPA SS	0-225	Massive fine-grained sandstone.
			SUNDANCE FORMATION: Redwater Member; Lak Member; Hulett Member; Stockade Beaver Mem.; Canyon Spr Member	250-450	Greenish-gray shale, thin limestone lenses. Glauconitic sandstone; red sandstone near middle.
			GYPSUM SPRING FORMATION	0-45	Red siltstone, gypsum, and limestone.
	TRIASSIC	TRPs	SPEARFISH FORMATION: Goose Egg Equivalent	375-800	Red silty shale, soft red sandstone and siltstone with gypsum and thin limestone layers. Gypsum locally near the base.
PALEOZOIC	PERMIAN	Pmk	MINNEKAHTA LIMESTONE	[1]25-65	Thin to medium-bedded, fine-grained, purplish gray laminated limestone.
		Po	OPECHE SHALE	[1]25-150	Red shale and sandstone.
	PERMIAN / PENNSYLVANIAN	PIPm	MINNELUSA FORMATION	[1]375-1,175	Yellow to red cross-bedded sandstone, limestone, and anhydrite locally at top. Interbedded sandstone, limestone, dolomite, shale, and anhydrite. Red shale with interbedded limestone and sandstone at base.
	MISSISSIPPIAN	MDme	MADISON (PAHASAPA) LIMESTONE	[1]<200-1,000	Massive light-colored limestone. Dolomite in part. Cavernous in upper part.
	DEVONIAN		ENGLEWOOD FORMATION	30-60	Pink to buff limestone. Shale locally at base.
	ORDOVICIAN	Ou	WHITEWOOD (RED RIVER) FORMATION	[1]0-235	Buff dolomite and limestone.
			WINNIPEG FORMATION	[1]0-150	Green shale with siltstone.
	CAMBRIAN	O€d	DEADWOOD FORMATION	[1]0-500	Massive to thin-bedded buff to purple sandstone. Greenish glauconitic shale flaggy dolomite and flat-pebble limestone conglomerate. Sandstone, with conglomerate locally at the base.
PRECAMBRIAN		p€u	UNDIFFERENTIATED IGNEOUS AND METAMORPHIC ROCKS		Schist, slate, quartzite, and arkosic grit. Intruded by diorite, metamorphosed to amphibolite, and by granite and pegmatite.

†Modified based on drill-hole data

STRATIGRAPHIC COLUMN OF THE BLACK HILLS AREA
(from Driscoll et al.)

DEWEY-BURDOCK PROJECT

DRAWN	L. Tafoya
DATE	12-Nov-2008
SCALE	NONE
FILENAME	Figure 6.7.dwg

POWERTECH (USA) INC.

Figure 3.3-2: Stratigraphic Column of the Black Hills Area

Mesozoic sediments include the Triassic age Spearfish Formation and the Sundance, Unkpapa and Morrison Formations of Jurassic age. The Sundance Formation is a minor aquifer in the southern Black Hills region. A thick sequence of Cretaceous age sediments completes the Mesozoic section.

The Early Cretaceous sediments of the Inyan Kara Group consist of the Lakota Formation and the Fall River Formation and is a transitional unit, exhibiting a change from terrestrial to marine deposition. The basal Lakota Formation (Chilson Member) is a fluvial sequence, which grades upward into marginal marine sediments as the Cretaceous Seaway inundated a stable land surface. Basal units of the Lakota Formation scour into clays of the underlying Morrison Formation and display the depositional nature of a large braided stream system, crossing a broad, flat coastal plain and flowing toward the northwest. Younger fluvial sand units of the Lakota become progressively thinner and less continuous and are separated by thin deposits of overbank and flood plain silts and clays. At the top of the Lakota is the Fuson Member. The Fuson consists of shale with minor beds of fine grained sandstone and siltstone. The Fuson separates the underlying Lakota Formation from the overlying Fall River Formation. The Fall River consists of thick, widespread fluvial sands in the lower portion, grading to thinner, less continuous, marginal sands in the upper part. The Cretaceous Lakota and Fall River Formations are the hosts of the roll front uranium mineralization in the Black Hills region.

Following deposition of the Fall River, this region was covered by the North American Cretaceous Seaway, which resulted in the accumulation of vast thicknesses of marine sediments. From 3000-5000 feet of these marine sediments are represented by the Skull Creek Shale, Newcastle Sandstone, Mowry Shale, Belle Fourche Shale, Greenhorn Formation, Carlisle Shale, Niobrara Formation and Pierre Shale. In Late Cretaceous time, the modern Rocky Mountain Uplift began, forcing the retreat of the Cretaceous seaway.

Unconformably overlying the Cretaceous sediments in the Black Hills region is the Tertiary-age (Oligocene) tuffaceous White River Formation. This thick, tuffaceous sequence was the result of volcanic eruptions to the west and was rich in volcanic fragments. The White River sediments have primarily been removed by erosion and can be found only as erosional remnants. This unit is thought to be the source of the uranium deposits found in the Black Hills region and the Powder River Basin of Wyoming.

The most recent sediments in the region are Quaternary-age deposits consisting of local material derived as a result of post-Laramide-uplift erosion. Recent deposits include alluvium and floodplain terrace deposits.

3.3.2 PAA Geology

The PAA geology is shown in Figure 3.3-3. The Fall River Formation outcrops across the eastern part of the PAA and the Skull Creek Shale and Mowry Shale outcrops across the western part of the PAA. The formations dip west and southwest at 2 to 6 degrees.

The geology of the Proposed Action was developed through the interpretation of data gathered from thousands of exploration drill holes. For each drill hole there was a suite of down-hole electric logs run to characterize natural radioactivity and the lithology (rock type) of the sediments in the subsurface. Resistivity and Self Potential provide the rock types encountered in the subsurface (sandstone, siltstone, shale, etc.). This is further enhanced by a geologist's description of the drill cuttings. Plate 3.3-1 is an example of a "type log" from PAA.

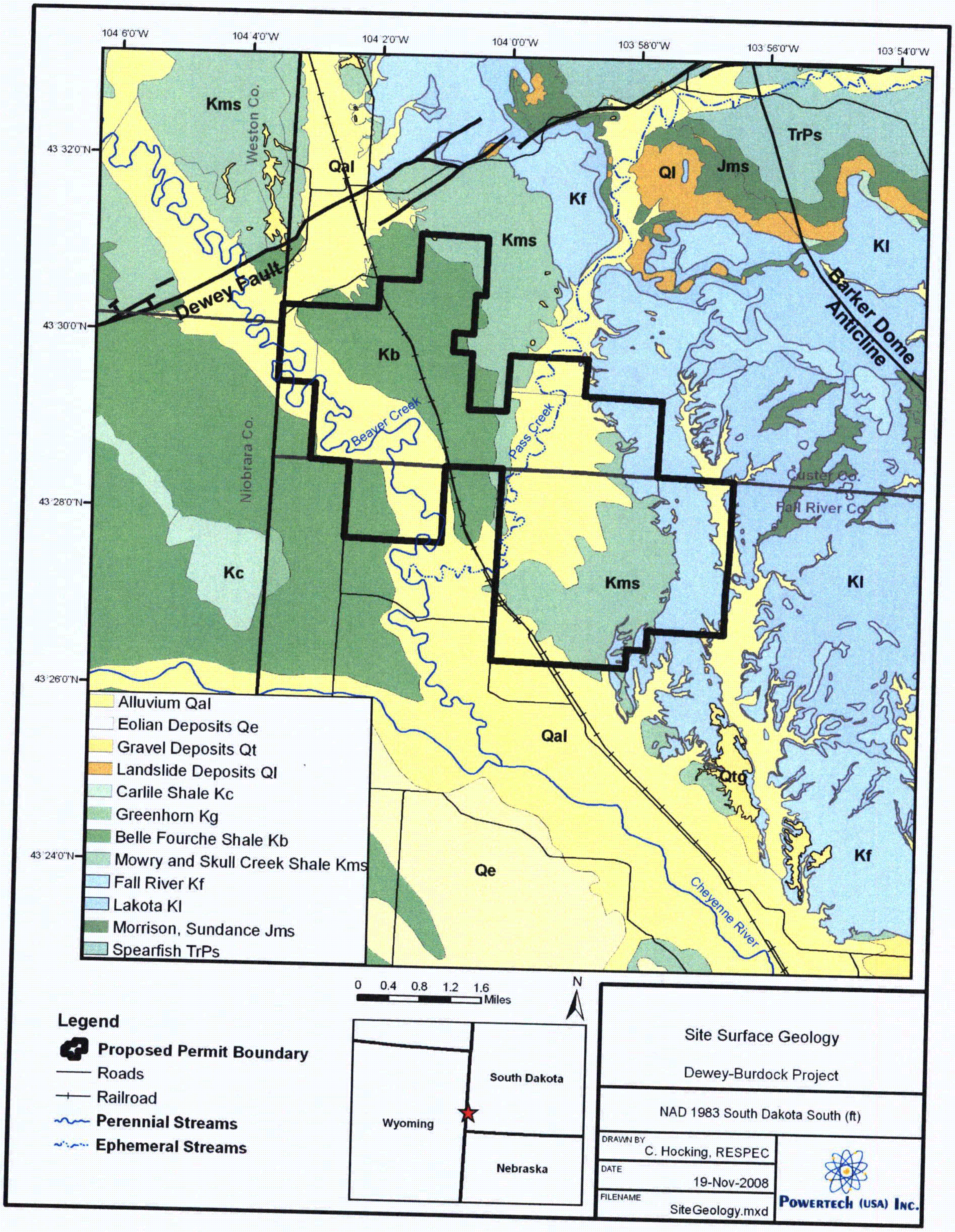

Figure 3.3-3: Site Surface Geology

3.3.2.1 Site Structure

The structure across the PAA is simple and shows sediments dipping gently 2 to 6 degrees to the southwest. This is illustrated by a structure contour maps on the tops of the Fall River Formation (Plates 3.3-2), the Chilson Member of the Lakota Formation (Plates 3.3-3) and the Unkpapa Formation (Plate 3.3-4).

The Dewey Fault, a northeast to southwest trending fault zone, is present approximately one mile north of the north and northwest parts of the PAA. The Dewey Fault is a steeply dipping to vertical normal fault with the north side uplifted approximately 500 feet by a combination of displacement and drag. The United States Geological Survey (USGS) considers an area 7 miles southeast of the PAA as the Long Mountain Structural Zone. This northeast – southwest trend contains several small shallow surface faults in the Inyan Kara. No faults show up along this trend on subsurface structure maps of the underlying Madison Formation, Minnelusa Formation or the Deadwood Formation. Despite the presence of faulting north and south of the site, there are no identified faults within the PAA.

There is some folding in the areas surrounding the Dewey-Burdock Project. East of the PAA is a northwest – southeast trending anticline that ends in a closed structure called the Barker Dome. To the west is the Fanny Peak Monocline. This monocline is the structural boundary between the Black Hills and the Powder River Basin.

3.3.2.2 Site Stratigraphy

The sedimentary rocks of primary interest that underlie the PAA range in age from Upper Jurassic to Early Cretaceous. The Upper Jurassic Morrison Formation is considered to be the Lower Confining Unit for the Proposed Action. The uranium mineralization is contained within the Inyan Kara Group (Lakota and Fall River Formations). The Skull Creek Shale is the Upper Confining Unit. Plate 3.3-5 is a generalized cross section of the PAA, illustrating the relationship between these sedimentary units, as well as their position to underlying rocks, ranging in age from Jurassic to Precambrian.

The following is a brief description of the formations of interest at Dewey-Burdock:

Morrison Formation - The Upper Jurassic Morrison Formation was deposited as flood plain deposits. It is composed of waxy, unctuous, calcareous, noncarbonaceous massive shale with numerous limestone lenses and a few thin fine grained sandstones. Below the site, this formation has an average thickness of approximately 100 feet and is the Lower Confining Unit for Proposed Action. Analyses of core samples demonstrate that the Morrison clays have extremely low vertical permeabilities, ranging from 3.9×10^{-9} centimeters per second (cm/sec) to 4.2×10^{-8} cm/sec (0.004 millidarcies to 0.043 millidarcies).

Inyan Kara Group – This Group consists of the Lakota Formation and the Fall River Formation. Sandstones within these two formations are hosts to all the uranium mineralization for the Proposed Action.

Lakota Formation – The Lakota Formation consists of three members; from lower to upper are the Chilson Member, the Minnewasta Limestone Member and the Fuson Member.

The Minnewasta Limestone Member is not present in the PAA.

The Chilson Member (commonly referred to as the Lakota Sandstone) is composed largely of fluvial deposits. These deposits consist of sandstone, shale, siltstone, and shale. The member consists of a complex of channel sandstone deposits and their laterally fine-grained equivalents. The Chilson Member consists of two units: a basal carbonaceous black mudstone and an overlying unit of channel sandstones with laterally fine-grained equivalents and interbedded shales. The sandstones are very fine to medium-grained and well sorted and were deposited by a northwest flowing river system. Analyses of core samples of these sandstones indicate these units exhibit high horizontal permeabilities, ranging from 2.6×10^{-3} cm/sec to 4.1×10^{-3} cm/sec (2697 millidarcies to 4161 millidarcies). The massive sandstone is made up of numerous individual sand filled channels, which contain the uranium deposits.

The isopach map of the Chilson Member of the Lakota Formation shows the thickness of the channel sandstones and interbedded shales within the Chilson Member. Thicknesses vary from 100 to 240 feet. This isopach map may not adequately show the total thickness of the Chilson Member because drilling usually did not penetrate its entire extent. Drilling was usually stopped in the lower carbonaceous shale unit of the Chilson Member and did not reach the Morrison Formation. (Plate 3.3-6).

The Fuson Member is the upper most member of the Lakota Formation and the shale-siltstone portion of the Fuson has been used to divide the Lakota Formation from the Fall River Formation. Analyses of core samples of these lithologies demonstrate low vertical permeabilities, ranging from 7.8×10^{-9} cm/sec to 2.2×10^{-7} cm/sec (0.008 millidarcies to 0.228 millidarcies).

The Fuson Member is described as having a lower discontinuous sandstone unit at its base and an upper discontinuous sandstone at the top of the member. If present the lower sandstone unit was mapped as Lakota sandstone. Similarly if the upper sandstone was present it was mapped as Fall River sandstone. The isopach map of the Fuson Member shows the thickness of the shale – siltstone unit ranging from 30 to 80 feet. It shows thinning of the shale under the overlying channel sandstones of the Fall River Formation. (Plate 3.3-7).

Fall River Formation - The Fall River formation is composed of carbonaceous interbedded siltstone and sandstone, channel sandstones, and a sequence of interbedded sandstone and shale. The lower part of the Fall River consists of dark carbonaceous siltstone interbedded with thin laminations of fine-grained sandstone. Channels were cut into this interbedded sequence by northwest flowing rivers and fluvial sandstones were deposited. These channel sandstones occur across various parts of the Proposed Action and generally contain the uranium deposits. Overlying the channel sandstones is another sequence of alternating sandstone and shales. The sandstones are cross-bedded to massive, fine to medium-grained, and well-sorted.

The isopach map of the Fall River Formation shows a range of thickness of 120 to 160 feet. The thickening of the formation indicates the presence channel sandstones. Along the northeastern portion of the PAA, this formation is exposed on the surface and erosion has taken place (Plate 3.3-8).

Skull Creek Shale - The Skull Creek Shale directly overlies the Fall River Formation and consists of dark-grey to black shale, organic material, and some silt sized quartz grains. The Skull Creek Shale has a thickness of approximately 200 feet and is the Upper Confining Unit for the Proposed Action. Analyses of core samples demonstrate that the Skull Creek clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies). The Skull Creek Shale is eroded from the eastern parts of the Proposed Action.

Mowry Shale – At the Proposed Action, the Skull Creek Shale is directly overlain by the Mowry shale and is also considered to be part of the Upper Confining Unit. Normally, the Newcastle Sandstone is present between the Skull Creek Shale and the Mowry Shale, but is absent across the PAA. The Mowry Shale consists of light gray marine shale with minor amounts of siltstone, fine grained sandstone, and a few thin beds of bentonite. Dark-gray to purple and black iron and manganese concretionary zones are common within the shale. The combined Skull Creek Shale – Mowry Shale reaches a thickness of 400 feet in the western part of the Proposed Action. Plate

3.3-9 is an isopach map showing the combined thickness of these two shale units. In the northeastern portion of the PAA, these units outcrop and have been eroded.

Terrace Deposits - Along the sides of drainages are relatively flat terrace deposits representing floodplains and former levels of streams. The terraces are primarily overbank deposits of clay and silt with gravel beds. Gravel deposits consist of boulders and pebbles of chert, sandstone, and limestone.

Alluvium - The most recent sedimentary units deposited within the PAA are the Quaternary age alluvium deposits. Alluvium is present in the major drainages and their tributaries. The alluvium consists of silt, clay sand and gravel.

Four site cross sections, based on exploration logs, were developed along each ore body to illustrate the relationship between mineralized Inyan Kara sands and their confining units. Plate 3.3-10 shows the locations of the four cross sections. The cross sections were generated in the MVS model and were hung on the elevation of each drill hole. Traces of electric logs of exploration holes were overlain on these cross sections to illustrate the data sources used in the preparation of these sections. Cross sections A-A'', F-F', H-H''', and J-J' show the Proposed Action stratigraphy and mineralization across the PAA and are presented in Plates 3.3-11, 3.3-12, 3.3-13, and 3.3-14. The Skull Creek Shale thickens from the east to the west. The Fall River Formation is continuous across the area and dips to the west. The Fuson Member of the Lakota thickens and thins across the area. The Chilson Member of the Lakota is continuous across the area and thickens and thins due to channeling. The uranium mineralization in the Fall River occurs in the lower sandstone unit. The mineralized sands in the Chilson Member of the Lakota occur within individual sandstone lenses or channels.

3.3.3 Ore Mineralogy and Geochemistry

Uranium deposits within the Proposed Action are classic, sandstone, roll-front type deposits, similar to those in Wyoming and Texas. These type deposits are usually "C" shaped in cross section, with the concave side of the deposit extending up-dip, toward the outcrop. Roll-front deposits are a few tens of feet-to-100 or more-feet wide and often thousands of feet long. Uranium minerals were emplaced in these deposits after migrating down gradient from the surface in oxygenated groundwater and precipitating in the subsurface upon encountering a reducing environment at depth. These roll-front deposits are centered at and follow the interface of naturally-occurring chemical boundaries between oxidized and reduced sands. Reducing conditions are the result of a reductant in the sands these can be from organic material or from H_2s or methane in the host sands.

There is a geochemical "footprint" associated with these roll-front deposits, resulting from the passage of oxygenated groundwater through subsurface sands. The typical alteration pattern associated with these oxidizing solutions consists of limonitic and hematitic staining of the sandstones. This is due to the alteration of naturally-occurring iron rich minerals (valence state of Fe^{+2}) to iron oxides (valence state of Fe^{+3}). On outcrop, most of the sandstones of the Inyan Kara Group exhibit trace to pervasive limonite staining of various shades of yellow and orange. Red hematite staining is less common and occurs as scattered streaks in most outcrops. Generally, the more porous and thicker the sandstone, the more pronounced the alteration. Reduced or unaltered sands have a medium to dark grey color. Alteration within the host sands has been mapped for distances of over 12 miles within the sandstones of the Inyan Kara Group in the PAA.

The primary uranium minerals in the Proposed Action deposits are very fine-grained, opaque pitchblende and coffinite. This mineralization occurs as sand grain coatings in the host sand, and marginal to or as replacement of pyrite grains.

Mineralized sands within the Proposed Action occur at depths of less than 100 feet in the outcrop area of Fall River Formation and at depths of up to 800 feet in the Lakota in the northwest part of the Proposed Action. This mineralization occurs in three sandstones in the Fall River Formation and within six sandstones of the Lakota Formation. The uranium mineralization occurs along a large "U" shaped trend that is 5 miles long and 3 to 4 miles wide. The average thickness of this mineralization has been calculated to be 6.1feet and the average grade is 0.21 percent U_3O_8.

In 1988 in a Thesis for a Master of Science in Geology degree, Bonnie Janine Blake used scanning x-ray fluorescence supplemented by standard x-ray fluorescence, x-ray diffraction, electron microprobe, scanning electron microscopy, and atomic absorption to study core samples from the Burdock ore body. She did not identify any uranium or vanadium minerals but concluded that the uranium was in an amorphous or poorly-crystalline form or was associated with the clays or carbonaceous material. Bonnie Blake noted "quartz grains illustrated layered clay coatings in the paragenetic sequence of a smectite partially covered by kaolinite with remnants of possible illite on the kaolinite. The smectite coatings showed isolated concentrations of uranium and vanadium." This is to be expected where uranium cation exchanges with the clays. The uranium mineralization is probably uranphane and coffinite.

3.3.4 Historic Uranium Exploration Activities

Uranium was first discovered in the Edgemont District in 1951 by professors from the South Dakota Scholl of Mines and Technology. They mined about 500 pounds of ore and hauled it to Grand Junction, Colorado. The Atomic Energy Commission (AEC) announcement of a new district at Edgemont led to a boom of stacking, mining, and dealing in the summer of 1952. By 1953 the AEC had built a buying station in Edgemont. In July 1956 a 250-ton per-day mill went on stream and soon expanded to a 500-ton-per-day. In 1960 a vanadium circuit was added. Production from the Edgemont District (open pits in the Fall River), some mines in the Powder River basin and several mines in the Northern Black Hills continued until 1972. Susquehanna Western Inc. (SWI) bought the Edgemont mill and took control of the mines in the Edgemont District. Until the late 1960's early 1970's they were the only company active in the Edgemont District.

In 1967, Homestake Mining Company began exploration in the Dewey area. In 1974, Wyoming Mineral Corporation (WMC) (Westinghouse) acquired the Dewey properties from Homestake. In 1974, TVA bought out the mill and mines from SWI. The mill was shut down, but exploration continued. Besides WMC and TVA, other companies exploring in the district were Union Carbide, Federal Resources, and Kerr McGee. TVA acquired the Dewey Project from WMC in 1978 and continued exploration until 1986. In total, over 4000 exploration drill holes were completed on this project.

In 1981 TVA completed a mine feasibility study on the Dewey Burdock deposits. A preliminary EIS was also prepared for an underground mine at the Burdock area. Due to falling uranium prices the Dewey Burdock leases was allowed to expire. In 1992 Energy Fuels Nuclear (EFN) acquired the leases and data on the Proposed Action. Their intention was to mine the uranium deposits by ISL. EFN did no additional exploration drilling on the Proposed Action. In 2000 EFN dropped the leases.

In 2005 Denver Uranium, LLC acquired the leases and claims covering the Dewey Burdock ore bodies. The following year, these properties were transferred to Powertech (USA), Inc. Since the spring of 2007, Powertech (USA) has drilled approximately 115 exploration holes, including 20 monitoring wells on the Proposed Action. Both the historic and recent drill holes have helped to generate the geologic mode and delineate the extent of the mineralized sands. Figure 3.3-4 is a map showing the location of all known drill holes. Appendix 3.3-A includes a table summarizing all historic exploration drilling.

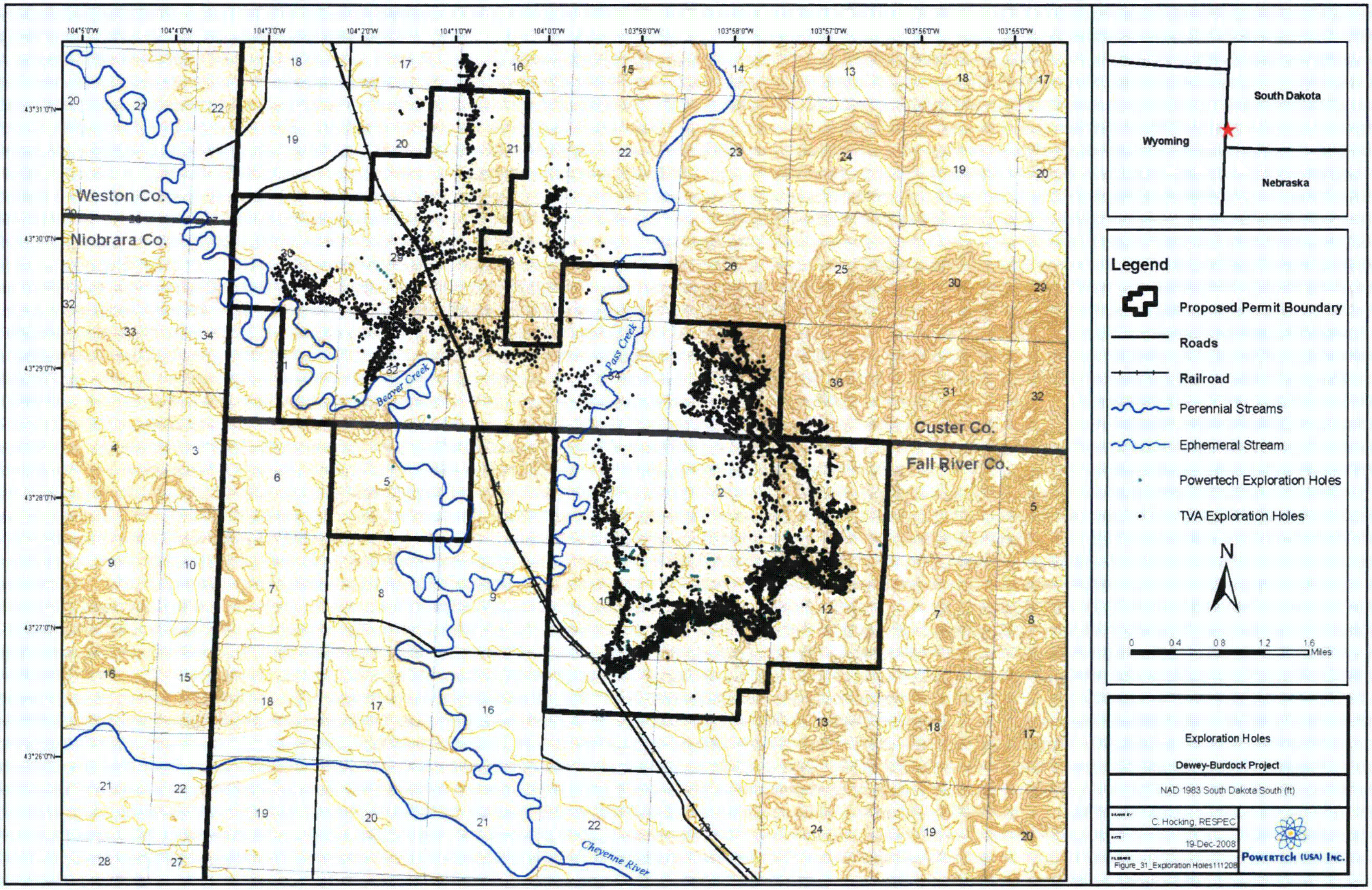

Figure 3.3-4: Location of all Known Exploration Drill Holes within the Proposed Project Site

3.3.5 Soils

Powertech (USA) conducted baseline soil sampling and mapping covering an estimated 7,964.26 acres as shown on Plate 3.3-15.

Stripping depths for the PAA were evaluated during mapping and sampling. Soil depths within a given mapping unit will vary based on any combination of the five primary soil forming factors, i.e., climate including effective precipitation, organisms, relief or topography, parent material, and time. Subtle differences in any one of the previously mentioned factors will impact development between series and within series designation but may not be as noticeable as when topography is a major factor. The proposed topsoil salvage depths are based on laboratory data of the samples found within the borders of the area, as well as field observations and knowledge of the soils in Custer and Fall River Counties, South Dakota.

Soils in the PAA are typical for semi-arid grasslands and shrublands in the Western United States. Parent material included colluvium, residuum, and alluvium. Most soils are classified taxonomically as Aridic Argiustolls, Aridic Ustorthents, and Aridic Haplusterts. Almost all soils have some suitable topsoil. The primary limiting factors within the PAA are EC-electrical conductivity, SAR-sodium adsorption ratio, calcium carbonates, and texture (clay percentage).

Refer to Appendix 3.3-B for the Soil Mapping Unit Descriptions. Refer to Appendix 3.3-C for the Soil Series Descriptions. Refer to Appendix 3.3-D for the Original Laboratory Data Sheets. Refer to Appendix 3.3-E for the Prime Farmland Designation. Refer to Appendix 3.3-F for the Site Photographs.

3.3.5.1 Methodology

3.3.5.1.1 Review of Existing Literature

The soils in this portion of Custer and Fall River Counties were studied and mapped to an Order 2 scale by the USDA, NRCS in 1982 and 1990. Information for Custer and Fall River Counties is available electronically as well as hard copy. The NRCS has also centralized dissemination of typical soil series descriptions; general information is available on the internet at www.nrcs.usda.gov.

3.3.5.1.2 Project Participants

BKS performed the 2007 soil survey field work and compiled the resulting report. All soil analysis was handled by Energy Labs in Gillette, Wyoming.

3.3.5.1.3 Soil Survey

Construction of the PAA soil map was completed according to techniques and procedures of the National Cooperative Soil Survey. Guideline No. 1 (August, 1994 Revision) of the WDEQ-LQD was followed during all phases of the work.

A total of 7,960.77 acres were included in the final soil mapping of the PAA, in which 3,065.74 of those acres were located in disturbance areas. Refer to Table 3.3-1 for soil mapping unit designations and associated acreage within the PAA. Table 3.3-1 also describes the soil map units in terms of actual map designations and slope percentages.

Table 3.3-1: PAA Soil Mapping Unit Acreages

Map Symbol	Map Unit Description	Permit Acreage	Disturbance Areas	% Total PAA
Aa	Alice, 0 to 6 percent slopes	36.99	0	0
Ar	Arvada, 0 to 6 percent slopes	258.3	121.78	3.97
As	Ascalon, 0 to 6 percent slopes	27.42	41.22	1.35
Bc	Barnum, 0 to 6 percent slopes	484.09	13.01	0.42
Bo	Boneek, 0 to 6 percent slopes	51.53	0	0
Br	Broadhurst, 6 to 15 percent slopes	60.22	190.74	6.22
Bw	Butche, 6 to 40 percent slopes	234.53	25.42	0.83
Cn	Colby, 6 to 15 percent slopes	72.2	0	0
Cy	Cushman, 6 to 15 percent slopes	110.06	12.26	0.40
Dg	Demar, 0 to 6 percent slopes	509.39	134.26	4.38
DA	Disturbed-Ag	196.05	41.36	1.35
GrA	Grummit, 0 to 6 percent slopes	250.81	37.85	1.24
GrB	Grummit, 6 to 15 percent slopes	632.43	369.1	12.04
GrC	Grummit, 15 to 60 percent slopes	550.67	48.43	1.58
Ha	Haverson, 0 to 6 percent slopes	233.1	0	0
He	Hisle, 0 to 6 percent slopes	307.65	54.52	1.78
Ky	Kyle, 0 to 6 percent slopes	471.39	333.96	10.89
Lo	Lohmiller, 0 to 6 percent slopes	38.06	5.66	0.19
Mm	Mathias, 15 to 40 percent slopes	331.62	34.08	1.11
MP	Mine Pit	340.48	18.31	0.60
Nf	Nihill, 15 to 50 percent slopes	11.36	25.61	0.84
No	Norka, 0 to 6 percent slopes	85.07	0	0
NuA	Nunn, 0 to 6 percent slopes	28.54	41.22	1.35
NuB	Nunn, 6 to 15 percent slopes	17.45	0	0
Pa	Paunsaugunt, 6 to 15 percent slopes	0.86	0	0
Pg	Penrose, 15 to 40 percent slopes	210.76	231.08	7.54
PeA	Pierre, 0 to 6 percent slopes	479.11	216.03	7.05
PeB	Pierre, 6 to 15 percent slopes	470.36	157.99	5.15
RO	Rock Outcrop	126.91	17.42	0.57
Sa	Samsil, 15 to 40 percent slopes	249.01	515.29	16.81
Sc	Satanta, 0 to 6 percent slopes	32.28	0	0
Sn	Shingle, 15 to 40 percent slopes	86.75	11.66	0.38
SS	Slickspots	536.39	148.77	4.85
Gs	Snomo, 6 to 15 percent slopes	179.92	106.06	3.46
Ta	Tillford, 0 to 6 percent slopes	171.69	7.84	0.26
W	Water	32.77	72.5	2.37
Wt	Winetti, 0 to 6 percent slopes	7.73	6.92	0.23
202	Worfka, 15 to 40 percent slopes	3.04	0	0
ZnB	Zigweid, 6 to 15 percent slopes	11.35	25.39	0.83
ZnC	Zigweid, 6 to 40 percent slopes	22.43	0	0
Total		**7,960.77**	3,065.74	**100**

3.3.5.1.4 Field Sampling

Soil series were sampled to reflect recommended sample numbers in WDEQ Guideline 1 (August 1994 Revision) based on mapping acreage. Most samples were taken either in or near disturbed areas. Additional sampling of soils in the permit area will occur as the operation is expanded outside the current disturbed areas.

Series were sampled and described by coring with a mechanical auger, i.e., truck-mounted Giddings. The physical and chemical nature of each horizon within the sampled profile was described and recorded in the field. Each hole augered for series and map unit verification was plotted on the soils map included with this report. Sampled soil material was placed in clean, labeled, polyethylene plastic bags and kept cool to limit chemical changes. Samples were kept out of direct sunlight and transported to Energy Labs for analysis. A total of 33 sites on the PAA were sampled for analysis; all had corresponding soil profile descriptions written. Refer to Table 3.3-2 Soils Series Sample Summary and Table 3.3-3 Soil Sample Locations.

Table 3.3-2: Soil Series Sample Summary for the PAA [1]

Soil Series	Number of Profiles Sampled for Chemical Analysis
Broadhurst	1
Kyle	3
Hisle	2
Nevee	1
Barnum	1
Ascalon	1
Cushman	1
Zigweid	1
Butche	1
Samsil	3
Paunsaugunt	1
Boneek	4
Arvada	1
Lohmiller	2
Pierre	2
Haverson	1
Demar	2
Penrose	1
Satanta	1
Snomo	1
Grummit	1
Shingle	1
Total	**33**

[1]Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

Table 3.3-3: PAA[1] Soil Sample Locations

Soil Sample Number	Map Unit Designation	Soil Series
17	Broadhurst silty clay, 6 to 15 percent slopes	Broadhurst
27	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
36	Kyle noncalcareous variant, 0 to 6 percent slopes	Kyle
39	Hisle silt loam, 0 to 6 percent slopes	Hisle
40	Hisle noncalcareous variant, 0 to 6 percent slopes	Hisle
41	Nevee silt loam, 6 to 15 percent slopes	Nevee
42	Barnum silt loam, 0 to 6 percent slopes	Barnum
43	Ascalon clay loam, 0 to 6 percent slopes	Ascalon
50	Cushman loam, 6 to 15 percent slopes	Cushman
56	Zigweid loam, 0 to 6 percent slopes	Zigweid
57	Butche clay loam, 3 to 15 percent slopes	Butche
60	Samsil clay loam, 15 to 40 percent slopes	Samsil
63	Paunsaugunt loam, 6 to 15 percent slopes	Paunsaugunt
64	Boneek silty clay loam, 0 to 6 percent slopes	Boneek
72	Arvada silty clay loam, 0 to 6 percent slopes	Arvada
73	Lohmiller loam, 0 to 6 percent slopes	Lohmiller
74	Pierre sandy clay loam, 0 to 15 percent slopes	Pierre
75	Haverson clay loam, 0 to 6 percent slopes	Haverson
76	Demar loam, 0 to 6 percent slopes	Demar
77	Penrose clay loam, 0 to 6 percent slopes	Penrose
79	Demar silty clay loam, 0 to 6 percent slopes	Demar
82	Satanta loam, 0 to 6 percent slopes	Satanta
83	Snomo silty clay loam, 0 to 6 percent slopes	Snomo
84	Lohmiller silty clay loam, 0 to 6 percent slopes	Lohmiller
85	Kyle loam, 0 to 6 percent slopes	Kyle
88	Samsil noncalcareous variant, 15 to 40 percent slopes	Samsil
89	Pierre silty clay loam, 0 to 15 percent slopes	Pierre
90	Grummit silty clay, 0 to 6 percent slopes	Grummit
91	Boneek clay loam, 0 to 6 percent slopes	Boneek
92	Samsil silty clay loam, 15 to 40 percent slopes	Samsil
93	Shingle loam, 15 to 40 percent slopes	Shingle
94	Boneek noncalcareous variant, 0 to 6 percent slopes	Boneek
95	Boneek loam, 0 to 6 percent slopes	Boneek

[1]Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

3.3.5.1.5 Laboratory Analysis

Samples were individually placed into lined aluminum pans to air dry. Coarse fragments were measured with a 10 mesh screen prior to grinding; the entire sample was then hand ground to pass 10 mesh. An approximate 20 ounce subsample was obtained through splitting with a series of riffle splitters and subsequently analyzed. A second subsample was maintained in storage at Energy Labs. Approximately 10 percent of the samples are run for duplicate analysis. Actual laboratory analysis follows the methodology outlined in WDEQ-LQD Guideline 1 (August 1994 Revision). In general, samples were analyzed within 45 days of receipt of the samples at the laboratory. All analytical data is presented in Appendix 3.3-D, Original Laboratory Data Sheets.

3.3.5.2 Results and Discussion

3.3.5.2.1 Soil Survey - General

General topography of the area ranged from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the Powertech (USA) PAA were generally a clayey or very fine texture throughout with patches of sandy loam on upland areas and fine, clay textured soils occurring in or near drainages. The PAA contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks.

3.3.5.2.2 Soil Mapping Unit Interpretation

The primary purpose of the 2007 fieldwork was to characterize the soils within the PAA in terms of topsoil salvage depths and related physical and chemical properties. The total number of samples per series was established in line with WDEQ Guideline 1 (August 1994 Revision) recommendations based on estimated acreage of soil series known within the PAA. Refer to Appendix 3.3-B and 3.3-C for soil mapping unit descriptions and soil series descriptions, respectively.

3.3.5.2.3 Analytical Results

Analyzed parameters, as defined in WDEQ Guideline 1 (August 1994 Revision), are in Appendix 3.3-D, Original Laboratory Data Sheets. Laboratory soil texture analysis did not include percent fine sands. Field observations of fine sands within individual pedestals as well as sample site topographic position were used in conjunction with laboratory analytical results to determine series designation. Where applicable, field observation of fine sands is also included in the textures found in the soil series descriptions in Appendix 3.3-C. In several of the pedestal sampling locations, laboratory analysis yielded finer than expected textures (based upon field observations). Where textures are finer than typical for the series, it is noted in the Range of Characteristics (according to field observations, lab analysis) in the soil series descriptions.

3.3.5.2.4 Evaluation of Soil Suitability as a Plant Growth Medium

Approximate salvage depths of each map unit series are presented in Table 3.3-4 and ranged from 0.0 to 5.0 feet. Within the PAA, suitability of soil as a plant growth medium is generally affected by physical factors such as texture (clay percentage) and saturation percentage. Chemical limiting factors included selenium (Se), calcium carbonate content (based upon field observations of strong or violent effervescence), SAR, EC, pH, and boron (B). Marginal material, according to WDEQ Guideline 1, was found in 26 of the 33 profiles. Unsuitable material, according to WDEQ Guideline 1, was found in 14 of the 33 profiles. Marginal or unsuitable parameter information for sampled profiles is identified in Table 3.3-5. A summary of trends in marginal or unsuitable parameters as it relates to soil series is found in Table 3.3-6. Based on laboratory analysis and field observations, marginal material parameters primarily consisted of texture (clay percentage), calcium carbonates, EC, and SAR.

Table 3.3-4: PAA Summary of Approximate Soil Salvage Depths

Map Symbol	Mapping Unit Description	Disturbance Areas[1]	Salvage Depth (feet)	Total Volume (Acre feet)
Ar	Arvada	121.78	1.5	182.67
As	Ascalon	41.22	1.17	48.23
Bc	Barnum	13.01	0.5	6.51
Br	Broadhurst	190.74	0.67	127.80
Bw	Butche	25.42	0.67	17.03
Cy	Cushman	12.26	2.08	25.50
Dg	Demar	134.26	0.21	28.20
DA	Disturbed-Ag	41.36	-	-
GrA	Grummit, 0 to 6 percent slopes	37.85	1.67	63.21
GrB	Grummit, 6 to 15 percent slopes	369.1	1.67	616.40
GrC	Grummit, 15 to 60 percent slopes	48.43	1.67	80.88
He	Hisle Noncalc. Variant Average	54.52	5 5 5	272.60
Ky	Kyle Noncalc. Variant Average	333.96	2.5 0.80 1.65	551.03
Lo	Lohmiller	5.66	0.34	1.92
Mm	Mathias	34.08	0	0
MP	Mine Pit	18.31	-	-
Nf	Nihill	25.61	0.42	10.76
Nu	Nunn	41.22	2	82.44
Pg	Penrose	231.08	3	693.24
PeA	Pierre, 0 to 6 percent slopes	216.03	0.71	153.38
PeB	Pierre, 6 to 15 percent slopes	157.99	0.71	112.17
RO	Rock Outcrop	17.42	-	-
Sa	Samsil Noncalc. Variant Average	515.29	0.42 1.5 0.96	494.68
Sn	Shingle	11.66	0.67	7.81
SS	Slickspots	148.77	-	-
Gs	Snomo	106.06	0	0
Ta	Tilford	7.84	3.33	26.11
W	Water	72.5	-	-
Wt	Winetti	6.92	0.33	2.28
Zn	Zigweid	25.39	5	126.95
Average Salvage Depth of Study Area			**1.44**	
Total		**3,065.74**		**3,731.80**

[1]Samples were taken within proposed disturbed area as defined by initial estimates of the ore body.

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles

Series	Sample Point	Depth (in)	Parameter
Broadhurst	17	0-3 3-8 8-24 24-40 40-54 54-60	Marginal clay %
Broadhurst	17	8-24	Marginal saturation %
Broadhurst	17	40-54	Marginal pH (Low)
Broadhurst	17	54-60	Unsuitable pH (Low)
Kyle	27	2-17 17-24 24-39 39-60	Marginal clay %
Kyle	27	24-39	Marginal saturation %
Kyle	27	17-24 24-39 39-60	Marginal SAR
Kyle	36	2-15 15-26 26-36 36-60	Marginal clay %
Kyle	36	2-15 26-36	Marginal saturation %
Kyle	36	15-26 26-36	Marginal SAR
Hisle	40	27-38 38-60	Marginal clay %
Nevee	41	21-36 36-45 45-60	Unsuitable EC (Conductivity) Unsuitable SAR Marginal Selenium
Nevee	41	21-36	Unsuitable Boron
Barnum	42	6-17 17-39	Unsuitable EC (Conductivity) Unsuitable SAR
Barnum	42	39-60	Marginal EC (Conductivity) Marginal SAR
Barnum	42	6-17	Marginal Selenium
Ascalon	43	2-14	Marginal clay %
Ascalon	43	38-60	Unsuitable SAR
Samsil	60	3-10	Marginal clay %
Samsil	60	10-18	Marginal EC (Conductivity) Marginal Selenium
Samsil	60	3-10 10-18	Marginal SAR
Boneek	64	17-33	Marginal pH (High)
Boneek	64	33-42	Marginal EC (Conductivity) Marginal Selenium
Arvada	72	18-28	Marginal clay %

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles (cont'd)

Series	Sample Point	Depth (in)	Parameter
Arvada	72	28-43 43-60	Marginal EC (Conductivity)
Arvada	72	28-43	Marginal SAR
Arvada	72	43-60	Unsuitable SAR
Arvada	72	18-28 28-43 43-60	Marginal Selenium
Lohmiller	73	3-15 15-23 23-34 34-38 38-60	Marginal clay % Unsuitable SAR
Lohmiller	73	15-23 23-34 38-60	Marginal saturation %
Lohmiller	73	15-23	Marginal EC (Conductivity)
Lohmiller	73	23-34 34-38 38-60	Unsuitable EC (Conductivity)
Lohmiller	73	15-23 23-34 34-38 38-60	Marginal Selenium
Pierre	74	15-27 27-38	Marginal pH (High)
Pierre	74	27-38 38-51 51-60	Unsuitable EC (Conductivity) Marginal Selenium
Pierre	74	15-27 27-38 38-51 51-60	Unsuitable SAR
Haverson	75	15-35	Marginal SAR
Haverson	75	35-46 46-60	Unsuitable SAR
Demar	76	2-21 21-29	Marginal clay % Marginal SAR
Demar	76	29-46 46-60	Unsuitable SAR
Demar	76	46-60	Marginal Selenium
Penrose	77	36-48	Unsuitable Boron
Demar	79	3-17 17-30 30-42 42-60	Marginal clay % Unsuitable pH (Low)
Satanta	82	0-4	Marginal pH (Low)
Snomo	83	3-17 17-33	Marginal clay % Marginal texture

Table 3.3-5: PAA Summary of Marginal and Unsuitable Parameters within Sampled Profiles (concl.)

Series	Sample Point	Depth (in)	Parameter
Snomo	83	42-52	Marginal saturation %
Snomo	83	0-3 3-17	Unsuitable pH (Low)
Snomo	83	33-42 42-52 52-60	Unsuitable Boron
Lohmiller	84	18-37	Marginal clay % Marginal texture Unsuitable EC (Conductivity) Unsuitable SAR
Lohmiller	84	0-5 5-18	Marginal saturation %
Lohmiller	84	5-18 37-47 47-60	Marginal EC (Conductivity)
Lohmiller	84	5-18 37-47	Marginal SAR
Kyle	85	2-7	Marginal saturation %
Samsil	88	2-9	Marginal clay % Marginal texture
Pierre	89	0-2	Marginal pH (Low)
Pierre	89	2-18 18-31 31-37	Marginal clay % Marginal texture Marginal saturation %
Grummit	90	0-2 2-8 8-20	Marginal clay % Marginal texture Marginal saturation %
Boneek	91	4-19 40-48 48-60	Marginal saturation %
Boneek	91	19-40 40-48 48-60	Unsuitable EC (Conductivity) Unsuitable SAR
Boneek	91	48-60	Marginal Selenium
Samsil	92	7-19	Marginal clay % Marginal texture Marginal saturation %
Boneek	94	0-2 2-8 8-20 32-44 44-60	Marginal clay % Marginal texture Marginal saturation %
Boneek	94	20-32	Marginal saturation %
Boneek	95	24-38	Marginal Selenium

Table 3.3-6: PAA Summary of Trends in Marginal and Unsuitable Parameters for Soil Series

Series	Unsuitable/Marginal Parameter
Arvada	Sodium/Salts, Selenium/Boron
Ascalon	Sodium/Salts
Barnum	Sodium/Salts, Selenium/Boron
Boneek	Texture, Sodium/Salts, Selenium/Boron
Broadhurst	Texture, pH
Demar	Sodium/Salts
Grummit	Texture
Haverson	Sodium/Salts
Hisle	Texture
Kyle	Texture
Lohmiller	Texture, Sodium/Salts
Nevee	Sodium/Salts, Selenium/Boron
Penrose	Selenium/Boron
Pierre	pH
Samsil	Texture
Satanta	pH
Snomo	Texture, pH, Selenium/Boron

3.3.5.2.5 Topsoil Volume Calculations

Based on the 2007 fieldwork with associated field observations and subsequent chemical analysis, the recommended topsoil average salvage depth over the PAA was determined to be 1.43 feet. Refer to Table 3.3-4, Approximate Soil Salvage Depths.

3.3.5.2.6 Soil Erosion Properties and Impacts

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the PAA varies from negligible to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the very fine and clayey texture of the surface horizons throughout the majority of the PAA, the soils are more susceptible to erosion from water than wind. See Table 3.3-7 for a summary of wind and water erosion hazards within the PAA.

Table 3.3-7: PAA Summary of Wind and Water Erosion Hazards[1]

Soil Sample Number	Map Unit Description	Water Erosion Hazard	Wind Erosion Hazard
17	Broadhurst silty clay, 6 to 15 percent slopes	slight	very slight
27	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
36	Kyle noncalcareous variant, 0 to 6 percent slopes	moderate	very slight
39	Hisle silt loam, 0 to 6 percent slopes	moderate	slight
40	Hisle noncalcareous variant, 0 to 6 percent slopes	slight	very slight
41	Nevee silt loam, 6 to 15 percent slopes	moderate	slight
42	Barnum silt loam, 0 to 6 percent slopes	moderate	slight
43	Ascalon clay loam, 0 to 6 percent slopes	slight	slight
50	Cushman loam, 6 to 15 percent slopes	slight	moderate
56	Zigweid silty clay loam, 0 to 6 percent slopes	moderate	very slight
57	Butche clay loam, 3 to 15 percent slopes	slight	slight
60	Samsil clay loam, 15 to 40 percent slopes	slight	slight
63	Paunsaugunt loam, 6 to 15 percent slopes	slight	moderate
64	Boneek silty clay loam, 0 to 6 percent slopes	moderate	very slight
72	Arvada silty clay loam, 0 to 6 percent slopes	moderate	slight
73	Lohmiller loam, 0 to 6 percent slopes	very slight	slight
74	Pierre sandy clay loam, 0 to 15 percent slopes	negligible	severe
75	Haverson clay loam, 0 to 6 percent slopes	slight	slight
76	Demar loam, 0 to 6 percent slopes	slight	moderate
77	Penrose clay loam, 0 to 6 percent slopes	slight	slight
79	Demar silty clay loam, 0 to 6 percent slopes	slight	slight
82	Satanta loam, 0 to 6 percent slopes	very slight	severe
83	Snomo silty clay loam, 0 to 6 percent slopes	moderate	very slight
84	Lohmiller silty clay loam, 0 to 6 percent slopes	moderate	very slight
85	Kyle loam, 0 to 6 percent slopes	slight	slight
88	Samsil noncalcareous variant, 15 to 40 percent slopes	slight	slight
89	Pierre silty clay loam, 0 to 15 percent slopes	moderate	very slight
90	Grummit silty clay, 0 to 6 percent slopes	slight	negligible
91	Boneek clay loam, 0 to 6 percent slopes	slight	slight
92	Samsil silty clay loam, 15 to 40 percent slopes	slight	slight
93	Shingle loam, 15 to 40 percent slopes	slight	severe
94	Boneek noncalcareous variant, 0 to 6 percent slopes	slight	very slight
95	Boneek loam, 0 to 6 percent slopes	slight	moderate

[1]Based on lab analysis.

3.3.5.2.7 Prime Farmland Assessment

Prime farmland was assessed by Dan Shurtliff, the Acting State Soil Scientist out of Huron, South Dakota. The following sections in T6S R1E contain prime farmland if irrigated: Sections 27, 30, 31, 32, 34, and 35. The following sections in T7S R1E contain Prime farmland if irrigated: Sections 1, 3, 4, 5, 10, 12, 14, and 15. The following sections in T7S R1E contain Farmland of statewide importance: Sections 2, 3, 4, 5, 10, 11, 12, 14, and 15. See Appendix 3.3-E for prime farmland designation. The following soil series have been listed as Prime farmland if irrigated: Alice, Ascalon, Barnum, Boneek, Haverson, Norka, Nunn, Satanta, and Tilford. The following soil series have been listed as Farmland of statewide importance: Kyle, Lohmiller, Nunn, Pierre, Satanta, and Stetter.

3.3.6 Seismology

3.3.6.1 Seismic Hazard Review

The seismic hazard review was based on analysis of available literature and historical seismicity for the PAA. 10 CFR Part 40, Appendix A Criterion 4(e) states:

"The impoundment may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in section III (g) of Appendix A of 10 CFR Part 100. The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material."

There are no capable faults (i.e. active faults) with surface expression mapped within a radius of 100 kilometers (62 miles) from the center of the PAA, according to the 2002 U.S. Geological Survey's Quaternary Fault and Fold Database. In addition, there are no capable faults mapped in the entire state of South Dakota. The closest capable faults to the site are located in central Wyoming, nearly 345 km (200 miles) to the west-southwest.

3.3.6.2 Seismicity

South Dakota has a comparatively higher rate of seismicity than other areas in the northern plains states, although earthquakes in the area tend to be relatively rare and of low to moderate magnitude, and no active faults have been mapped in the vicinity. It is unclear which earthquakes, if any, in the PAA are associated with known faults. Since the Midwestern states are relatively stable in terms of earthquake activity, only a small number of seismograph stations are located in the region. South Dakota has one station located in Rapid City, which began operation in 1991. Two nearby stations are located in Golden, Colorado and French Village, Missouri.

Since 1872, a minimum of 65 earthquake epicenters have been identified in South Dakota (Hammond, 1992). These have mainly been concentrated in the southern and eastern regions of the state and are generally of low to moderate modified Mercalli intensity, with a maximum recorded intensity reaching VI. In general, the majority of the epicenters in the proximity of PAA (see Figure 3.3-5) exhibit modified Mercalli intensities from III to V (corresponding to Richter magnitudes ranging from 2.2 to 4.1). However, a 1966 earthquake with intensity VI (approximate Richter magnitude 4.4) was recorded approximately 63 miles northeast of PAA (17 miles northwest of Rapid City).

The U.S. Geological Survey Earthquake Database reports locations, times, and magnitudes for epicenters recorded since 1973. The database reports a total of 10 earthquakes with Richter magnitudes ranging from 2.3 to 3.7 within 100 km radius of the site (Appendix 3.3-G). This list includes epicenters in Wyoming and Nebraska. The closest historical earthquake to PAA (unknown magnitude) was recorded on May 16, 1975 approximately 19 km (12 miles) southeast of the site. The most recent earthquake recorded in the entire state of South Dakota took place on February 7, 2007, 35 miles east of Rapid City (approximately 80 miles northeast of PAA) and displayed a magnitude of 3.1.

According to the U.S. Geological Survey Earthquake Database (Appendix 3.3-G), two historical earthquakes, each exhibiting a magnitude of 3.7, represent the largest historical events recorded within 100 km (62 miles) of PAA. These events occurred on February 6, 1996, and April 9, 1996, and were located 76 km (47 miles) to the north and 30 km (19 miles) to the southwest of the site, respectively. If we expand the search radius to 200 km (124 miles), an earthquake with magnitude 5.50 occurring on October 18, 1984 approximately 180 km (112 miles) to the southwest of the site is the largest magnitude event near the site.

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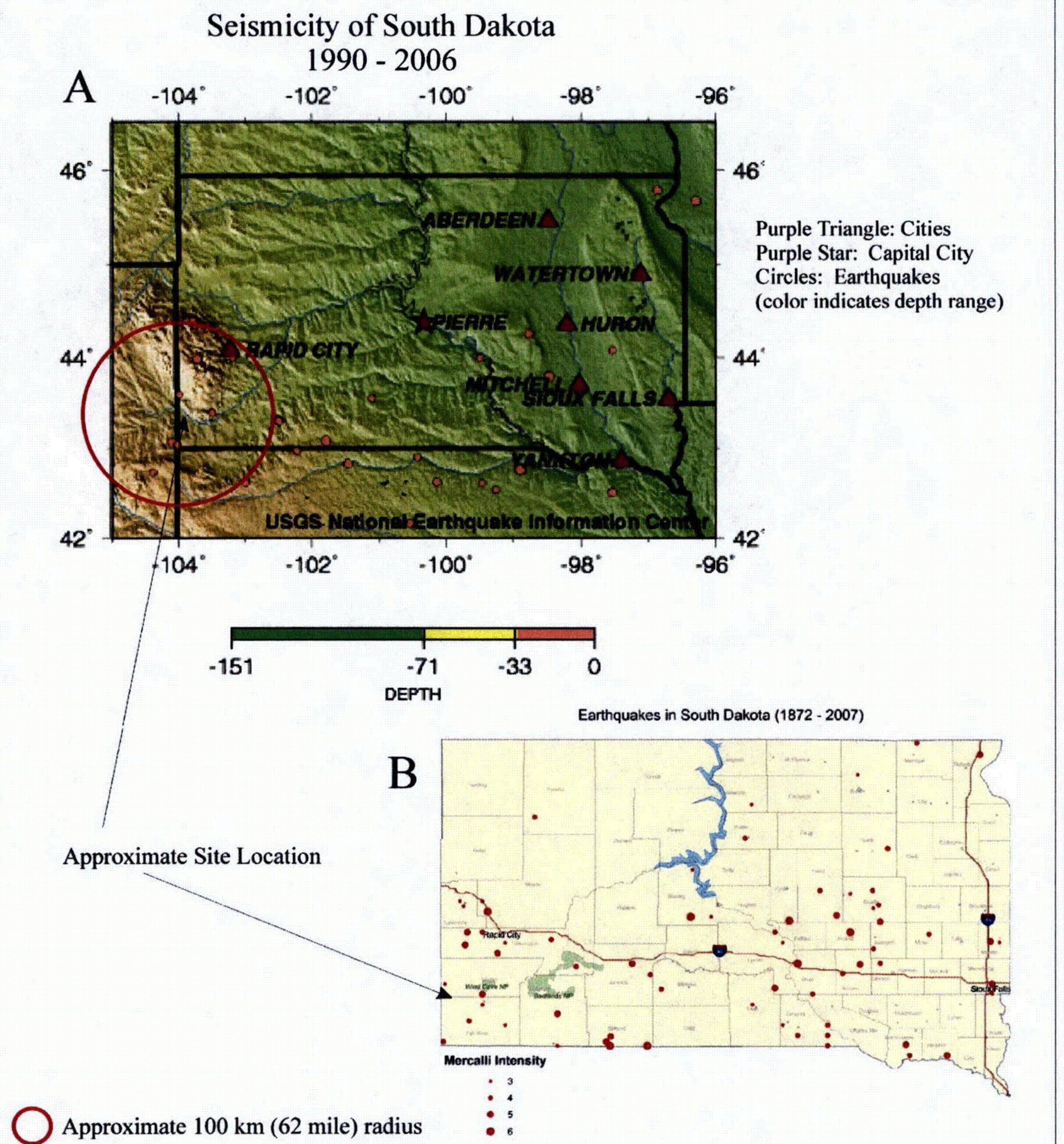


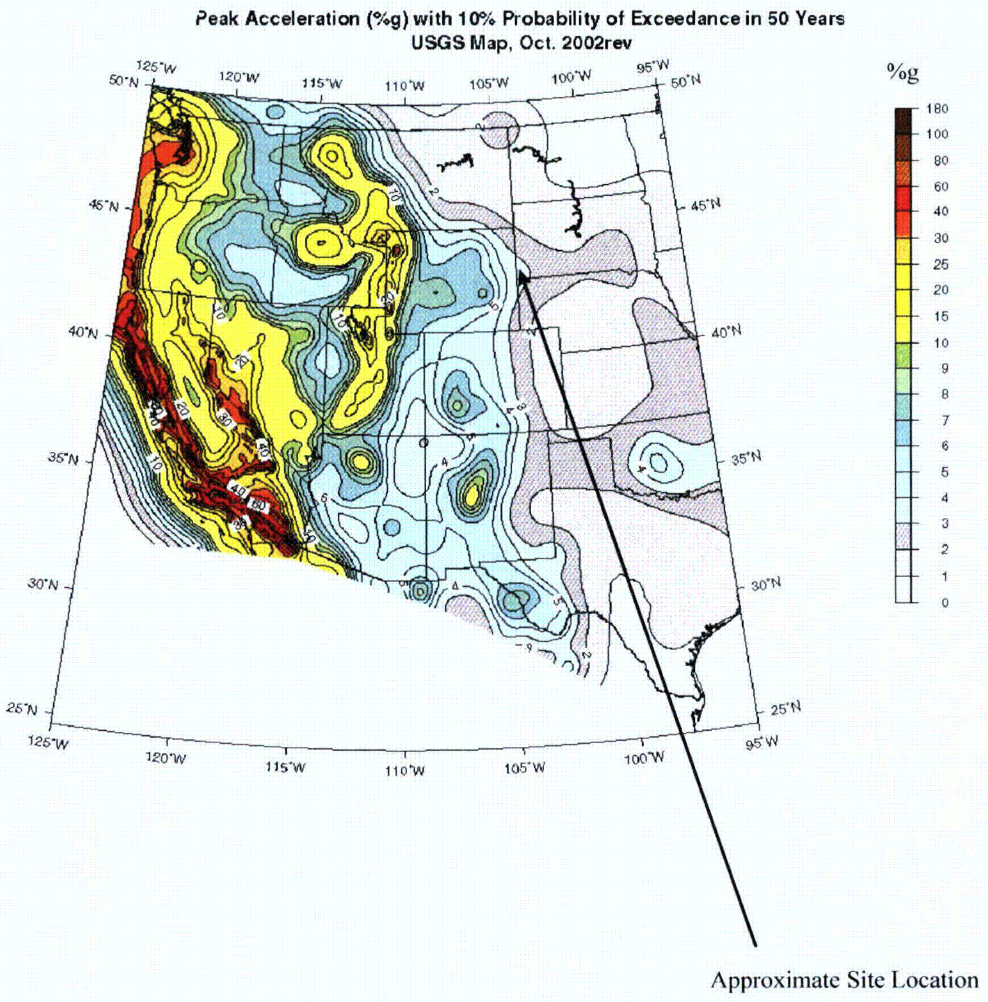
Earthquake locations are from the USGS/DEIC PDE catalog.
Map Source A: USGS website (http://earthquake.usgs.gov/regional/states/south_dakota/seismicity.php)
Map Source B: USGS website (http://www.sdgs.usd.edu/digitalpubmaps/quakemap.html)

Michael W. West and Associates, Inc. *Consulting Engineers and Geologists*	*Seismicity Maps Dewey-Burdock Project southwestern South Dakota*	*BY: JMF*	*05/12/2008*
		Proj.: 08807	

Figure 3.3-5: Seismicity of South Dakota, 1990 – 2006; and Earthquakes in South Dakota, 1872 - 2007

A zone of higher earthquake frequency is recorded along the eastern flank of the Black Hills (structural deformation also seems to be concentrated on the eastern flank; Geological Survey of South Dakota, 2004) and in the southwest corner of South Dakota (Figure 3.3-6). In addition, the peak ground acceleration (PGA) maps (USGS, 2002) of the area display an increase in ground motion to the west and southwest part of the state (Figures 3.3-7 and 3.3-8). Earthquakes may be concentrating along or near the boundaries of structural provinces (e.g. Black Hills and Missouri Plateau, or Missouri Plateau and High Plains) in the Precambrian, crystalline basement. Two possible faulting mechanisms may be at work: 1) initiation of movement along preexisting fractures due to crustal plate movements; or 2) fault movement and fracturing due to glacial rebound (South Dakota Department of Emergency Management website).

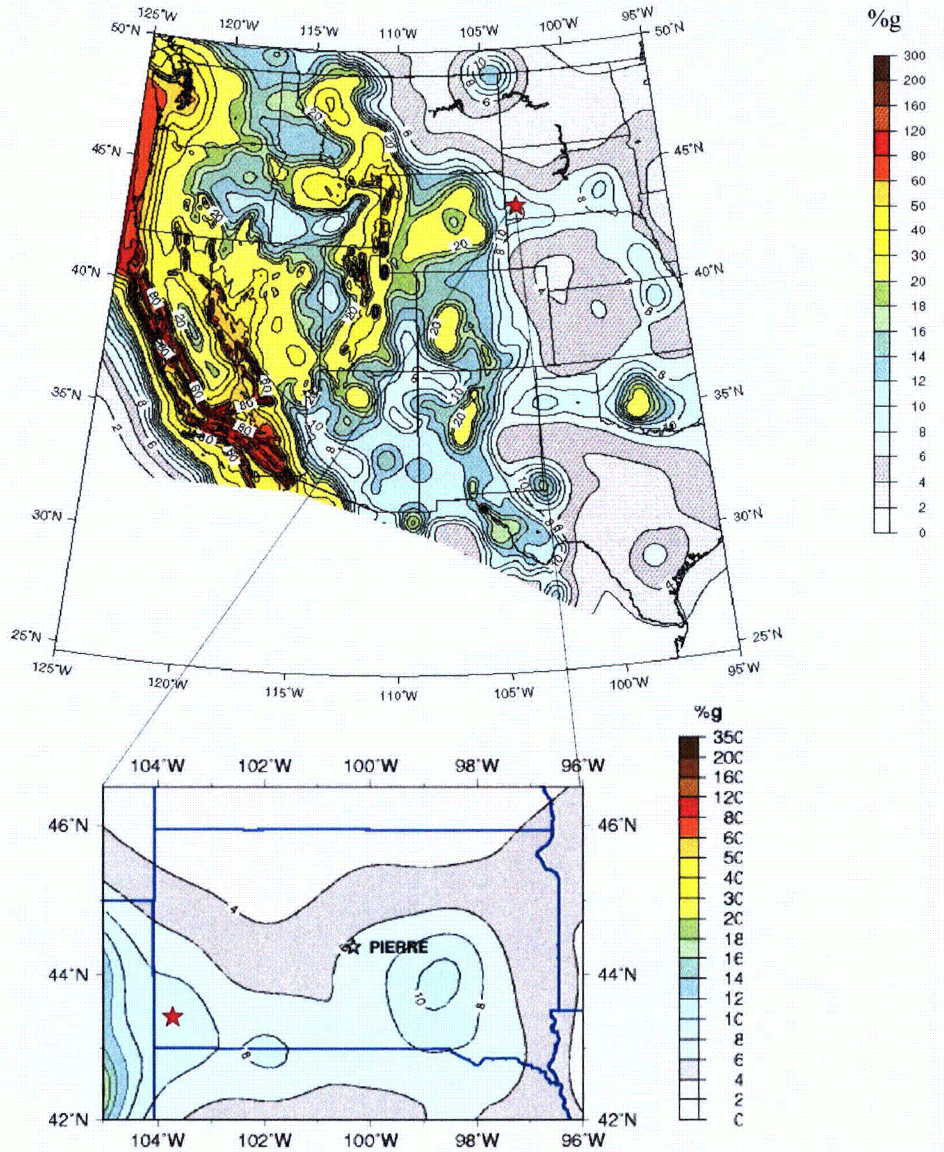
According to the U.S. Geological Survey's 2002 Seismic Hazard Mapping Program, the PGA derived from the probabilistic maximum bedrock acceleration with a 10 percent exceedance in 50 years (475-year return period) is 0.03g (Figure 3.3-7) for the southwestern part of South Dakota. The probabilistic maximum bedrock acceleration with a 2 percent chance of exceedance in 50 years (2,475-year return period) is 0.09g for the region (Figure 3.3-8).



Map Source: USGS website (http://earthquake.usgs.gov/research/hazmaps/products_data/2002/wus2002.php)

Michael W. West and Associates, Inc. Consulting Engineers and Geologists	PGA Map (10% Probability Exceedance 50 years) Dewey-Burdock Project southwestern South Dakota	BY: JMF	05/12/2008
		Proj.: 08807	

Figure 3.3-6: Peak Ground Acceleration (PGA), Illustrating 10% Probability of Exceedance in the Next 50 Years



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary
National Seismic Hazard Mapping Project

★ Approximate Site Location

Map Source: USGS website (http://earthquake.usgs.gov/research/hazmaps/products_data/2002/wus2002.php)

Michael W. West and Associates, Inc. Consulting Engineers and Geologists	PGA Map (2% Probability Exceedance in 50 Years) Dewey-Burdock Project southwestern South Dakota	BY: JMF	05/12/2008
		Proj.: 08807	

Figure 3.3-7: Peak Ground Acceleration (PGA), Illustrating 2% Probability of Exceedance in the Next 50 Years

3.3.6.2.1 Seismic Sources

Assessment of seismic hazards requires consideration of potential earthquake source zones, either identifiable faults or larger areas with common seismic characteristics. Once potential source zones have been identified, design earthquakes can be assigned based on a synthesis of geological and seismological data.

3.3.6.2.2 Capable Faults

PAA is located in an area of historically low seismic potential. There are no known capable faults within 100 km (62 miles) of the site and a relatively low number of historical earthquakes (Figure 3.3-6; Appendix 3.3-G). The closest capable fault zone to PAA is located nearly 345 km (200 miles) west of the site in central Wyoming. Therefore, the randomly occurring 'floating' earthquake is considered to be the most significant seismic hazard for PAA (discussed below), the same as the maximum credible earthquake as defined in 10 CFR Part 40, Appendix A Criterion 4(e) quoted above.

3.3.6.2.3 The Randomly Occurring 'Floating' Earthquake

Industry standards and federal regulations require an analysis of the earthquake potential in regions where the surface expression of active faults is not mapped or exposed, and where earthquake epicenters are associated with buried faults with no associated surface rupture. Earthquakes associated with buried faults are assumed to occur randomly and can occur anywhere within that area of uniform earthquake potential. In reality, random earthquake distribution may not be the case, since all earthquakes are associated with specific faults. However, since all buried faults in the PAA have not been identified, it is reasonable to consider the distribution to be random. A 'floating' earthquake is an earthquake that is considered to occur randomly within a tectonic province.

The U.S. Geological Survey identified tectonic provinces for the contiguous United States (Algermissen et al., 1982). PAA is located in a source zone with a uniformly distributed seismicity which generally encompasses the Black Hills and surrounding environs. The zone is characterized by an earthquake with maximum magnitude M_{max}=6.1. We use this magnitude as our best estimate for the floating earthquake.

3.3.6.3 Conclusion

Seismic hazards at PAA include low to moderate ground shaking associated with regional and local earthquake sources. Figures 3.3-6 through 3.3-8 illustrate seismicity and PGA maps for the PAA, and Appendix 3.3-G is a summary of the USGS database results for historical earthquakes recorded within 100 and 200 km from the site since 1973.

There are no capable faults (as defined in section III(g) of Appendix A of 10 CFR Part 100) known to be present within 100 km of the PAA. The closest capable fault zone to the PAA is located nearly 345 kilometers (200 miles) west of the site in central Wyoming. Therefore, the most significant seismic hazard is the randomly occurring, or 'floating', earthquake for the PAA. This is the maximum credible earthquake estimated for the project based on available literature, geologic information of the surrounding area, and historical data. A magnitude M_{max}=6.1 is estimated for this event.

According to the U.S. Geological Survey's 2002 Seismic Hazard Mapping Program, PGA derived from the probabilistic maximum bedrock acceleration with a 10 percent exceedance in 50 years (475-year return period) is 0.03g (Figure 3.3-7) for the southwestern part of South Dakota. The probabilistic maximum bedrock acceleration with a 2 percent chance of exceedance in 50 years (2,475-year return period) is 0.09g for the region (Figure 3.3-8). Both of these estimates are considered to reflect a relatively low ground motion hazard.

3.4 Water Resources

3.4.1 Water Use

3.4.1.1 Regional Groundwater Use

The PAA is located at the southwestern edge of the Black Hills. The major aquifers of the Black Hills are the Inyan Kara, Minnelusa, Madison and Deadwood (see Section 3.3.1.2). Within Fall River and Custer Counties, each of these aquifers is used, with wells generally being drilled into the next underlying aquifer below the surface. There is no public data available to quantify the use from each of these aquifers within Fall River or Custer County.

3.4.1.2 Site Area Groundwater Use

In the PAA, the Fall River and Lakota Formations, together forming the Inyan Kara aquifer, are the principal sources of water. An inventory of private water-supply wells within an approximate 2 km radius of the proposed permit boundary was conducted in June 2007, during which about 80 wells were located (see Appendix 3.4-A). Most wells within 2 km of the site serve as water supply for livestock (26), although some wells are used for domestic (10) or other purposes (47) including piezometers, mine dewatering wells, and garden watering.

Wells within 2 km of the site include 24 wells known to obtain water from the Fall River Formation, with 12 of these wells being flowing artesian wells. Based on measurements from flowing wells and estimates from others, an estimated 15 gpm is currently being consumed from the Fall River. Within this same 2 km radius, there are 39 wells currently obtaining water from the Lakota Formation, 14 of which are flowing artesian. The estimated flow from these Lakota wells is 46 gpm. Additionally, 10 wells are completed within an unknown formation of the Inyan Kara aquifer (Fall River, Lakota, or both). The total estimated flow from the Inyan Kara (including wells screened within the Fall River, Lakota, or both) within 2 km of the site is approximately 70 gpm. There are six wells completed in the Sundance/Unkpapa, with four that are flowing. Within 2 km, an additional eight wells are completed into an unknown aquifer. Wells within the PAA that are currently in use are shown on Figure 3.4-1. Twenty-six wells in the vicinity of the PAA were deemed abandoned because of the condition and inactivity of the well; these wells termed abandoned are not considered properly plugged and abandoned.

Well completion reports and other related data are found in Appendix 3.4-B.

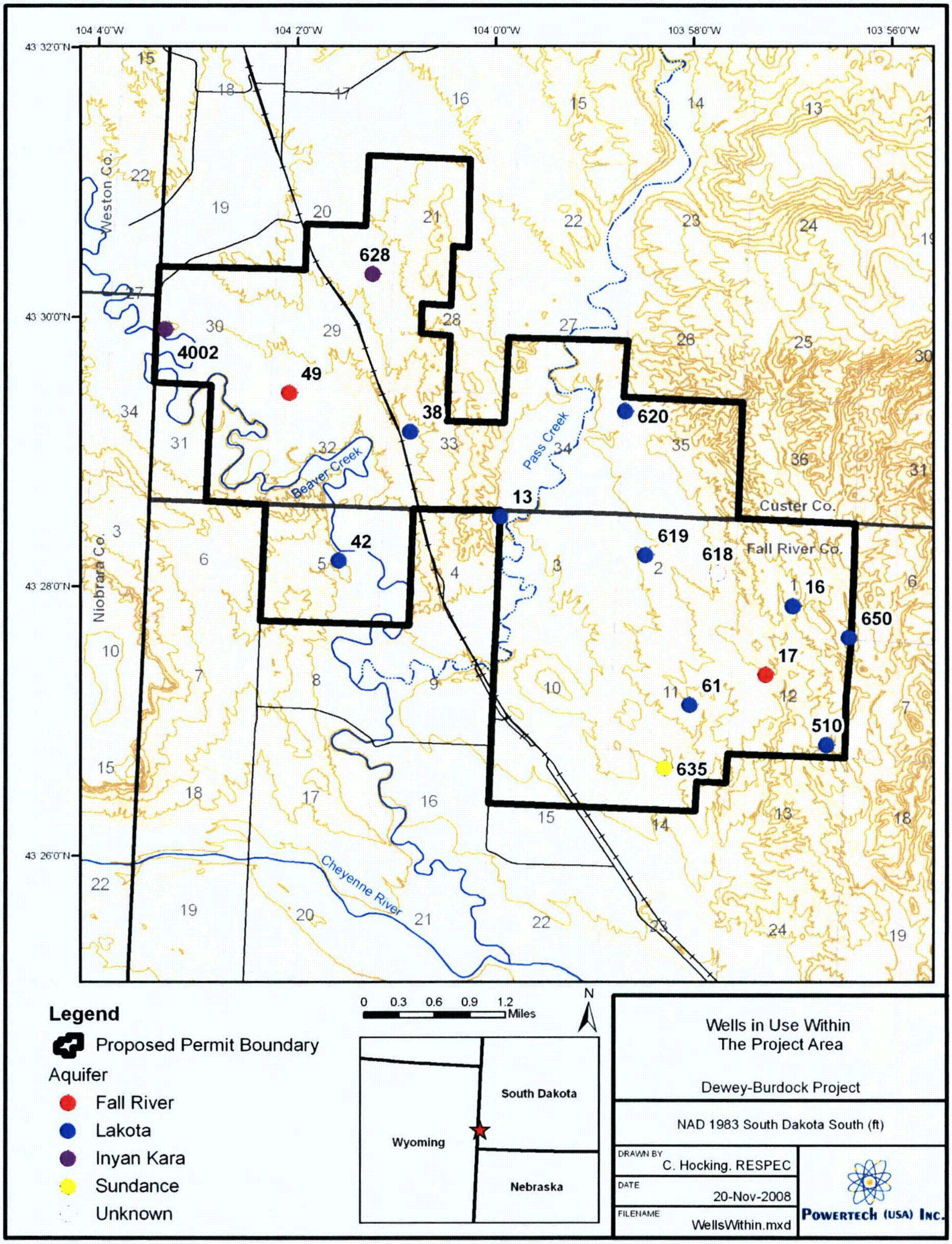


Figure 3.4-1: Wells in Use within the PAA

3.4.2 Surface Water

The Upper Cheyenne River basin extends through three states – Wyoming, Nebraska, and southwestern South Dakota (HUC No. 10120106, 10120107, 10120108). Within these states the Cheyenne River basin, above Angostura Reservoir in South Dakota, drains an area of approximately 8,996 square miles (mi^2) (Beauvais, 2000). The northern and central portions of the watershed are in the Black Hills division of the Great Plains and the southern portion is in the Pierre Hills division of the Great Plains (Kalvels, 1982 and Ensz, 1990). Land elevation ranges from about 3,160 feet (963 meters [m]) to 7,015 feet (2,138 m) above mean sea level.

3.4.2.1 Drainage Basins

The PAA lies primarily within the Beaver Creek Basin and is drained by both Beaver Creek and Pass Creek. The Pass Creek watershed is a sub-basin within the Beaver Creek basin, but the two watersheds were characterized as separate basins. The Beaver Creek system flows through the northwestern section of the PAA from the northwest to the southeast. The Pass Creek system flows south through the central portion of the PAA and joins Beaver Creek southwest of the PAA. Three miles south of this confluence, Beaver Creek converges with the Cheyenne River (Figure 3.4-2) which eventually flows into the Missouri River.

The nearest discharge gage on the Cheyenne River upstream of its confluence with Beaver Creek is USGS gage 06386500 near Spencer, WY. The nearest discharge gage downstream of the confluence of Beaver Creek and the Cheyenne River is USGS gage 06395000 at Edgemont, SD. This gage captures the contribution of flow to the Cheyenne River from Beaver Creek and Pass Creek between Spencer, WY and Edgemont, SD. Figure 3.4-3 shows an annual hydrograph for gage 06386500 from 1948 to 2008, and Figure 3.4-4 shows an annual hydrograph for gage 06395000 from 1903 to 2008. The lines in Figures 3.4-3 and 3.4-4 indicate the upper bound flow values for the 25th, 50th, and 95th flow percentiles for each of the 365 days per year. For example (in Figure 3.4-4), based on all of the January 1st flow values during 1903 to 2008 (106 data points), the flow was less than 1 cfs on 25 percent of those days (26 days), less than 4 cfs on 50 percent of those days (53 days) and less than 30 cfs on 95 percent of those days (101 days). Therefore, the graph indicates how variable the stream flow tends to be at various times during the year (e.g., more variable during a typical July than a typical November).

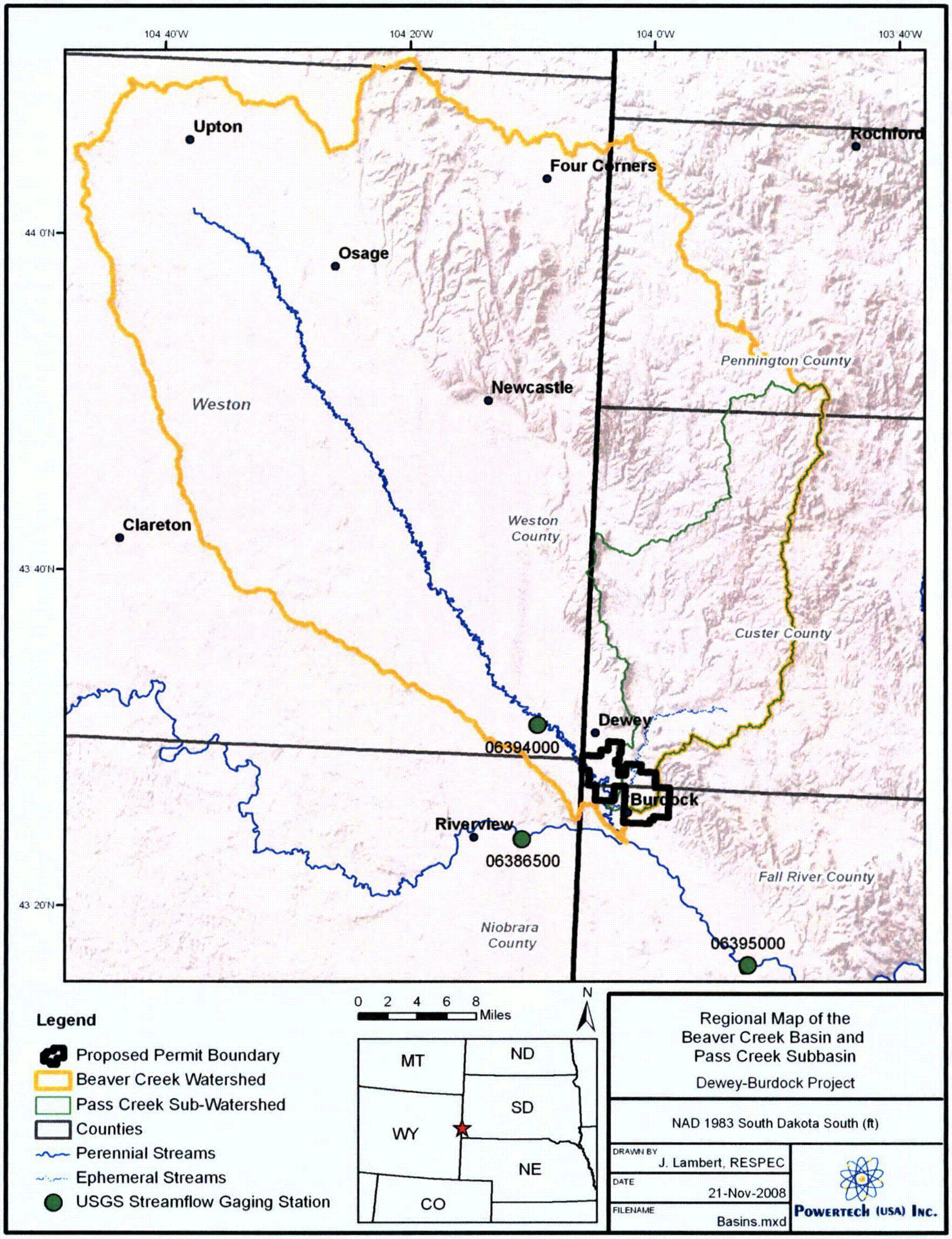


Figure 3.4-2: Regional map of the Beaver Creek and Pass Creek Basins

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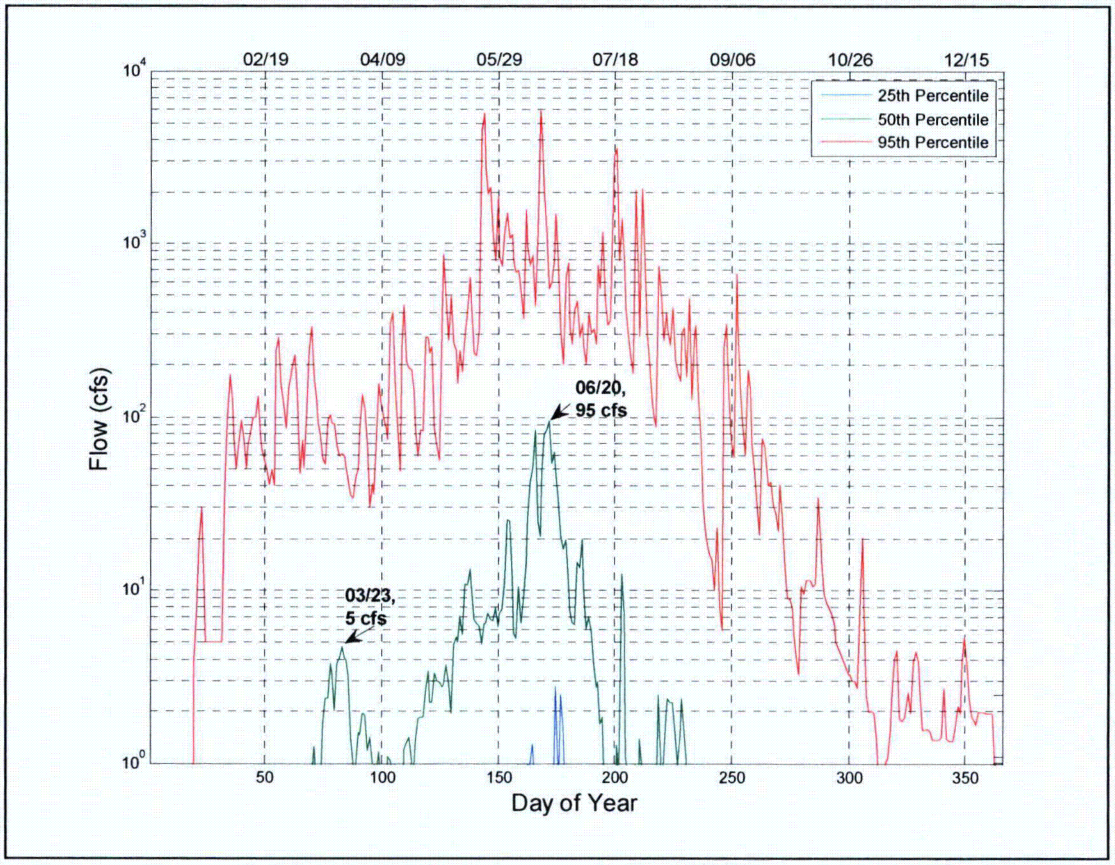

Figure 3.4-3: Annual Hydrograph for USGS Gage 06386500 on the Cheyenne River near Spencer, WY from 1948 to 2008

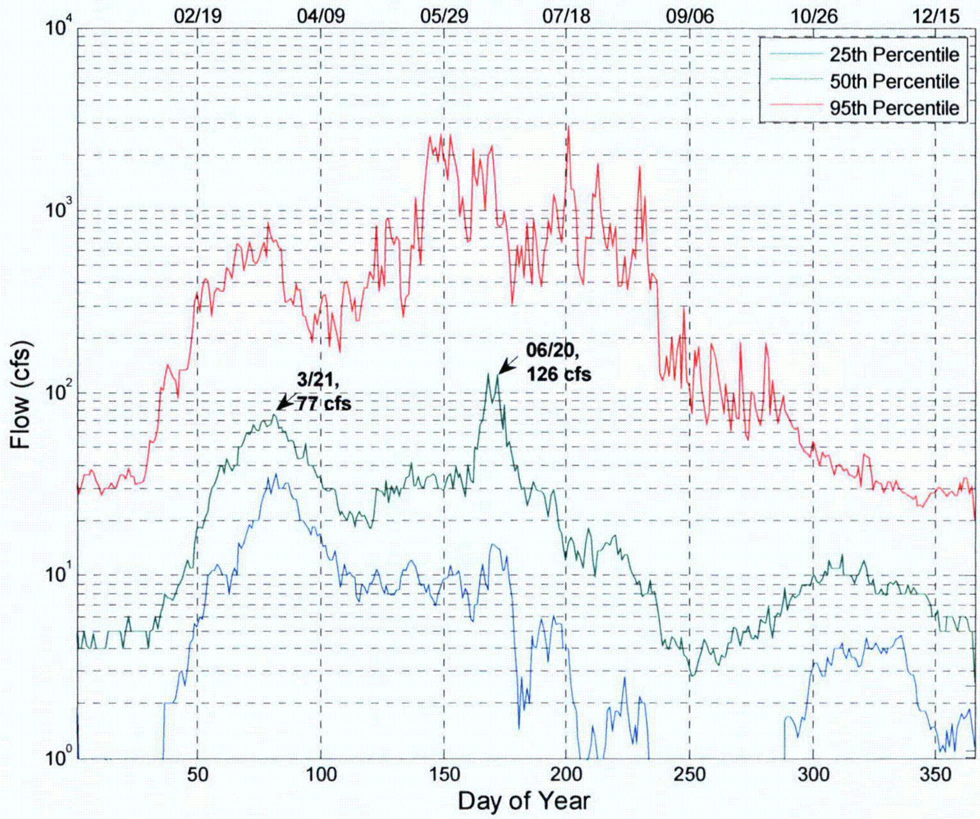

Figure 3.4-4: Annual Hydrograph for USGS Gage 06395000 on the Cheyenne River at Edgemont, SD from 1903 to 2008

3.4.2.1.1 Beaver Creek Basin

The Beaver Creek Basin is 1360 mi^2, excluding the Pass Creek sub-basin. It extends from a few miles northwest of Upton, WY to about eight miles southeast of Dewey, SD and lies within Weston, Niobrara and Crook Counties in Wyoming, and within Pennington, Custer and Fall River Counties in South Dakota. Beaver Creek is a perennial stream with ephemeral tributaries. Discharge data for Beaver Creek is collected at USGS gage 06394000 near Newcastle, WY (Figure 3.4-2). Figure 3.4-5 shows an annual hydrograph with the 25^{th}, 50^{th} and 95^{th} flow percentiles for this gage from 1944 to 1998. Figure 3.4-6 shows monthly average flow data for this gage from 1944 to 1998.

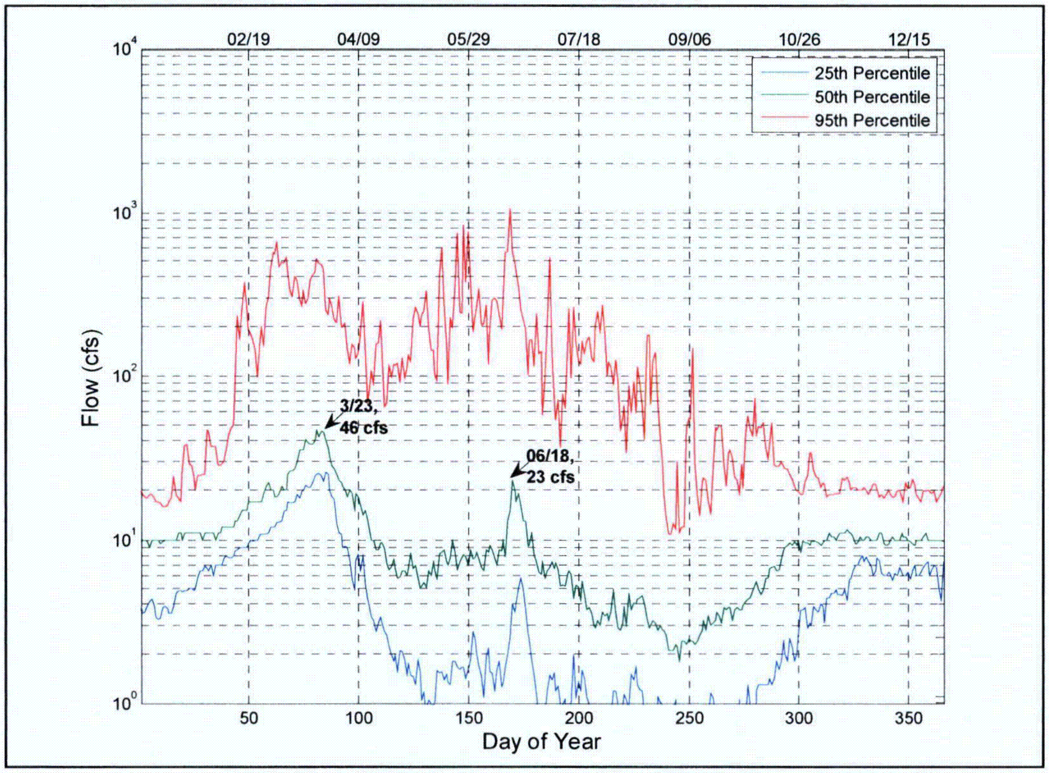

Figure 3.4-5: Annual Hydrograph for USGS Gage 06394000 on Beaver Creek near Newcastle, WY from 1944 to 1998

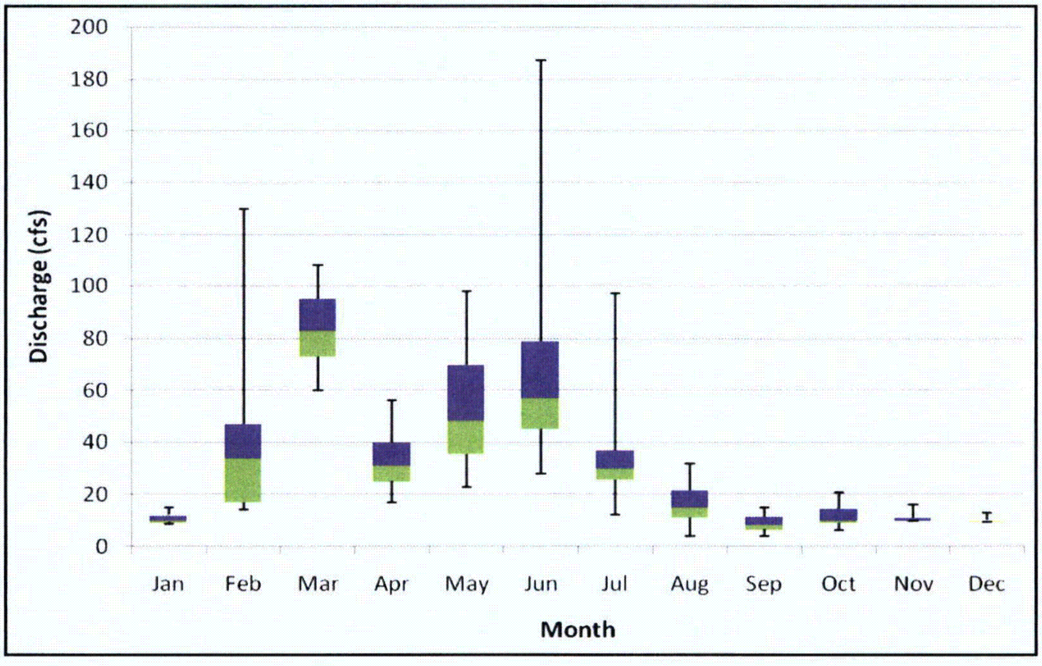

Figure 3.4-6: Monthly average flows at USGS gage 06394000 on Beaver Creek near Newcastle, WY from 1944 to 1998

3.4.2.1.2 Pass Creek Watershed

The Pass Creek watershed, characterized as a subbasin of the larger Beaver Creek Basin, comprises most of the east-southeast portion of the Beaver Creek Basin and is almost fully contained in South Dakota. The Pass Creek watershed is 230 mi^2 and is located in Custer, Fall River, and Pennington Counties in South Dakota and a very small portion of Weston County in Wyoming. Pass Creek is dry except for brief periods of runoff following major storms. There is no permanent stream flow gage stationed along Pass Creek.

3.4.2.2 Surface Water Quality

The proposed PAA is drained by the Cheyenne River and its tributaries (Figure 3.4-2). Beaver Creek and Pass Creek drain the proposed permit area and discharges into the Cheyenne River downstream of the proposed permit area. Beaver Creek drains the southeastern portion of Weston County in Wyoming before entering Custer County in South Dakota and discharging to the Cheyenne River south of Burdock in Fall River County. Beaver Creek drains approximately 1670 mi^2 (1,069,000 acres); 71 percent of the watershed is in Wyoming and 29 percent is in South Dakota. The Pass Creek watershed, characterized as a sub basin of the larger Beaver Creek basin, comprises most of the east-southeast portion of the Beaver Creek basin and is almost fully contained in South Dakota. The Pass Creek watershed is 230 mi^2 and is located in Custer, Fall River, and Pennington Counties in South Dakota and a very small portion of Weston County in Wyoming. Several smaller ephemeral tributaries are also located within or adjacent to the proposed permit area. These streams, including the Cheyenne River, often experience extended periods of no flow. Water quality varies considerably and is dependent on the flow regime. Relatively high amounts of sediment and low dissolved solids occur during periods of high flows, while less turbid waters with higher dissolved solids occur during periods of low flows (Krantz, 2006).

All surface waters in the State of South Dakota are classified into one or more of the following beneficial uses:

1. Domestic water supply waters
2. Coldwater permanent fish life propagation waters
3. Coldwater marginal fish life propagation waters
4. Warmwater permanent fish life propagation waters

5. Warmwater semipermanent fish life propagation waters
6. Warmwater marginal fish life propagation waters
7. Immersion recreation waters
8. Limited contact recreation waters
9. Fish and wildlife propagation, recreation, and stock watering waters
10. Irrigation waters
11. Commerce and industry waters

Table 3.4-1 gives State of South Dakota assigned beneficial uses for Beaver Creek, Cheyenne River, and Pass Creek. Water quality standards associated with beneficial uses of Cheyenne River, Beaver Creek, and Pass Creek are given in Table 3.4-2.

Table 3.4-1: Beneficial uses of Streams in and near the Dewey-Burdock Permit Area

Waterbody	Uses
Beaver Creek	3, 8, 9, 10
Cheyenne River (from Wyoming border to Angostura Reservoir)	5, 8, 9, 10
Pass Creek	9, 10

Table 3.4-2: Beneficial Use Numeric Criteria

Parameters (mg/L) except where noted	(3) Coldwater marginal fish life propagation BC	(5) Warmwater semipermanent fish life propagation CR	(8) Limited contact recreation BC, CR	(9) Fish, wildlife propagation, recreation, stock watering ALL	(10) Irrigation ALL
alkalinity (CaCO3)				≤750[1] ≤1,313[2]	
Chlorine, total residual	≤0.019 (acute); ≤0.011 (chronic)	≤0.019 (acute); ≤0.011 (chronic)			
Coliform, fecal (cfu per 100 mL)			≤1,000 (mean); ≤2,000 (single sample)		
Conductivity (µmhos/cm @ 25°C)				≤4,000[1] ≤7,000[2]	≤2,500[1] ≤4375[2]
Hydrogen sulfide, undisassociated	≤0.002	≤0.002			
Nitrogen, unionized ammonia as N	Calculation[3]	Calculation[3]			
Nitrogen, nitrates as N				≤50[1] ≤88[2]	
Oxygen, dissolved	≥5.0	≥5.0			
pH (standard units)	6.5 – 8.8	6.5 – 9.0		6.0 – 9.5	
Sodium Adsorption Ratio					≥10
Solids, suspended	≤90[1] ≤158[2]	≤90[1] ≤158[2]			
Solids, total dissolved				≤2,500[1] ≤4,375[2]	
Temperature (°F)	≤75	≤90			
Total Petroleum Hydrocarbons				≤ 10.0	
Oil and Grease				≤ 10.0	

[1] Thirty-day average [2] Daily maximum [3] Calculation based on temperature and pH

Cheyenne River in South Dakota upstream and downstream of the proposed permit boundary is classified as having beneficial uses 5, 8, 9, and 10. According to the State of South Dakota 2006 303(d) list, the Cheyenne River from the Wyoming border to Beaver Creek is impaired with respect to beneficial uses fish and wildlife propagation, recreation, and stock watering (9), and irrigation (10) due to high levels of total dissolved solids (TDS), sodium adsorption ratio (SAR), and conductivity. The rivers support status related to warm water semi-permanent fish life propagation (5) and limited contact recreation (8) is listed as "insufficient info" (SD DENR, 2006). The Cheyenne River from Beaver Creek to Angostura Reservoir is listed as supporting the beneficial use of limited contact recreation (8), but is impaired for the other three uses (5, 9, 10) due to high levels of TDS, SAR, conductivity, and total suspended solids (TSS).

Beaver Creek in South Dakota has been classified as being suitable for the same uses as the Cheyenne River except that this stream has been classified as being suitable for cold water marginal fish life propagation rather than warm water semi-permanent fish life propagation. The State of Wyoming has classified Beaver Creek in the PAA vicinity as presently supporting game fish or having the potential to support game fish. Beaver Creek has also been classified by Wyoming as a warm water fishery. Beaver Creek is listed as impaired from the Wyoming border to the confluence with the Cheyenne River with respect to all assigned beneficial uses due to high conductivity, TDS, TSS, fecal coliform, SAR, and temperature.

Pass Creek is classified by the State of South Dakota as having the beneficial uses of fish and wildlife propagation, recreation, and stock watering (9), and irrigation (10). Pass Creek is listed as being in full support of assigned beneficial uses.

3.4.3 Groundwater

3.4.3.1 Regional Hydrogeology

Five major aquifers are utilized as groundwater resources in the Black Hills. These main aquifers are the Inyan Kara, Minnelusa, Madison, and Deadwood. The groundwater hydrology is influenced by distribution and variation in recharge, leakage between overlying and underlying hydrogeologic units, lateral flow within the aquifers, and discharge to pumping wells, artesian wells, and springs.

Regionally, the general direction of groundwater flow is downdip or radially away from the central part of the Black Hills where the aquifers are recharged via infiltration from local rainfall. The aquifers transition from unconfined at the outcrop areas to confined away from the central highlands. At some distance away from the highlands the groundwater often is under sufficient pressures for artesian conditions and flowing artesian wells to exist.

Figure 3.4-7 provides an overview of the hydrologic setting and general hydrogeologic flow within the Black Hills.

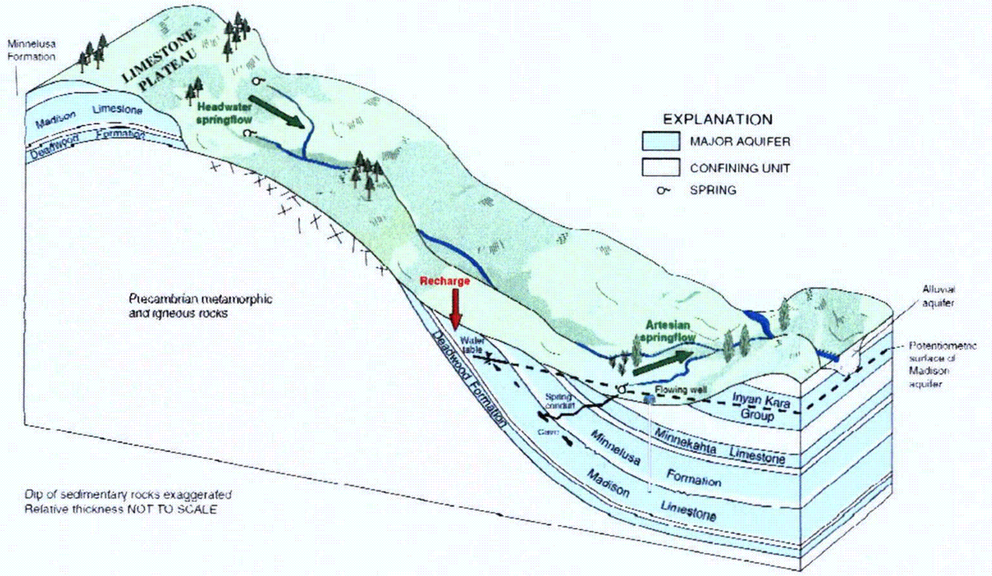

DIAGRAM SHOWING A SIMPLIFIED VIEW OF THE HYDROGEOLOGIC SETTING OF THE BLACK HILLS AREA (modified from Driscoll et al, 2002)

DEWEY-BURDOCK PROJECT

DRAWN	L. Tafoya
DATE	12-Nov-2008
SCALE	NONE
FILENAME	Figure 5.1.dwg

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Figure 3.4-7: Diagram Showing a Simplified View of the Hyrdrogeologic Setting of the Black Hills Area

3.4.3.1.1 Regional Hydrostratigraphic Units

This section summarizes the aquifers in the Black Hills, including general characteristics and hydraulic properties. Hydrologic units of interest within the Black Hills area are shown on the stratigraphic column in Figure 2.2-4. Additional information on the geologic units within the study area is provided in Section 2.6. Table 3.4-3 (from Driscoll et al., 2002) summarizes hydraulic properties of major aquifers determined in previous investigations.

3.4.3.1.2 Inyan Kara Aquifer

On the prairie away from the central Black Hills, the Inyan Kara is typically the first significant aquifer encountered. The Inyan Kara aquifer is comprised of two sub-aquifers, the Lakota and the Fall River, which are separated by the Fuson shale confining unit. Regionally, the Inyan Kara ranges from 250 to 500 feet. The Inyan Kara is a very heterogeneous formation, which results in the two (2) aquifers exhibiting a large variation in local characteristics. Regionally, the Inyan Kara exhibits a large effective porosity (0.17) and the aquifer can yield considerable water from storage (Driscoll et al., 2002). Within the Black Hills, transmissivity of the Inyan Kara ranges from 1 to 6,000 ft^2/day. This high variability is an indication of the complex heterogeneity of the Inyan Kara formation. The Inyan Kara is confined below by the Morrison Formation (50-100 ft thick) and above by Cretaceous Graneros Group shale.

3.4.3.1.3 Minnelusa Aquifer

The Minnelusa Formation consists of interbedded siltstone, sandstone, anhydrite, and limestone (SDSM&T, 1963). The Minnelusa aquifer occurs primarily in saturated sandstone and anhydrite beds within the upper part of the formation (Williamson and Carter, 2001). Within the Black Hills, the Minnelusa ranges in thickness from 375 to 1,175 feet (Driscoll et al., 2002). The porosity is dominantly primary porosity within the sandstone beds, although secondary porosity is present in association with fractures and dissolution features (Williamson and Carter, 2001). Various studies have found the transmissivity of the Minnelusa to range from 1 to 12,000 ft^2/day (Table 3.4-3). The Minnelusa aquifer is confined above by the Opeche Shale and below by lower permeability layers at the base of the Minnelusa formation.

Table 3.4-3: Estimates of Hydraulic Conductivity, Transmissivity, Storage Coefficient, and Porosity of Major Aquifers from Previous Investigations

[ft/d, feet per day; ft²/d, feet squared per day; --, no data; <, less than]

Source	Hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)	Storage coefficient	Total porosity/ effective porosity	Area represented
Precambrian aquifer					
Rahn, 1985	--	--	--	0.03/0.01	Western South Dakota
Galloway and Strobel, 2000		450 - 1,435		0.10/--	Black Hills area
Deadwood aquifer					
Downey, 1984	--	250 - 1,000	--	--	Montana, North Dakota, South Dakota, Wyoming
Rahn, 1985	--	--	--	0.10/0.05	Western South Dakota
Madison aquifer					
Konikow, 1976	--	860 - 2,200	--	--	Montana, North Dakota, South Dakota, Wyoming
Miller, 1976	--	0.01 - 5,400	--	--	Southeastern Montana
Blankennagel and others, 1977	$2.4x10^{-5}$ - 1.9	--	--	--	Crook County, Wyoming
Woodward-Clyde Consultants, 1980	--	3,000	$2x10^{-4}$ - $3x10^{-4}$	--	Eastern Wyoming, western South Dakota
Blankennagel and others, 1981	--	5,090	$2x10^{-5}$	--	Yellowstone County, Montana
Downey, 1984	--	250 - 3,500	--	--	Montana, North Dakota, South Dakota, Wyoming
Plummer and others, 1990	--	--	$1.12x10^{-6}$ - $3x10^{-5}$	--	Montana, South Dakota, Wyoming
Rahn, 1985	--	--	--	0.10/0.05	Western South Dakota
Cooley and others, 1986	1.04	--	--	--	Montana, North Dakota, South Dakota, Wyoming, Nebr.
Kyllonen and Peter, 1987	--	4.3 - 8,600	--	--	Northern Black Hills
Imam, 1991	$9.0x10^{-6}$	--	--	--	Black Hills area
Greene, 1993	--	1,300 - 56,000	0.002	0.35/--	Rapid City area
Tan, 1994	5 - 1,300	--	--	0.05	Rapid City area
Greene and others, 1999	--	2,900 - 41,700	$3x10^{-4}$ - $1x10^{-3}$	--	Spearfish area
Carter, Driscoll, Hamade, and Jarrell, 2001	--	100 - 7,400	--	--	Black Hills area
Minnelusa aquifer					
Blankennagel and others, 1977	$<2.4x10^{-5}$ - 1.4	--	--	--	Crook County, Wyoming
Pakkong, 1979	--	880	--	--	Boulder Park area, South Dakota
Woodward-Clyde Consultants, 1980	--	30 - 300	$6.6x10^{-5}$ - $2.0x10^{-4}$	--	Eastern Wyoming, western South Dakota

Table 3.4-3: Estimates of Hydraulic Conductivity, Transmissivity, Storage Coefficient, and Porosity of Major Aquifers from Previous Investigations (Concl.)

Source	Hydraulic conductivity (ft/d)	Transmissivity (ft^2/d)	Storage coefficient	Total porosity/ effective porosity	Area represented
Minnelusa aquifer—Continued					
Rahn, 1985	--	--	--	0.10/0.05	Western South Dakota
Kyllonen and Peter, 1987	--	0.86 - 8,600	--	--	Northern Black Hills
Greene, 1993	--	12,000	0.003	0.1/--	Rapid City area
Tan, 1994	32	--	--	--	Rapid City area
Greene and others, 1999	--	267 - 9,600	$5.0x10^{-9}$ - $7.4x10^{-5}$	--	Spearfish area
Carter, Driscoll, Hamade, and Jarrell, 2001	--	100 - 7,400	--	--	Black Hills area
Minnekahta aquifer					
Rahn, 1985	--	--	--	0.08/0.05	Western South Dakota
Inyan Kara aquifer					
Niven, 1967	0 - 100	--	--	--	Eastern Wyoming, western South Dakota
Miller and Rahn, 1974	0.944	178	--	--	Black Hills area
Gries and others, 1976	1.26	250 - 580	$2.1x10^{-5}$ - $2.5x10^{-5}$	--	Wall area, South Dakota
Boggs and Jenkins, 1980	--	50 - 190	$1.4x10^{-5}$ - $1.0x10^{-4}$	--	Northwestern Fall River County
Bredehoeft and others, 1983	8.3	--	$1.0x10^{-5}$	--	South Dakota
Rahn, 1985	--	--	--	0.26/0.17	Western South Dakota
Kyllonen and Peter, 1987	--	0.86 - 6,000	--	--	Northern Black Hills

3.4.3.1.4 Madison Aquifer

Within the Black Hills, the Madison Limestone, also known as the Pahasapa Limestone, could be considered the most important aquifer because it is the source of municipal water in numerous communities including Rapid City and Edgemont. The hydraulic characteristics of the Madison Limestone aquifer have been studied for several decades in the region and Table 3.4-3 summarizes the regional findings. The Madison aquifer is mainly a dolomite unit characterized by extensive secondary porosity resulting from fractures and associated karstic features (Williamson and Carter, 2001). The thickness of the Madison ranges from 200 feet in the southern Black Hills to 1,000 feet regionally. In the Rapid City area, Greene (1993) found the transmissivity to vary widely between 1,300 and 56,000 ft^2/day. The aquifer varies from unconfined at its outcrop areas to confined, where reported storativity values range from 10^{-3} to 10^{-6} (Table 3.4-3). Regionally a paleosol and low permeability layers within the overlying Minnelusa Formation act to confine the Madison. Locally, these confining layers may be absent or their hydraulic characteristics are higher such that intercommunication between the Madison and Minnelusa occurs. The Madison may be in connection with the underlying Deadwood aquifer when the Whitewood and Winnipeg confining units are absent.

3.4.3.1.5 Deadwood Aquifer

Overlying the Precambrian, the Cambrian Deadwood Formation consists of basal conglomerates, sandstone, limestone, and mudstone. The thickness of the Deadwood is between zero (0) and 500 feet (Driscoll et al., 2002). Rahn (1985) estimated the effective porosity of the aquifer to be 0.05. In the northern Black Hills the effective porosity is presumably lower, in areas where the formation has undergone extensive hydrothermal alteration. The transmissivity of the Deadwood within the region is 250 to 1,000 ft2/day (Table 3.4-3) (Downey, 1984). Regionally, "the Precambrian rocks act as a lower confining unit to the Deadwood aquifer," although local connection can exist (Williamson and Carter, 2001). The Deadwood aquifer is in contact with the overlying Madison aquifer except where the Whitewood and Winnipeg formations are present and act as semiconfining units (Strobel et al., 1999).

3.4.3.1.6 Minor Aquifers

In addition to the major aquifers, minor aquifers around the Black Hills include the Minnekahta Limestone, Sundance/Unkpapa, Newcastle Sandstone, and alluvium. Where present and saturated, these units may yield small amounts of water. Locally, beds within the confining units may also contain aquifers (Driscoll et al., 2002). Typically, these minor aquifers are not heavily utilized because of more reliable sources in adjacent aquifers.

3.4.3.1.7 Regional Hydraulic Connection of Aquifers

Because of the geologic variability across the Black Hills, several mechanisms can serve to create hydraulic connection between aquifers. Most interconnection appears to be associated with the thinning or absence of confining units between aquifers, which has been documented in local and regional geologic studies (Miller, 2005). Analyses of regional aquifer tests conducted around the Black Hills provide direct evidence of aquifer interconnection or separation. A few examples are mentioned below.

- Recent pumping tests within the Deadwood aquifer near Jewel Cave indicate that vertical leakage through a confining layer is occurring in that area (Valder, 2006).
- In Rapid City, Rahn (1989) points to different artesian pressures reported in Sioux Park wells, installed into different hydrogeologic units, as evidence that the units are hydraulically separated.
- Studies by Long and Putnam (2002) of paired Madison and Minnelusa wells at the City Quarry site indicate hydraulic connection between these units. The variation in yields between areas indicates that locally the interlaying layers may not provide hydraulic separation between the two units. Both well tests and outcrop observations show the variability of hydraulic connection between the Deadwood, Madison, and Minnelusa aquifers.
- Various sources have also suggested that breccia pipes serve as a path between aquifers. The majority of these features are believed to originate within the Minnelusa Formation and extend upward as high as the Inyan Kara (Gott et al., 1974). These breccia pipes are the result of dissolution of significant thicknesses of anhydrite from the upper Minnelusa and subsequent collapse. The greatest concentration of these breccia pipes has been noted within a few miles of the outcrop, although groups of pipes can be concentrated along joints and may extend as "high in the stratigraphic section as the Lakota Formation" (Braddock, 1963). Gott, Wolcott, and Bowles (1974) believed that these breccia pipes allowed large quantities of water to migrate upwards from the Minnelusa into the Inyan Kara.

3.4.3.1.8 Regional Potentiometric Surfaces

As part of the Black Hills Hydrology Study, the USGS developed 1:100,000-scale potentiometric maps for five aquifers including the Inyan Kara, Minnekahta, Minnelusa, Madison, and Deadwood (Strobel et al, 2000). The purpose of these maps is to show the potentiometric surface of the aquifers and to serve as a tool for evaluating groundwater flow directions and hydraulic gradients in the Black Hills area. The potentiometric maps were created by contouring elevations of water levels in wells completed in their respective aquifers. Structural features such as folds and faults were also considered in the contouring of the potentiometric surfaces. In areas where the potentiometric contours have been inferred (dashed), deviations between the map and actual water levels may occur. The following conclusions can be drawn from analysis of the figures:

- Regional flow within the different units is consistent for all units. Flow is radially outward from the central highlands toward the plains.

- Near the outcrop, the aquifers are unconfined. With distance, the aquifers are confined and have water levels above the top of the formation, and locally above the land surface.

3.4.3.1.9 Regional Groundwater Recharge

Aquifers in the Black Hills are recharged by infiltrating precipitation, streamflow losses, and minor seepage from other aquifers. The relative contribution of each of these recharge components is variable in the Black Hills. For instance, recharge is dominated by precipitation on the western limestone plateau, while streamflow dominates in parts of the southern hills (Carter et al., 2000).

The Black Hills are relatively arid with rainfall ranging from 12 to 28 inches per year in the area. Most precipitation can be accounted for as surface runoff or evapotranspiration. Regionally, the percentage of precipitation that recharges the aquifers varies from 30 percent in the northwestern Black Hills to approximately 2 percent in the drier southwestern Black Hills.

Streamflow losses can contribute to aquifer recharge if connection between the stream and underlying aquifer exists. Generally, surface water recharge to groundwater is limited to relatively shallow alluvial aquifers in relatively close proximity to the streams. The exception to this rule occurs in areas where karstic features provide preferential pathways for recharge into the subsurface.

Other sources of recharge to individual units can occur from leakage between units. Regionally, water elevations increase with depth, which provides an upward potential for ground-water flow. This limits the potential for downward recharge. Locally these flow head relationships can be reversed due to pumping of wells, thus creating localized zones where the potential for downward leakage exists.

3.4.3.1.10 Regional Groundwater and Surface Water Interactions

Throughout the Black Hills there are numerous springs in both the Madison and Minnelusa formations. These springs provide the headwaters for many streams in the western hills (Long and Putnam, 2002). Where these streams cross aquifer outcrops along the eastern Black Hills they lose flow into the subsurface through sinkholes and re-emerge downstream in springs and wells (Rahn, 1971 and Long and Putnam, 2002).

In alluvial aquifers, flow is often exchanged between subsurface and surface water. Many of the streams in the Black Hills are losing streams from which stream water infiltrates into the alluvial aquifers. Streams also can be gaining streams, in which they have increased discharge due to inflow from an alluvial aquifer.

The maximum amount of streamflow loss that occurs is known as the loss threshold. When streamflows are less than the loss threshold, then the discharge is the maximum that can be absorbed as recharge. If streamflow is greater than (or equal to) the loss threshold, then recharge equals the loss threshold and the stream will flow over the entire outcrop area.

Hortness and Driscoll (1998) conducted a study of streamflow loses across the Black Hills. Several factors that have been theorized to affect loss rates include streamflow rate, duration of flow across a loss zone, or deposition of large amounts of sediment. These observations are consistent with factors known to influence recharge into the surface: volume of water available, the time period during which recharge can occur, and connectivity with the subsurface as represented by thickness of overlying sediments. Hortness and Driscoll (1998) found no evidence that loss thresholds were affected by upstream flow rates.

3.4.3.2 Site Hydrogeology

Only hydrogeologic units younger than and including the Spearfish Formation (Permo-Triassic age) are described here

Spearfish Formation Confining Unit

In general, the Spearfish Formation is characterized by a thick sequence (250 to 450 feet) of red shale and siltstone. Based on the few exploration holes that have penetrated the entire thickness of the formation in the PAA, the Spearfish is an average of 320 feet thick. This thick sequence of shale serves as a hydrologic barrier or confining unit preventing nearly all vertical flow between the Paleozoic aquifers and the Jurassic/Cretaceous aquifers.

Sundance and Unkpapa Aquifers

Overlying the Spearfish formation, the Sundance and Unkpapa aquifers are considered aquifers of minor importance within the Black Hills. These aquifers are a source of water within the PAA. The Sundance Formation is composed primarily of shale and sandstone with an average thickness of 280 feet thick near the Proposed Action. Where present, the Unkpapa is 50 to 80 feet of well sorted, fine-grained, eolian sandstone. For the purpose of this study, the Sundance and Unkpapa aquifers are considered equivalent, as there is no intervening confining unit separating the two.

Morrison Formation Confining Unit

Overlying the Sundance and Unkpapa aquifers is the Morrison Formation. The Morrison is a shale layer approximately 100 feet thick, which serves as an underlying confining unit between the Inyan Kara and the Sundance aquifers. It is also a hydrogeologic barrier to all other deeper aquifers including the Madison (and the Unkpapa where it exists). The Morrison underlies the entire PAA. Analyses of core samples demonstrate that the Morrison clays have extremely low vertical permeabilities, ranging from 3.9×10^{-9} cm/sec to 4.2×10^{-8} cm/sec (0.004 millidarcies to 0.043 millidarcies).

Inyan Kara Group

The Inyan Kara Group is the principal aquifer in the region of the Proposed Action. Locally, the Cretaceous Inyan Kara Group is consistent with its regional characteristics and is composed of two formations the Lakota (Fuson and Chilson members) and Fall River. In general, the Inyan Kara consists of interbedded sandstone, siltstone, and shale. Based on several measured outcrop sections within the Dewey Quadrangle, the Inyan Kara Group averages 350 feet thick. The Fuson member of the Lakota, underlying the Fall River, varies in thickness from 40 to 70 feet. Throughout most of the region, the Fuson is expected to be an effective interaquifer confining unit. Locally, however, results of aquifer tests at the PAA indicate that the Fuson Shale is not an effective barrier in some locations (TVA, 1979). It is possible that, "interaquifer connection here could result from as-yet-unidentified structural features or old open exploration holes" (TVA, 1979). As such, the Inyan Kara is treated in this report as one aquifer with the Fall River and Lakota representing sub-aquifers. The Inyan Kara is confined above by the Graneros Group, a thick sequence of dark shale that varies in thickness from zero (0) feet where the Inyan Kara crops out to more than 500 feet thick in the plains, preventing the vertical migration of water between the Inyan Kara and alluvial aquifers.

Graneros Group Confining Unit

The Graneros Group is composed of several geologic formations including the Skull Creek, Newcastle, Mowry, and Belle Fourche. The group acts as a single unit that confines the Inyan Kara aquifer. In the PAA, the thickness of the Graneros is zero (0) at the outcrop but increases westward to more than 500 feet thick. The Skull Creek Shale has a thickness of approximately 200 feet and is the upper confining unit for the Proposed Action. Core samples were collected from the lower Skull Creek shale; analyses of these core samples demonstrate that the Skull Creek clays have extremely low vertical permeabilities, in the range of 6.8×10^{-9} cm/sec (0.007 millidarcies).

Alluvial Aquifers

For the purpose of this report, the alluvial aquifers in the vicinity of the PAA consist of any saturated alluvial material along Pass Creek, Beaver Creek, and the Cheyenne River. In general, the thickness of the alluvial material varies from zero (0) to 25 feet, although it can reach 40 feet. Based on water level measurements in five alluvial piezometers, the upper 10 to 15 feet of the alluvium is unsaturated. The alluvial material is typically unconfined although localized areas of confinement may exist where weathered shale and other material has slumped on top of the alluvium.

3.4.3.3 Groundwater Quality

This section presents a summary of analyses of recent groundwater quality samples, field measurements, laboratory results. Complete groundwater quality data results are available in Appendix 3.4-C. A number of parameters in the groundwater samples collected at the PAA exceeded the National Primary Drinking Water Standards. Constituents with samples exceeding the standards include arsenic, lead, uranium, radium-226, and gross alpha particles.

3.4.3.3.1 Results for Field Parameters

Results of the groundwater field data gathered during well sampling activities are presented below. Table 3.4-4 gives summary statistics for temperature, dissolved oxygen, specific conductivity, pH, and turbidity for all field data. Tables 3.4-5 and 3.4-6 give field parameter statistics for Lakota, Fall River, and Inyan Kara wells where samples were collected monthly and quarterly, respectively. Table 3.4-7 gives field parameter statistics for alluvial well samples. A comparison of pH and specific conductance values for field and laboratory measurements reveals that laboratory results are within reasonable limits. Most pH values taken in the field are within a few hundredths to few tenths of a pH unit from that measured in the laboratory. For example, the highest pH recorded was 12.67 during sampling of Fall River well 691 on July 1, 2008. The high pH value was verified by the contracting laboratory which reported a pH of 12.4 in the sample. (This represents extremely alkaline water far outside the typical range of groundwater pH. Based on drill core, beds of the Fall River Formation in this area can be extremely well cemented with calcite.)

In the field, a maximum specific conductance of 12,220 uS/cm was measured at alluvial well 677 on September 28, 2007. The laboratory measured a specific conductance of this sample of 11,000 uS/cm. It is important to note that the laboratory conductance is given for the sample at 25°C and at the time of field measurements, the temperature of nearly every sample was much lower.

Table 3.4-4: Statistics for all Field Parameters Collected During Well Sampling Activities

	Temperature, C	pH	Dissolved Oxygen, mg/L	Specific Conductance, uS/cm	Turbidity, NTU
N	156	165	99	169	136
Mean	12.62	7.63	1.29	2122	25.7
StDev	2.09	0.77	2.17	1843	133
Q1	11.73	7.10	0.17	1250	0.6
Median	12.63	7.62	0.29	1409	3.2
Q3	14.08	7.92	1.35	2390	7.5
Min	0.75	6.09	0.02	740	-0.4
Max	16.08	12.67	10.02	12220	1092

N = The number of measurements for a particular parameter.
Mean = Arithmetic mean
StDev = Standard deviation
Q1 = First Quartile. The value holding ranked position 0.25 x (n + 1) for each parameter. Value may be interpolated.
Median = The middle value of ranked n. Value may be interpolated.
Q3 = Third Quartile. The value holding ranked position 0.75 x (n + 1) for each parameter. Value may be interpolated.
Min = The minimum value recorded from all wells
Max = The maximum value recorded from all wells

Table 3.4-5: Field Parameter Statistics for Inyan Kara Wells (Monthly)

	Temperature, C	pH	Dissolved Oxygen, mg/L	Specific Conductance, uS/cm	Turbidity, NTU
N	82	79	53	82	78
Mean	13.41	7.54	0.33	1593	7.2
StDev	1.39	0.76	0.58	611	10.5
Q1	12.33	7.03	0.12	1176	0.7
Median	13.15	7.53	0.19	1345	4.35
Q3	14.56	7.8	0.27	2196	7.5
Min	10.86	6.09	0.02	925	-0.2
Max	16.08	10.79	3.83	3098	71

Table 3.4-6: Field Parameter Statistics for Inyan Kara Wells (Quarterly)

	Temperature, C	pH	Dissolved Oxygen, mg/L	Specific Conductance, uS/cm	Turbidity, NTU
n	42	51	29	53	36
Mean	11.63	7.79	1.80	1469	4.2
StDev	2.59	0.40	1.82	419	9.4
Q1	11.21	7.5	0.43	1214	0.3
Median	11.96	7.86	1.32	1408	0.70
Q3	12.74	8.07	1.87	1579	2.2
Min	0.75	6.96	0.05	740	-0.4
Max	15.78	8.65	7.09	2390	40.9

Table 3.4-7: Field Parameter Statistics for Alluvial Wells

	Temperature, C	pH	Dissolved Oxygen, mg/L	Specific Conductance, uS/cm	Turbidity, NTU
n	18	20	11	19	10
Mean	10.91	7.06	4.53	5964	268
StDev	2.03	0.26	4.05	3195	438
Q1	9.15	6.93	0.91	2920	3
Median	10.99	7.04	1.67	5872	16.9
Q3	12.17	7.18	8.83	6779	505
Min	7.67	6.32	0.55	2609	1.4
Max	15.18	7.52	10.02	12220	1092

3.4.3.3.2 Results for Laboratory Parameters

Summary statistics for baseline monitoring program laboratory samples are contained in Appendices 3.4-D and 3.4-E. Appendix 3.4-D gives statistics for all groundwater constituents detected at or above PQL by constituent. Appendix 3.4-E gives the minimum and maximum value for all sampled constituents detected at or above the PQL, and the site ID and date of the sample that had minimum and maximum detection value. Complete laboratory analytical results for each well are provided in Appendix 3.4-C.

3.4.3.3.3 Comparison of Site Baseline Water Quality to Drinking Water Standards

3.4.3.3.3.1 US EPA and South Dakota Primary Drinking Water Standards

Table 3.4-8 gives current National Primary and Secondary Drinking Water Standards as regulated by EPA. Also listed is the number of samples analyzed for each constituent, the total number of detections above the reporting limit, and the total number of detections equal to or above the Maximum Contaminant Level (MCL) for each constituent. These standards or MCLs are enforced by the EPA on public drinking water systems but can only serve as a guide for private water systems. Private water systems, as defined by the EPA, serve less than 25 people and have less than 15 service connections; all other systems are defined as public water systems. All drinking water wells within the PAA are private water systems.

As of August 24, 2004 all of the South Dakota Drinking Water Standards rules (ARSD 74:04:05) and Public Notice rules (ARSD 74:04:06) were repealed. In their place is ARSD 74:04:12. This new rule adopts by reference the latest published version of the Code of Federal Regulations (40 CFR Part 141), making South Dakota drinking water standards the same as EPA Primary Drinking Water Quality standards (Table 3.4-8).

Table 3.4-8: Sampling Statistics with Water Quality Regulatory Limits for Public Drinking Water Supply Systems

Test Analyte/Parameter	Units	EPA Maximum Contaminant Level (MCL)	Number of Samples Analyzed*	Number of Detections	Number of Detections equal to or above MCL
BULK PROPERTIES					
pH	pH Units	6.5- 8.5 [1]	141	141	6
Total Dissolved Solids (TDS)	mg/L	500 [1]	141	141	141
CATIONS/ANIONS					
Sodium, Na	mg/L	200 [1]	141	141	63
Chloride, Cl	mg/L	250 [1]	141	141	4
Fluoride, F	mg/L	4; 2[1]	141	136	0
Sulfate, SO4	mg/L	250 [1]	141	141	141
Nitrate (as Nitrogen)	mg/L	10	141	29	0
Nitrite (as Nitrogen)	mg/L	1	141	0	0
Nitrate and Nitrite (Combined)	mg/L	10	141	29	0
TRACE METALS (total)**					
Antimony, Sb	mg/L	0.006	98	0	0
Aluminum, Al	mg/L	0.05-0.2 [1]	141	0	0
Arsenic, As	mg/L	0.01	98	80	11
Barium, Ba	mg/L	2	98	6	0
Beryllium, Be	mg/L	0.004	98	2	0
Boron, B	mg/L	1.4 [2]	98	29	3
Cadmium, Cd	mg/L	0.005	98	0	0
Chromium, Cr	mg/L	0.1	98	1	0
Copper, Cu	mg/L	1.0 [1]; 1.3 [3]	98	5	0
Iron, Fe	mg/L	0.3 [1]; 5 [4]	98	95	2 [1], 1 [4]
Mercury, Hg	mg/L	0.002	170	1	0
Manganese, Mn	mg/L	0.05 [1]; 0.8 [4]	98	98	89 [1], 19 [4]
Molybdenum, Mo	mg/L	0.04 [2]	98	8	2
Nickel, Ni	mg/L	0.1 [2]	98	1	1
Lead, Pb	mg/L	0.015 [3]	98	18	8
Selenium, Se	mg/L	0.05	98	26	0
Silver, Ag	mg/L	0.1 [1], [2]	98	0	0
Strontium, Sr	mg/L	4 [2]	98	97	37
Thallium, Tl	mg/L	0.002	98	0	0
Uranium, U	mg/L	0.030	102	77	18
Zinc, Zn	mg/L	5 [1]; 2 [2]	98	35	0

Table 3.4-8: Sampling Statistics with Water Quality Regulatory Limits for Public Drinking Water Supply Systems (concl.)

Test Analyte/Parameter	Units	EPA Maximum Contaminant Level (MCL)	Number of Samples Analyzed*	Number of Detections	Number of Detections equal to or above MCL
RADIONUCLIDES					
Alpha Particles (dissolved)	pCi/L	15	141	141	104
Beta Particles and Photons	mRem/Year	4	141	137	N/A
Radium 226 and 228 (Combined)	pCi/L	5	135	119	59
Radon-222 (total)	pCi/L	300 [5]	121	121	105

Notes:
[1] "Secondary" guideline value above which use of water may give rise to complaints by consumers
[2] Health Advisory-Lifetime
[3] Action level which if exceeded triggers treatment
[4] Region 8 Permit Limit
[5] Proposed MCL
N/A – Not available
* Number of samples includes results for only those wells that were sampled quarterly or monthly as part of the baseline sampling plan.
**Number of samples analyzed under trace metals is based on samples that were analyzed for total trace metals.

3.4.3.3.3.2 Exceedances of Primary Drinking Water Standards

A number of groundwater samples collected at the PAA exceeded the National Primary Drinking Water Standards. Constituents with samples exceeding the standards include arsenic (Table 3.4-9), lead (Table 3.4-10), uranium (Table 3.4-11), radium-226 (Table 3.4-12), and gross alpha particles (Table 3.4-13); these tables provide constituent concentrations, well ID, and sample date for regulated constituents detected at or above MCL levels.

As shown on the table, nearly 75 percent of the samples exceeded the MCL for gross alpha particles (15 pCi/L), with the exceedances occurring in samples from the Inyan Kara aquifer and alluvial aquifer. The range of gross alpha particles in alluvial wells was 13.3 to 129 pCi/L. The range of gross alpha particles in Inyan Kara wells was 1.4 to 6500 pCi/L. Two of the three wells (680 and 681) having gross alpha concentrations over 1000 pCi/L are known to be directly within an ore body. The third is downgradient of open pit mines within the Fall River Formation.

Each sample collected from wells 615 and 3026 exceeded the MCL for arsenic. Also, half of all uranium exceedances are from alluvial aquifer samples.

3.4.3.3.3.3 Exceedances of Other Drinking Water Standards

In addition to primary drinking water standards established by the EPA, there are also a number of constituents (including radon-222) that have proposed standards which have not yet been adopted. Secondary drinking water standards (SMCL) set by the EPA are designated for constituents that alter the color, taste, and odor of water; these constituents are not considered health risks but may deter human consumption. These constituents, along with the number of samples that exceed these guidelines, are presented in Table 3.4-8.

Bulk water quality properties with SMCLs include pH and TDS. For samples collected as part of the baseline study, six wells exceeded the SMCL for pH with values ranging from 8.6 to 10.3. All of the samples exceeded the recommended concentration of TDS. Values of TDS ranged from 670 to 9700 mg/L with the highest values obtained from alluvial well samples.

A number of samples also exceeded the SMCL for sodium and sulfate. A total of 63 samples exceeded the secondary standard for sodium with values ranging from 201 to 2140 mg/L. The highest values of sodium were again from alluvial well samples. To date, all 141 samples exceeded the SMCL for sulfate of 250 mg/L; 86 of these samples were over double the limit (over 500 mg/L), and 59 samples were over 1000 mg/L sulfate. Fourteen samples had concentrations of sulfate over 3000 mg/L, all of which were from the alluvial aquifers.

Exceedances were noted for trace metals including boron, iron, manganese, and strontium. The three exceedances for boron were all collected from well 678 with values from 1.4 to 1.6 mg/L. Nearly half of the samples collected exceeded the SMCL of 0.3 mg/L for iron; 16 samples exceeded the Region 8 limit of 5.0 mg/L. The only water supply wells exceeding the Region 8 limit for iron are stock wells 619 and 650. The SMCL for manganese was exceeded by 89 of 98 samples; the Region 8 limit of 0.8 mg/L was exceeded by 19 samples. Values of manganese over the secondary guideline range from 0.05 to 3.4 mg/L. Strontium was exceeded in 37 of 98 samples analyzed with values ranging from 4.2 to 11.6 mg/L. The alluvial wells had the highest values for SMCL exceeded trace metals including boron, iron, manganese, and strontium.

Currently, there is no primary drinking water standard for Radon-222. The proposed EPA MCL is 300 pCi/L. Of the 121 samples analyzed for Radon-222 as part of the Proposed Action baseline sampling program, 105 samples exceed the recommended level. Values of samples exceeding the limit range from 304 to 462000 pCi/L. Thirty-six samples have over 10 times the recommended concentration of radon-222; 20 of these samples are over 100 times the proposed MCL. The wells with the highest concentration include wells 680 and 681, which are directly in a known ore body, and well 42, a private well used for domestic and stock water. The only well not exceeding the radon-222 limit is well 650, a Lakota well upgradient of historic uranium mining activities.

Table 3.4-9: Samples with Arsenic (Total) Results Equal to or Greater than the Arsenic MCL of 0.01 mg/L

Well	Sample Date	Result, mg/L	Well Use
615	01-Apr-08	0.024	Monitoring
615	01-Apr-08	0.025	Monitoring
615	21-Apr-08	0.024	Monitoring
615	28-May-08	0.024	Monitoring
615	25-Jun-08	0.024	Monitoring
676	05-Feb-08	0.021	Alluvial Monitoring
679	18-May-08	0.011	Alluvial Monitoring
3026	30-Mar-08	0.023	Monitoring
3026	22-Apr-08	0.022	Monitoring
3026	28-May-08	0.028	Monitoring
3026	24-Jun-08	0.025	Monitoring

Table 3.4-10: Samples with Lead (Total) Results Equal to or Greater than the Lead MCL of 0.015 mg/L

Well	Sample Date	Result, mg/L	Well Use
622	21-Apr-08	0.026	Monitoring
622	28-May-08	0.023	Monitoring
622	25-Jun-08	0.03	Monitoring
650	24-Mar-08	0.05	Discontinued Stock
676	05-Feb-08	0.06	Alluvial Monitoring
679	03-Feb-08	0.015	Alluvial Monitoring
679	18-May-08	0.022	Alluvial Monitoring
689	25-Jun-08	0.017	Monitoring

Table 3.4-11: Samples with Uranium (total) Results Equal to or Greater than the Uranium MCL of 0.03 mg/L

Well	Sample Date	Result, mg/L	Well Use
675	05-Feb-08	0.0387	Alluvial Monitoring
675	29-Apr-08	0.0502	Alluvial Monitoring
675	29-Apr-08	0.0516	Alluvial Monitoring
676	05-Feb-08	0.0687	Alluvial Monitoring
676	29-Apr-08	0.0591	Alluvial Monitoring
677	05-Feb-08	0.0414	Alluvial Monitoring
677	29-Apr-08	0.0471	Alluvial Monitoring
678	05-Feb-08	0.0379	Alluvial Monitoring
678	05-Feb-08	0.0352	Alluvial Monitoring
678	29-Apr-08	0.0387	Alluvial Monitoring
680	31-Mar-08	0.0541	Monitoring
698	30-Mar-08	0.123	Monitoring
698	30-Mar-08	0.122	Monitoring
698	22-Apr-08	0.119	Monitoring
698	28-May-08	0.116	Monitoring
698	28-May-08	0.119	Monitoring
698	24-Jun-08	0.113	Monitoring
3026	28-May-08	0.0322	Monitoring

Table 3.4-12: Samples with Radium-226 (Dissolved) Results Equal to or Greater than the Radium-226 MCL of 5 pCi/L

Well	Sample Date	Result, pCi/L	Well Use
16	27-Sep-07	26.2	Domestic
16	12-Nov-07	8.1	Domestic
16	30-Mar-08	15.3	Domestic
16	30-Jun-08	6.4	Domestic
42	28-Sep-07	96.5	Domestic
42	12-Nov-07	102	Domestic
42	5-Feb-08	100	Domestic
42	30-May-08	100	Domestic
615	25-Jun-08	7.2	Monitoring
619	27-Sep-07	120	Stock
619	12-Nov-07	100	Stock
619	24-Mar-08	99.7	Stock
619	17-Jun-08	110	Stock
628	28-Sep-07	7.4	Stock
628	14-Nov-07	20.7	Stock
628	20-Feb-08	9	Stock
628	29-May-08	6.1	Stock
631	26-Sep-07	12.9	Stock
631	14-Nov-07	9.5	Stock
631	20-Feb-08	19.4	Stock
631	19-May-08	22.1	Stock
680	30-Jan-08	1180	Stock
680	31-Mar-08	1150	Monitoring
680	21-Apr-08	1230	Monitoring
680	13-May-08	1430	Monitoring
680	21-May-08	1240	Monitoring
680	10-Jun-08	1410	Monitoring
680	7-Jul-08	1280	Monitoring
681	30-Jan-08	421	Monitoring
681	30-Mar-08	414	Monitoring
681	21-Apr-08	377	Monitoring
681	12-May-08	407	Monitoring
681	18-May-08	423	Monitoring
681	25-Jun-08	434	Monitoring
681	1-Jul-08	357	Monitoring
688	7-Jul-08	6.7	Monitoring
689	30-Mar-08	7.9	Monitoring
689	28-May-08	5.7	Monitoring
689	25-Jun-08	5.5	Monitoring
689	1-Jul-08	7.7	Monitoring
695	22-Apr-08	5	Monitoring

Table 3.4-12: Samples with Radium-226 (Dissolved) Results Equal to or Greater than the Radium-226 MCL of 5 pCi/L (concl.)

Well	Sample Date	Result, pCi/L	Well Use
695	24-Jun-08	5.2	Monitoring
697	31-Mar-08	6.3	Monitoring
698	30-Mar-08	387	Monitoring
698	30-Mar-08	398	Monitoring
698	22-Apr-08	370	Monitoring
698	28-May-08	412	Monitoring
698	28-May-08	413	Monitoring
698	24-Jun-08	429	Monitoring
3026	28-May-08	9.6	Monitoring
4002	27-Sep-07	63.6	Stock
4002	27-Sep-07	60	Stock
4002	14-Nov-07	54.2	Stock
4002	12-Feb-08	57	Stock
4002	19-May-08	52.3	Stock
7002	28-Sep-07	8.5	Stock
7002	12-Nov-07	8.1	Stock
7002	20-Feb-08	8.8	Stock
7002	29-May-08	8	Stock

Note: Radium-228 was not analyzed due to the absence of Thorium-232 in samples

Table 3.4-13: Samples with Radium-226 (Suspended) Results Equal to or Greater than the Radium-226 MCL of 5 pCi/L

Well	Sample Date	Result, pCi/L	Well Use
42	05-Feb-08	5.1	Domestic
619	24-Mar-08	11.4	Stock
619	17-Jun-08	8.8	Stock
676	05-Feb-08	11.4	Alluvial Monitoring
679	03-Feb-08	9	Alluvial Monitoring
680	30-Jan-08	12.7	Monitoring
680	13-May-08	13.2	Monitoring
681	30-Jan-08	9.9	Monitoring
698	30-Mar-08	15.3	Monitoring
698	30-Mar-08	12.4	Monitoring
698	22-Apr-08	6.4	Monitoring
698	28-May-08	14	Monitoring
698	28-May-08	13.5	Monitoring
698	24-Jun-08	11.6	Monitoring
4002	27-Sep-07	19.4	Stock
4002	12-Feb-08	37	Stock
4002	19-May-08	8.4	Stock

Note: Radium-228 was not analyzed due to the absence of Thorium-232 in samples.

Table 3.4-14 Samples with Radium-226 (Total) Results Equal to or Greater than the Radium-226 MCL of 5 pCi/L

Well	Sample Date	Result, pCi/L	Well Use
16	27-Sep-07	17.4	Domestic
42	28-Sep-07	79.7	Domestic
619	27-Sep-07	120	Stock
628	28-Sep-07	6.8	Stock
631	26-Sep-07	15.2	Stock
4002	27-Sep-07	62.7	Stock
4002	27-Sep-07	79.4	Stock
7002	28-Sep-07	6.3	Stock

Note: Radium-228 was not analyzed due to the absence of Thorium-232 in samples

Table 3.4-15: Samples with Gross Alpha (Total) Results Equal to or Greater than the Gross Alpha MCL of 15 pCi/L

Well	Sample Date	Result, pCi/L	Well Use
7	20-Feb-08	15.5	Domestic
13	20-Feb-08	19.5	Domestic
16	27-Sep-07	62.7	Domestic
16	30-Mar-08	85.7	Domestic
16	30-Jun-08	28.3	Domestic
18	26-Sep-07	15.7	Domestic
18	12-Nov-07	20	Domestic
18	12-Nov-07	18.9	Domestic
18	12-Feb-08	31.7	Domestic
18	30-May-08	27.5	Domestic
42	28-Sep-07	371	Domestic
42	12-Nov-07	375	Domestic
42	5-Feb-08	526	Domestic
42	30-May-08	558	Domestic
615	1-Apr-08	18.2	Monitoring
615	1-Apr-08	17.7	Monitoring
615	21-Apr-08	15.1	Monitoring
615	28-May-08	15.3	Monitoring
615	25-Jun-08	38.3	Monitoring
619	27-Sep-07	367	Stock
619	12-Nov-07	341	Stock
619	24-Mar-08	438	Stock
619	17-Jun-08	398	Stock
622	1-Apr-08	15	Monitoring
622	21-Apr-08	22.6	Monitoring
622	28-May-08	32.6	Monitoring
622	25-Jun-08	36.4	Monitoring
628	28-Sep-07	29.9	Stock
628	14-Nov-07	83.9	Stock
628	20-Feb-08	64.5	Stock

Well	Sample Date	Result, pCi/L	Well Use
628	29-May-08	39	Stock
631	26-Sep-07	51	Stock
631	14-Nov-07	46.5	Stock
631	20-Feb-08	162	Stock
631	19-May-08	60.7	Stock
675	28-Sep-07	18.8	Monitoring
675	27-Nov-07	18.3	Monitoring
675	5-Feb-08	29.3	Monitoring
675	29-Apr-08	55.2	Monitoring
675	29-Apr-08	51.1	Monitoring
676	28-Sep-07	37.1	Monitoring
676	27-Nov-07	31.9	Monitoring
676	5-Feb-08	95.5	Monitoring
676	29-Apr-08	51.6	Monitoring
677	28-Sep-07	41	Monitoring
677	27-Nov-07	38.7	Monitoring
677	5-Feb-08	129	Monitoring
677	29-Apr-08	43.1	Monitoring
678	28-Sep-07	23.2	Monitoring
678	27-Nov-07	18.9	Monitoring
678	5-Feb-08	41.5	Monitoring
678	5-Feb-08	30.2	Monitoring
678	29-Apr-08	54.7	Monitoring
679	28-Sep-07	19.9	Monitoring
679	3-Feb-08	18.4	Monitoring
679	18-May-08	22.4	Monitoring
680	30-Jan-08	4090	Monitoring
680	31-Mar-08	6440	Monitoring
680	21-Apr-08	4270	Monitoring
680	13-May-08	6500	Monitoring
680	21-May-08	4500	Monitoring
680	7-Jul-08	4280	Monitoring
680	10-Jun-08	4370	Monitoring
681	30-Jan-08	656	Monitoring
681	30-Mar-08	2170	Monitoring
681	21-Apr-08	1400	Monitoring
681	12-May-08	2220	Monitoring
681	18-May-08	1220	Monitoring
681	25-Jun-08	1390	Monitoring
681	1-Jul-08	1180	Monitoring
688	10-Jun-08	17.3	Monitoring
688	7-Jul-08	29.8	Monitoring
689	30-Mar-08	64.3	Monitoring
689	21-Apr-08	25.5	Monitoring
689	28-May-08	34.9	Monitoring

Well	Sample Date	Result, pCi/L	Well Use
689	25-Jun-08	36.5	Monitoring
689	1-Jul-08	33.4	Monitoring
694	21-Apr-08	19.2	Monitoring
694	21-Apr-08	18.1	Monitoring
694	24-Jun-08	23.7	Monitoring
695	22-Apr-08	29.4	Monitoring
695	21-May-08	25.6	Monitoring
695	24-Jun-08	39.7	Monitoring
696	24-Jun-08	23.9	Monitoring
697	31-Mar-08	52.2	Monitoring
698	30-Mar-08	1750	Monitoring
698	30-Mar-08	1880	Monitoring
698	22-Apr-08	2110	Monitoring
698	28-May-08	1210	Monitoring
698	28-May-08	1390	Monitoring
698	24-Jun-08	1790	Monitoring
3026	30-Mar-08	47.6	Monitoring
3026	22-Apr-08	43.8	Monitoring
3026	28-May-08	92.4	Monitoring
3026	24-Jun-08	116	Monitoring
4002	27-Sep-07	141	Stock
4002	27-Sep-07	120	Stock
4002	14-Nov-07	227	Stock
4002	12-Feb-08	314	Stock
4002	19-May-08	127	Stock
7002	28-Sep-07	45.6	Stock
7002	12-Nov-07	39.8	Stock
7002	20-Feb-08	91.4	Stock
7002	29-May-08	29.5	Stock

3.5 Ecological Resources

3.5.1 Introduction

This section provides a general discussion of the affected environment and environmental consequences to vegetative resources, vertebrate terrestrial wildlife, and aquatic species (vertebrates and macro-invertebrates). The subsequent sub-sections address the potential impacts to vegetative communities and specific groups of wildlife species (hereafter, includes both terrestrial and aquatic species unless specified). As no underground or open pit mining would occur as part of the Proposed Action, the impact analysis in this document is limited to the Proposed Action (ISL of uranium resources) and No Action alternatives.

Ecological baseline studies for flora and fauna were collected to fulfill the objectives specified in U.S. Nuclear Regulatory Commission (NRC) NUREG-1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs*. Ecological surveys were also conducted in accordance with applicable SD DENR, SD Game, Fish and Parks (SDGFP), and U.S. Fish and Wildlife Service (USFWS) guidelines. These agencies were consulted prior to initiating field surveys to ensure that adequate objectives, survey methodologies, and data collection techniques were employed.

3.5.2 Regional Setting

The PAA (license area) spans approximately 10,580 acres in Townships (T) 6-7 South (S), Range (R) 1 East (E) (Refer to Plate 3.5-1). Approximately 2,488 acres (23 percent) are expected to be disturbed by ISL operations associated with this project. The PAA is comprised primarily of private lands small portions of BLM lands and lies adjacent to parcels of USFS land. The current principal land use in the region is cattle grazing.

The PAA is within the mixed grass eco-region of the Northern Great Plains (EPA 1993), near the southwestern extension of the Black Hills. The elevation within the PAA ranges from approximately 3,600 feet to 3,900 feet above mean sea level, with the highest elevations along the pine breaks that overlap its eastern boundary. Topography in the PAA and surrounding lands is primarily gently rolling in the western quarter, with more varied terrain in the pine breaks and dissected hills that comprise the rest of the area.

The PAA is comprised of five main vegetative communities, in descending order: Ponderosa Pine Woodland, Big Sagebrush Shrubland, Greasewood Shrubland, Upland Grassland, and Cottonwood Gallery. Despite the overall ranking, Upland Grassland was present in the largest individual parcels. Interspersed among those primary habitats are smaller inclusions of Silver Sagebrush Shrubland, Agricultural Land, creek channels, and numerous ephemeral draws.

The overall PAA (license area and surrounding perimeter) is located within the Cheyenne River watershed. Two main stream channels pass through the PAA: Beaver Creek (perennial) and Pass Creek (intermittent). Both flow south into the Cheyenne River, which runs from west to east approximately 2.5 miles south of the PAA boundary. A few small stock reservoirs are scattered throughout the area, though they may not retain water year-round.

Trees are present along the riparian corridors of both primary creeks, and on the higher elevation hilltops in the PAA. The plains cottonwood (*Populus deltoides*) was the only tree present along the creek channels, and was more prevalent in the Pass Creek corridor. Ponderosa pine (*Pinus ponderosa*) dominates the higher elevation hilltops and breaks in the central and eastern portions of the PAA, with Rocky Mountain juniper (*Juniperus scopulorum*) present as individual trees or small inclusions in some of the dry drainages.

The PAA is characterized as semi-arid continental or steppe with a dry winter season. The area commonly experiences low precipitation levels, high evaporation rates, low relative humidity, and plentiful sunshine. Temperatures are moderate, with large diurnal and annual variations, and extremes ranging from approximately -37 degrees Fahrenheit (F) in the winter to 114 degrees F in the summer. The first freeze typically occurs in mid- to late September, with the last freeze often recorded during late May.

Yearly precipitation totals average about 14 inches. Approximately one-half of the annual precipitation falls during the months of May, June, and July. As expected, most of the winter precipitation occurs as snow, with an annual average of 37 inches. Thunderstorms are relatively frequent in the PAA during the summer months, averaging 40-45 days per year. Much of the annual rainfall is associated with these events.

Windy conditions are fairly common in the PAA and generally average about 10 miles per hour (mph). Prevailing winds come from the west-northwest during much of the year, though east-southeast winds are also common.

3.5.3 Climate

The PAA is characterized as semi-arid continental or steppe with a dry winter season. The area commonly experiences low precipitation levels, high evaporation rates, low relative humidity, and plentiful sunshine. Temperatures are moderate, with large diurnal and annual variations, and extremes ranging from approximately -37 degrees F in the winter to 114 degrees F in the summer. The first freeze typically occurs in mid- to late September, with the last freeze often recorded during late May.

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Windy conditions are fairly common in the PAA, generally averaging 10 mph. Prevailing winds come from the west-northwest during much of the year, though east-southeast winds are also common.

3.5.4 Baseline Data

Ecological baseline studies for flora and fauna were collected to fulfill the objectives specified in U.S. NRC NUREG-1569, *Standard Review Plan for ISL Leach Uranium Extraction License Applications*. Ecological surveys were also conducted in accordance with applicable SD DENR, SDGFP, and USFWS established guidelines. These agencies were consulted prior to initiating field surveys to ensure that adequate objectives, survey methodologies, and data collection techniques were employed.

Vegetation sampling was conducted by BKS Environmental Associates, Inc. (BKS) of Gillette, Wyoming. Initial surveys were conducted during July 2007, with supplemental sampling performed to adjust to subsequent changes in the PAA boundary. Wildlife and aquatics sampling were conducted by ICF Jones & Stokes (formerly Thunderbird-Jones & Stokes), of Gillette, Wyoming from July 2007 through early August 2008 to meet agency requirements of one year of baseline data, and to accommodate changes to the PAA boundary during that period.

The following sections were generated from the final survey reports completed by BKS and Jones & Stokes for this project.

3.5.5 Terrestrial Ecology

Powertech (USA) conducted terrestrial ecological baseline field surveys including vegetation, wetlands, wildlife. The methodology and results are discussed in the following sections.

3.5.5.1 Vegetation

3.5.5.1.1 Survey Methodology

<u>General</u>

All sampling procedures and methodologies are consistent with standard industry practices utilized in applications for AEA licenses including those for: Smith Ranch, Nichols Ranch, Moore Ranch and Highlands Ranch. Refer to Appendix 3.5-A for the submitted methodology.

Mapping

Seven different plant communities were identified for the PAA, i.e., Big Sagebrush Shrubland (BS), Greasewood Shrubland (GW), Ponderosa Pine Woodland (PP), Upland Grassland (UG), Cottonwood Gallery (CG), Silver Sagebrush Shrubland (SS), and Agricultural Land (AG), using 2001 color infra-red (CIR) aerial photography, which was verified by field survey. The Agricultural Land was not sampled as it was actively being used for crop production. The Silver Sagebrush Shrubland will be described as an inclusion of the Greasewood Shrubland Community.

Transect Origin Selection

The transects were randomly located in the field within each sampled vegetation community. Each transect was at least 150 feet from the previous transect. Random numbers between 1 and 360 were generated to determine cover transect direction, and compasses were utilized to orient transects to the nearest 1/8 of 360 degrees in the field. Each sample site was marked with hand-held Garmin Global Positioning System (GPS), and these points were later plotted on the final vegetation survey map (Plate 3.5-2).

Cover

A sample size of 37 50-m point-intercept cover transects were sampled within the Ponderosa Pine Woodland and Greasewood Shrubland communities, while 27 samples were taken in the Big Sagebrush Shrubland, 26 samples for the Cottonwood Gallery and 30 samples for the Upland Grassland community for a total of 157 cover points in the PAA.

In the vegetation communities, each 50-m transect represented a single sample point. Percent cover measurements were taken from point-intercepts at 1-m intervals along a 50-m transect. Transects that exceeded the boundaries of the vegetation community being sampled were redirected back into its vegetation community at a 90 degree angle from the original transect direction at the point of intercept. In instances where a 90 degree angle of reflection did not place the transect within the sampled community, a 45 degree angle of reflection was used. Each point-intercept represents 2 percent towards cover measurements.

Percent cover measurements record "first-hit" point-intercepts by live foliar vegetation species, litter, rock, or bare ground. Multiple hits on vegetation were recorded, but used only for the purpose of constructing a plant species list for each plant community (Appendix 3.5-B).

Total Vegetation Cover

Vegetation data cover was recorded by species, using first hit data. All point intercepts of living vegetation and growth produced during the current growing season was counted toward total vegetation cover. Total vegetation cover measurements were expressed in absolute percentages for each sample point. Percent vegetation cover is the vertical projection of the general outline of plants to the ground surface. Cover summaries for each vegetation community are contained in Appendix 3.5-C.

Total Ground Cover

Total ground cover data was recorded by live vegetation, litter, or rock, minus bare ground. Litter includes all organic material that is dead including manure. Rock fragments were recorded when equal to or greater than two cm in size (i.e., sheet flow, minimum non-erodible particle size). Total ground cover measurements were expressed in absolute percentages for each sample point. Total ground cover equals the sum of cover values for percent vegetation, percent litter, and percent rock.

Shrub Density

This data was taken at the time of cover sampling to ensure adequate use of field time. Summarization of that data can be found in Appendix 3.5-C.

Shrub density data was collected in conjunction with randomly selected cover transects, wherever possible. All shrubs, full, half, or sub, were counted within 50 cm on either side of the 50-m cover transect (1 m x 50 m belt transect), yielding a 100 square meters (m^2) belt transect. Sample adequacy was not calculated for shrub density. The number of belt transects equaled the number of cover transects for a given vegetation type.

Tree Density

This data was taken at the time of cover sampling to ensure adequate use of field time. Summarization of that data can be found in Appendix 3.5-D.

Tree density data was collected in the Ponderosa Pine Woodland vegetation community in conjunction with randomly selected cover transects, wherever possible. Tree density in this community was determined using the point-center quarter method. Trees within the Cottonwood Gallery or Riparian areas were directly counted on an aerial photograph. Within other vegetation communities, individual *Pinus ponderosa* (Ponderosa Pine) or other tree species found were directly counted for numbers. Sample adequacy was not calculated on the point-center quarter plots.

Species Composition

A list of plant species encountered during 2007 quantitative sampling is compiled in Appendix 3.5-B by vegetation community type for each of the five vegetation communities. The species list includes plant species sampled in cover transects as well as plant species observed along the belt transect. Plant names in the Rocky Mountain Vascular Plants of Wyoming (Dorn 2001, 3rd Edition) were utilized. Plant identification was confirmed by Robert Dorn, when necessary. Scientific nomenclature followed that in use at the Rocky Mountain Herbarium in Laramie, Wyoming, during 2007.

Sample Adequacy

A minimum of 20 cover transects per vegetation type was sampled in five vegetation communities. Sample adequacy was calculated and an incremental number of cover transects was sampled up the maximum of 50.

The following sample adequacy formula was utilized to determine the minimum required size of the sample population.

$$n_{min} \geq \frac{2(sz)^2}{(dx)^2}$$

Where n_{min}= minimum number of sampled line transects needed to adequately represent native vegetation types
s= sample standard deviation
z= the z statistic
d= the amount of reduction desired
x= sample mean for cover

This sample adequacy formula is used by the WDEQ. The 2 in the numerator makes this a very conservative test. The term "grassland" indicates that a community has less than or equal to 20 percent relative cover by shrub species while a "shrubland" is greater than or equal to 20 percent relative cover by shrub species according to the WDEQ.

The five vegetation communities have been identified as "grassland", or "shrubland". Upland Grassland is identified as grassland while the Ponderosa Pine Woodland, Big Sagebrush Shrubland, Greasewood Shrubland, and Cottonwood Gallery communities are identified as shrublands. The constant values to be used in statistical tests for cover are: "z"=1.28 and "d" = 0.1 for grasslands and shrublands. All sampled vegetation was included in the sample adequacy test (i.e., "undesirable" species were not eliminated from the equation). Also as adjustments were made to the permit boundary, the samples that fell outside of the boundary were not excluded as they were initially part of the boundary at the time of survey.

Extended Reference Area

The Extended Reference Area (EXREFA) is a native land unit used to evaluate revegetation success on portions of the same native plant community that could be affected by the Proposed Action. This study shows the Proposed Action will affect five plant communities, Big Sagebrush Shrubland, Cottonwood Gallery, Greasewood Shrubland, Ponderosa Pine Woodland, and Upland Grassland. All areas of these communities not affected by the Proposed Action may serve as the EXREFA.

3.5.5.1.2 Vegetation Survey Results

Mapping

Approximately 10,557 acres of the PAA was surveyed. Of these acres, Big Sagebrush Shrubland was 2,501.74 acres (23.70 percent), Greasewood Shrubland was 2,190.45 acres (20.75 percent), Ponderosa Pine Woodland was 2,183.76 acres (20.69 percent), Upland Grassland was 2,187.56 acres (20.72 percent), Agricultural Land was 780.79 acres (7.40 percent), Disturbed areas were 14.7 acres (0.14 percent), existing mine pits were 326.99 acres (3.10 percent), Cottonwood Gallery was 240.6 acres (2.28 percent), Silver Sagebrush Shrubland was 119.49 acres (1.13 percent), water was 8.94 acres (0.08 percent), and Shale Outcrop was 2.19 acres (0.02 percent). Refer to Table 3.5-1 for acreage of each vegetation community by permit acreage, and ½-mile buffer acreage.

Table 3.5-1: Acreage and Percent of Total Area for Each of the Map Units

Map Unit	Permit area	% of Area	1/2 Mile Buffer Area	% of Area
Sampled Vegetation Communities				
Big Sagebrush Shrubland	2,501.56	23.70	2,639.45	31.75
Greasewood Shrubland	2,190.45	20.75	837.66	10.07
Ponderosa Pine Woodland	2,183.76	20.69	2,036.58	24.49
Upland Grassland	2,187.56	20.72	2,027.18	24.38
Cottonwood Gallery	240.6	2.28	103.13	1.24
Described Vegetation Communities				
Agricultural Land	780.79	7.40	604.19	7.27
Disturbed	14.7	0.14	--	--
Existing Mine Permit	326.99	3.10	--	--
Silver Sagebrush Shrubland	119.49	1.13	53.65	0.65
Shale Outcrop	2.19	0.02	--	--
Water	8.94	0.08	12.6	0.15
TOTAL	**10,557.03**	**100.00**	**8,314.44**	**100.00**

General

The EXREFA will remain unaffected over the course of the proposed the Proposed Action and will be used to evaluate revegetation success. The EXREFA will include portions of the same native plant communities that area affected by the Proposed Action but located outside those disturbed areas and within PAA.

3.5.5.1.3 Big Sagebrush Shrubland

Cover

The Big Sagebrush Shrubland community comprised 2,501.56 of the 10,557.03 acres of the PAA (23.70 percent). Twenty-seven cover transects were sampled for this community. Absolute total vegetation cover was 45.89 percent. Absolute bare soil and litter/rock percentages were 14.07 percent and 38.52 percent, respectively. Absolute total ground cover was 85.78 percent. *Bouteloua gracilis* (blue grama), provided the highest relative vegetation cover at 24.38 percent, while *Buchloe dactyloides* (buffalograss) provided the next highest relative vegetation cover at 20.98 percent. Refer to Table 3.5-2 for the absolute cover values.

Table 3.5-2: 2007 Absolute Cover for the Big Sagebrush Shrubland Vegetation Community

Vegetation Parameter
Absolute Total Vegetation Cover (45.89%)
Absolute Total Cover (85.78%)

Sample Adequacy

There were 27 samples taken in the Big Sagebrush Shrubland plant community. The sample adequacy formula outlined earlier was utilized to determine the minimum required size of the sample population. Big Sagebrush Shrubland met sample adequacy

Refer to Table 3.5-3 below for sample adequacy values.

Table 3.5-3: Summary of Sample Adequacy Calculations for Percent Vegetation Cover in the Big Sagebrush Shrubland

Map Unit	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Big Sagebrush Shrubland						
Total Vegetation Cover	22.75	6.52	26.91	27.00	2.56	99.48
Total Ground Cover	42.64	3.49	2.20	27.00	8.98	NA

Shrub Density

Big Sagebrush Shrubland supported an average of 3,661.46 shrubs per acre or 0.90 shrubs/m^2. The following full and half/sub-shrub species were found: *Artemisia tridentata* (big sagebrush), *Artemisia frigida* (fringed sagewort), and *Gutierrezia sarothrae* (broom snakeweed). Refer to Appendix 3.5-D for a complete Big Sagebrush Shrubland density summary.

Species Composition

Species composition for the Big Sagebrush Shrubland community was dominated by warm season perennial grasses with 46.33 percent relative vegetation cover, followed by cool season perennial grasses with 20.33 percent relative vegetation cover. Perennial shrubs had 15.82 percent relative vegetation cover, while annual grasses had 10.15 percent relative vegetation cover. Annual forbs had 1.90 percent relative vegetation cover. Perennial forbs had 1.11 percent relative vegetation cover; sub-shrubs had a total of 2.59 percent relative vegetation cover. Succulents had 1.77 percent relative vegetation cover. The cool season perennial grasses were mainly *Elymus smithii* (western wheatgrass), *Carex filifolia* (threadleaf sedge), and *Poa secunda* (Sandberg bluegrass). The warm season perennial grasses were mainly blue grama, buffalograss, and *Bouteloua curtipendula* (sideoats grama). Annual grasses were *Bromus japonicus* (Japanese brome) and *Bromus tectorum* (cheatgrass). Perennial forbs were dominated by *Calochortus nuttallii* (sego lily), *Phlox spp.* (phlox), and *Sphaeralcea coccinea* (scarlet globemallow). Annual forbs included *Alyssum desertorum* (desert alyssum) and *Lepidium densiflorum* (prairie peppergrass). Present shrubs/sub-shrubs was big sagebrush, fringed sagewort, and broom snakeweed. Also present was the succulent *Opuntia polyacantha* (plains prickly pear). Refer to Table 3.5-4 for relative Big Sagebrush Shrubland cover summary and Appendix 3.5-C for a complete Big Sagebrush Shrubland cover summary.

Table 3.5-4: Vegetation Cover Sampling Data Summary of Species by Lifeform for the Big Sagebrush Shrubland Community

	Vegetation Cover	
	Absolute	Relative (%)
Cool Season Perennial Grasses	9.33	20.33
Warm Season Perennial Grasses	21.26	46.33
Annual Grasses	4.66	10.15
Annual Forbs	0.87	1.90
Perennial Forbs	0.51	1.11
Perennial Shrubs	7.26	15.82
Perennial Sub-Shrubs	1.19	2.59
Succulents	0.81	1.77

3.5.5.1.4 Greasewood Shrubland

Cover

The Greasewood Shrubland community comprised 2,190.45 of the 10,557.03 acres of the PAA (20.75 percent). Thirty-seven cover transects were sampled for this community. Absolute total vegetation cover was 37.11 percent. Absolute bare soil and litter/rock percentages were 18.70 percent and 42.54 percent, respectively. Absolute total ground cover was 81.41 percent. Western wheatgrass provided the highest relative vegetation cover at 23.31 percent. *Sarcobatus vermiculatus* (greasewood), provided the next highest cover at 22.88 percent. Refer to Table 3.5-5 for the absolute cover values.

Table 3.5-5: 2007 Absolute Cover for the Greasewood Shrubland Vegetation Community

Vegetation Parameter	Mean
Absolute Vegetation Cover (%)	37.11
Absolute Total Cover (%)	81.41

Sample Adequacy

There were 37 samples taken in the Greasewood Shrubland community. The sample adequacy formula outlined earlier was utilized to determine the minimum required size of the sample population. Greasewood Shrubland met sample adequacy. Refer to Table 3.5-6 for sample adequacy values.

Table 3.5-6: Summary of Sample Adequacy Calculations for Percent Vegetation Cover in the Greasewood Shrubland

Map Unit	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Greasewood Shrubland						
Total Vegetation Cover	18.84	5.80	31.06	37.00	2.79	99.74
Total Ground Cover	40.70	6.74	8.99	37.00	5.19	NA

Shrub Density

Greasewood Shrubland supported an average of 2,589.42 shrubs per acre or 0.64 shrubs/m^2. The following full and half/sub-shrub species were found: greasewood, big sagebrush and *Artemisia cana* (silver sagebrush), *Ericameria nauseosa* (rubber rabbitbrush), and fringed sagewort. Refer to Appendix 3.5-D for a complete Greasewood Shrubland density summary

Species Composition

Species composition for the Greasewood Shrubland community was dominated by perennial shrubs with 28.70 percent relative vegetation cover, followed by cool season perennial grasses with 27.67 percent relative vegetation cover. Warm season perennial grasses had 24.31 percent relative vegetation cover. Annual grasses had 4.96 percent relative vegetation cover while annual forbs had 10.32 percent relative vegetation cover. Perennial forbs had 0.40 percent relative vegetation cover. Succulents had 3.64 percent relative vegetation cover. The cool season perennial grasses were mainly western wheatgrass, *Agropyron cristatum* (crested wheatgrass), threadleaf sedge, *Bromus inermis* (smooth brome), and *Elymus lanceolatus* (thickspike wheatgrass). Warm season perennial grasses were mainly blue grama, buffalograss, *Distichlis stricta* (inland saltgrass), and *Sporobolus airoides* (alkali sacaton). Annual grasses were dominated by Japanese brome and cheatgrass. Perennial forbs were dominated by scarlet globemallow, *Ambrosia psilostachya* (western ragweed), and *Convolvulus arvensis* (field bindweed). Annual forbs included *Bassia sieversiana* (summer cypress), *Plantago patagonica* (Pursh's plantain), and *Monolepis nuttalliana* (Nuttall's povertyweed). Shrubs included greasewood, big sagebrush and silver sagebrush. Plains prickly pear was also present. An area dominated by silver sagebrush was present within this community. This area was wetter than the typical greasewood community. The species composition was likely similar except for the dominance of silver sagebrush in the shrub component which is due to the increased moisture present within this area. Refer to Table 3.5-7 for relative Greasewood Shrubland cover summary and Appendix 3.5-C for a complete Greasewood Shrubland cover summary.

Table 3.5-7: Vegetation Cover Sampling Data Summary of Species by Lifeform for the Greasewood Shrubland Community

	Vegetation Cover Absolute	Relative (%)
Cool Season Perennial Grasses	10.27	27.67
Warm Season Perennial Grasses	9.02	24.31
Annual Grasses	1.84	4.96
Annual Forbs	3.83	10.32
Perennial Forbs	0.15	0.40
Perennial Shrubs	10.65	28.70
Succulents	1.35	3.64

3.5.5.1.5 Ponderosa Pine Woodland

Cover

The Ponderosa Pine Woodland community comprised approximately 2,188.76 of the 10,557.03 acres of the PAA (20.69 percent). Thirty-seven cover transects were sampled for this community. Absolute total vegetation cover was 34.33 percent. Absolute bare soil and litter/rock percentages were 10.54 and 53.57, respectively. Absolute total ground cover was 88.92 percent. *Pinus ponderosa* (ponderosa pine) provided the highest relative vegetation cover at 45.03 percent, while *Carex geyeri* (Geyer's sedge) provided the next highest relative vegetation cover at 13.37 percent. Refer to Table 3.5-8 for the absolute cover values.

Table 3.5-8: 2007 Absolute Cover for the Ponderosa Pine Woodland Vegetation Community

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	34.33
Absolute Total Cover (%)	88.92

Sample Adequacy

There were 37 samples taken in the Ponderosa Pine Woodland community. The sample adequacy formula outlined earlier was utilized to determine the minimum required size of the sample population. Ponderosa Pine Woodland met sample adequacy. Refer to Table 3.5-9 below for sample adequacy values.

Table 3.5-9: Summary of Sample Adequacy Calculations for Percent Vegetation Cover in the Ponderosa Pine Woodland

Map Unit	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Ponderosa Pine Woodland						
Total Vegetation Cover	17.19	5.25	30.56	37.00	2.82	97.67
Total Ground Cover	44.19	3.86	2.50	37.00	3.80	NA

Shrub Density

Ponderosa Pine Woodland supported an average of 1,224.27 shrubs per acre or 0.30 shrubs/m^2. The following full and half/sub-shrub species were found: big sagebrush, silver sagebrush, rubber rabbitbrush, *Chrysothamnus viscidflorus* (Douglas rabbitbrush), fringed sagewort, broom snakeweed, *Rosa arkansana* (prairie rose), and *Yucca glauca* (yucca or small soapweed). Refer to Appendix 3.5-D for a complete Ponderosa Pine Woodland density summary.

Tree Density

Ponderosa Pine Woodland supported an average of 75.88 ponderosa pine trees per acre or 0.019 trees/m^2. *Juniperus scopulorum* (Rocky Mountain juniper) was also observed within this community; however no quantitative evaluations were made for this species. Refer to Appendix 3.5-E for a complete tree density summary for the Ponderosa Pine Woodland community.

Species Composition

Species composition for the Ponderosa Pine Woodland community was dominated by trees with 52.58 percent relative vegetation cover, followed by warm season perennial grasses with 22.34 percent relative vegetation cover. Cool season perennial grasses had 19.34 percent relative vegetation cover. Annual grasses had 0.79 percent relative vegetation cover while annual forbs had 0.44 percent relative vegetation cover. Biennial forbs had 0.15 percent relative vegetation cover, while perennial forbs had 1.22 percent relative vegetation cover. Succulents had 0.47 percent relative vegetation cover while perennial shrubs and sub-shrubs had 2.04 percent and 0.64 percent relative vegetation cover, respectively. The trees were dominated by ponderosa pine and *Juniperus scopulorum* (Rocky Mountain juniper). The cool season perennial grasses were mainly Geyer's sedge, western wheatgrass and *Hesperostipa comata* (needleandthread). Warm season perennial grasses were mainly blue grama, sideoats grama, *Schizachyrium scoparium* (little bluestem), and *Aristida purpurea var. fendleriana* (Fendler's threeawn). Annual grasses were dominated by Japanese brome and cheatgrass. Perennial forbs were dominated by *Erigeron spp.* (fleabane), *Thermopsis rhombifolia* (prairie thermopsis), *Antennaria parvifolia* (small-leaf pussytoes), *Liatris punctata* (dotted blazing star), and *Vicia americana* (American vetch). Annual forbs included *Chenopodium berlandieri* (pitseed goosefoot), *Draba nemorosa* (yellow draba), and *Lappula redowski* (beggars-tick). Biennial forbs included *Melilotus officinalis* (yellow sweetclover). The shrubs and subshrubs present were big sagebrush, silver sagebrush, and fringed sagewort. Plains prickly pear was also present. Refer to Table 3.5-10 for relative Ponderosa Pine Woodland cover summary and Appendix 3.5-C for a complete Ponderosa Pine Woodland cover summary.

Table 3.5-10: Vegetation Cover Sampling Data Summary of Species by Lifeform for the Ponderosa Pine Woodland Community

	Vegetation Cover	
	Absolute	**Relative (%)**
Cool Season Perennial Grasses	6.64	19.34
Warm Season Perennial Grasses	7.67	22.34
Annual Grasses	0.27	0.79
Annual Forbs	0.15	0.44
Biennial Forbs	0.05	0.15
Perennial Forbs	0.42	1.22
Perennial Shrubs	0.70	2.04
Perennial Sub-Shrubs	0.22	0.64
Succulents	0.16	0.47
Trees	18.05	52.58

3.5.5.1.6 Upland Grassland

Cover

The Upland Grassland community comprised approximately 2,187.56 of the 10,557.03 acres of the PAA (20.72 percent). Thirty cover transects were sampled for the Upland Grassland community. Originally there were 31 transects sampled in this community, however, upon review transect 26 was discarded due to the fact that it was not representative of the community. Absolute total vegetation cover was 46.02 percent. Absolute bare soil and litter/rock percentages were 11.07 and 41.13, respectively. Absolute total ground cover was 88.95 percent. Buffalograss provided the highest relative vegetation cover at 27.81 percent, while blue grama provided the next highest relative vegetation cover at 27.10 percent. Refer to Table 3.5-11 for the absolute cover values.

Table 3.5-11: Absolute Cover for the Upland Grassland Vegetation Community

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	46.02
Absolute Total Cover (%)	88.47

Sample Adequacy

There were 30 samples taken in the Upland Grassland community. The sample adequacy formula outlined earlier was utilized to determine the minimum required size of the sample population. Upland Grassland met sample adequacy. Refer to Table 3.5-12 for sample adequacy values.

Table 3.5-12: Summary of Sample Adequacy Calculations for Percent Vegetation Cover in the Upland Grassland

Map Unit	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Upland Grassland						
Total Vegetation Cover	23.00	6.88	29.32	30.00	1.29	90.15
Total Ground Cover	44.23	3.04	1.55	30.00	5.63	NA

Shrub Density

Upland Grassland supported an average of 51.01 shrubs per acre or 0.01 shrubs/m^2. The following full and half/sub-shrub species were found: big sagebrush, fringed sagewort, and broom snakeweed. Refer to Appendix 3.5-D for a complete Upland Grassland density summary.

Species Composition

Species composition for the Upland Grassland community was dominated by warm season perennial grasses with 54.91 percent relative vegetation cover, followed by cool season perennial grasses with 27.66 percent relative vegetation cover. Annual grasses had 9.00 percent relative vegetation cover, while annual forbs had 3.35 percent relative vegetation cover. Perennial forbs had 0.43 percent relative vegetation cover. Subshrubs had a total 0.15 percent relative vegetation cover. Succulents had 4.50 percent relative vegetation cover. The cool season perennial grasses were dominated by western wheatgrass, threadleaf sedge, and crested wheatgrass. Warm season grasses were dominated by blue grama and buffalograss. Annual grasses were dominated by Japanese brome and cheatgrass. Perennial forbs included scarlet globemallow. Annual forbs included desert alyssum, prairie peppergrass, and *Thlaspi arvense* (field pennycress). Fringed sagewort was the only sub-shrub present. Also present was plains prickly pear. Refer Table 3.5-13 for relative Upland Grassland cover summary and to Appendix 3.5-C for an Upland Grassland complete cover summary.

Table 3.5-13: Vegetation Cover Sampling Data Summary of Species by Lifeform for the Upland Grassland Community

	Vegetation Cover	
	Absolute	Relative (%)
Cool Season Perennial Grasses	12.73	27.66
Warm Season Perennial Grasses	25.27	54.91
Annual Grasses	4.14	9.00
Annual Forbs	1.54	3.35
Perennial Forbs	0.20	0.43
Perennial Sub-Shrubs	0.07	0.15
Succulents	2.07	4.50

3.5.5.1.7 Cottonwood Gallery

Cover

The Cottonwood Gallery community comprised approximately 240.60 of the 10,557.03 acres of the PAA (2.28 percent). Twenty-six cover transects were sampled for the Cottonwood Gallery community. Absolute total vegetation cover was 62.61 percent. Absolute bare soil and litter/rock percentages were 1.19 and 17.50, respectively. Absolute total ground cover was 97.62 percent. Smooth brome provided the highest relative vegetation cover at 29.12 percent, while western wheatgrass provided the next highest relative vegetation cover at 26.29 percent. Refer to Table 3.5-14 for the absolute cover values.

Table 3.5-14: 2007 Absolute Cover for the Cottonwood Gallery Vegetation Community

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	62.61
Absolute Total Cover (%)	97.62

Sample Adequacy

There were 26 samples taken in the Cottonwood Gallery community. The sample adequacy formula outlined earlier was utilized to determine the minimum required size of the sample population. Cottonwood Gallery met sample adequacy. Refer to Table 3.5-15 for sample adequacy values.

Table 3.5-15: Summary of Sample Adequacy Calculations for Percent Vegetation Cover in the Cottonwood Gallery

Map Unit	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Cottonwood Gallery						
Total Vegetation Cover	31.31	7.65	19.56	26.00	2.95	99.84
Total Ground Cover	48.81	2.08	0.60	26.00	16.92	NA

Shrub Density

Cottonwood Gallery supported an average of 567.60 shrubs per acre or 0.14 shrubs/m^2. The following full and half/sub-shrub species were found: big sagebrush, silver sagebrush, rubber rabbitbrush, greasewood, and *Symphoricarpos occidentalis* (western snowberry). Refer to Appendix 3.5-D for a complete Cottonwood Gallery density summary.

Tree Density

Tree species within this community were counted on an aerial photograph. Upon counting the number of plains cottonwoods within the community was 295.

Species Composition

Species composition for the Cottonwood Gallery community was dominated by cool season perennial grasses with 55.41 percent relative cover, followed by trees with 21.37 percent relative cover. Warm season perennial grasses had 0.37 percent relative cover. Annual forbs had 18.06 percent relative cover while annual grasses had 1.23 percent relative cover. Perennial forbs had 2.33 percent relative cover. Shrubs had a total 1.23 percent relative cover. The cool season perennial grasses were dominated by smooth brome and western wheatgrass. The warm season perennial grasses included inland saltgrass. Annual grasses were dominated by Japanese brome and cheatgrass. Perennial forbs were dominated by *Cirsium arvense* (Canada thistle) and *Achillea millefolium* (common yarrow). Annual forbs included summer cypress and *Chenopodium album* (lambsquarters goosefoot). Present shrubs were silver sagebrush, greasewood, and *Symphoricarpos occidentalis* (western snowberry). *Populus deltoides* (plains cottonwood) was the only tree present. Refer to Table 3.5-16 below for relative Cottonwood Gallery cover summary and to Appendix 3.5-C for a Cottonwood Gallery complete cover summary.

Table 3.5-16: Vegetation Cover Sampling Data Summary of Species by Lifeform for the Cottonwood Gallery Community

	Vegetation Cover	
	Absolute	**Relative (%)**
Cool Season Perennial Grasses	34.69	55.41
Warm Season Perennial Grasses	0.23	0.37
Annual Grasses	0.77	1.23
Annual Forbs	11.31	18.06
Perennial Forbs	1.46	2.33
Perennial Shrubs	0.77	1.23
Trees	13.38	21.37

3.5.5.1.8 Vegetation Survey Discussion

The 10,580 acre PAA consists of five vegetation communities: Big Sagebrush Shrubland, Greasewood Shrubland, Ponderosa Pine Woodland, Upland Grassland, and Cottonwood Gallery. Each community was investigated for baseline vegetation information in support of a NRC Source Materials License and SD DENR Regular Mine Permit Application.

No threatened or endangered species were encountered within the PAA. The presence of the state designated weed Canada thistle was present within the Cottonwood Gallery vegetation community. The presence of the Fall River County designated weed field bindweed was present within the Greasewood Shrubland vegetation community.

3.5.5.2 Wetlands

3.5.5.2.1 Wetland Survey Methodology

The wetland surveys were conducted in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region. All WoUS and OWUS were assessed during the surveys. The routine wetland delineation approach with on-site inspection was utilized, and the survey was conducted by pedestrian reconnaissance and review of existing maps of the PAA. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. Wetland Determination Data Forms-Great Plains Region-DRAFT, were utilized for each observation point. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Figure 3.5-1 below identifies Beaver Creek, Figure 3.5-2 identifies the Cottonwood Gallery, and Figure 3.5-3 identifies the concentration of old mine pits.

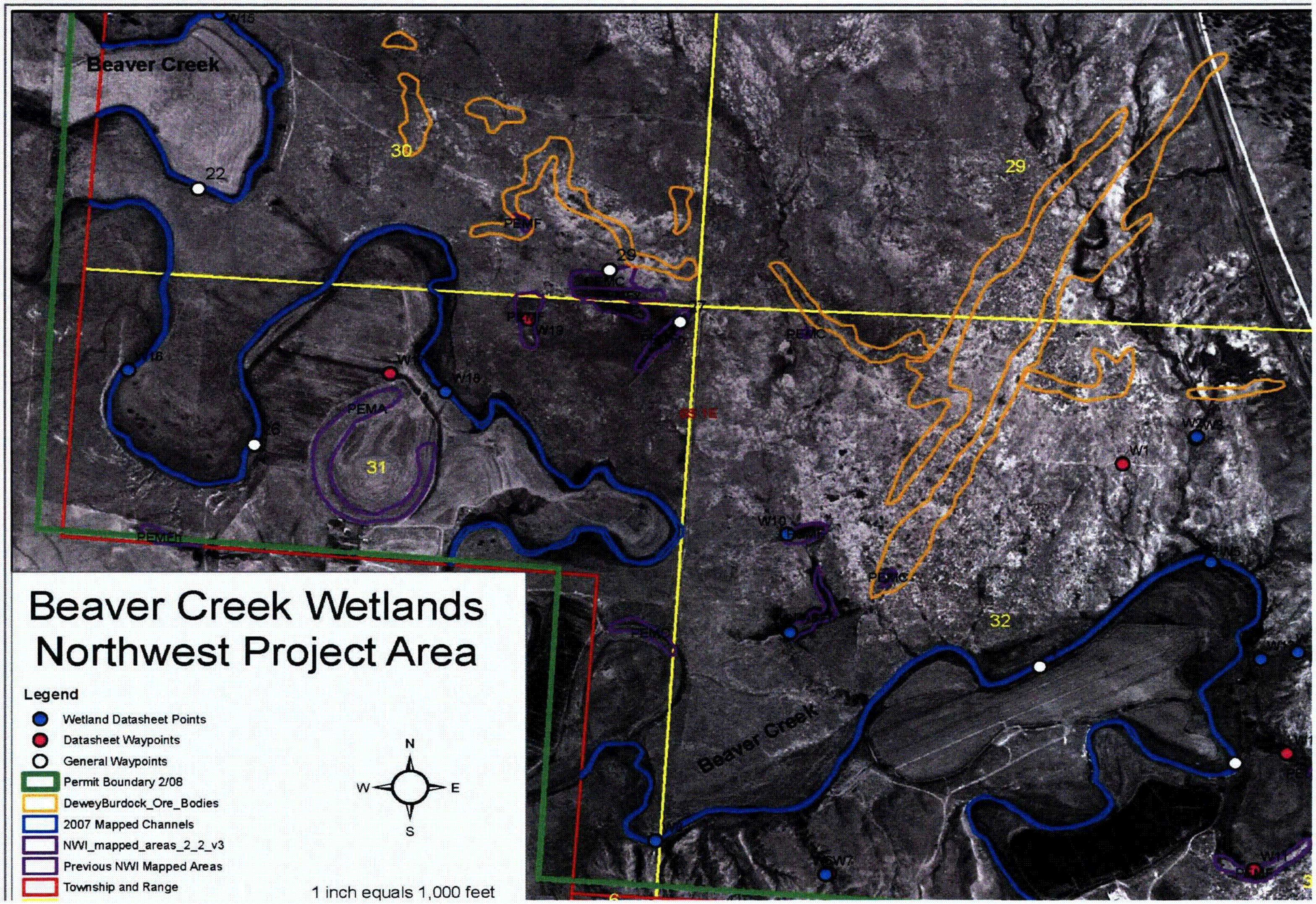

Figure 3.5-1: B

Beaver Creek Wetlands Northwest PAA

POWERTECH (USA) INC.

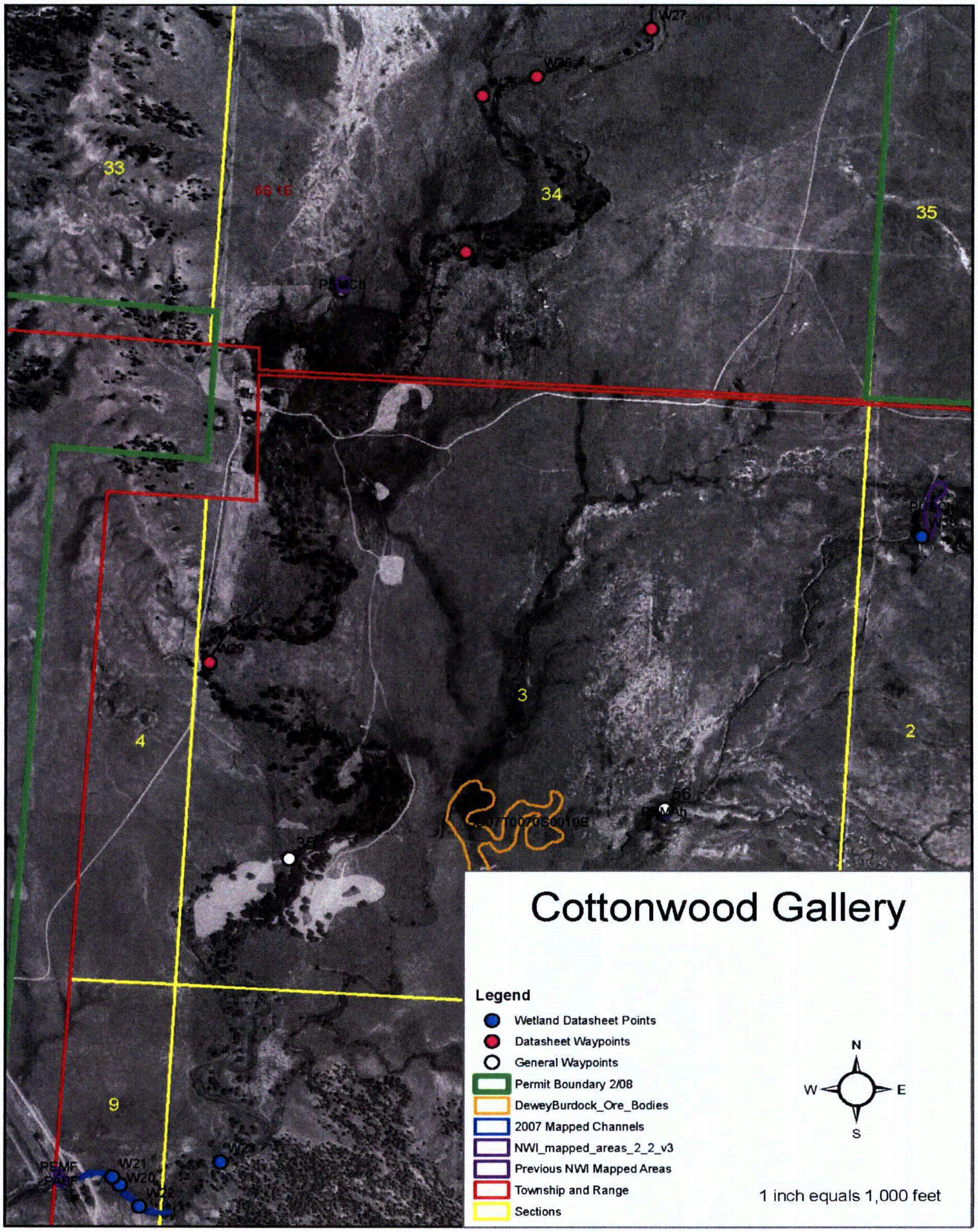

Figure 3.5-2: Cottonwood Gallery

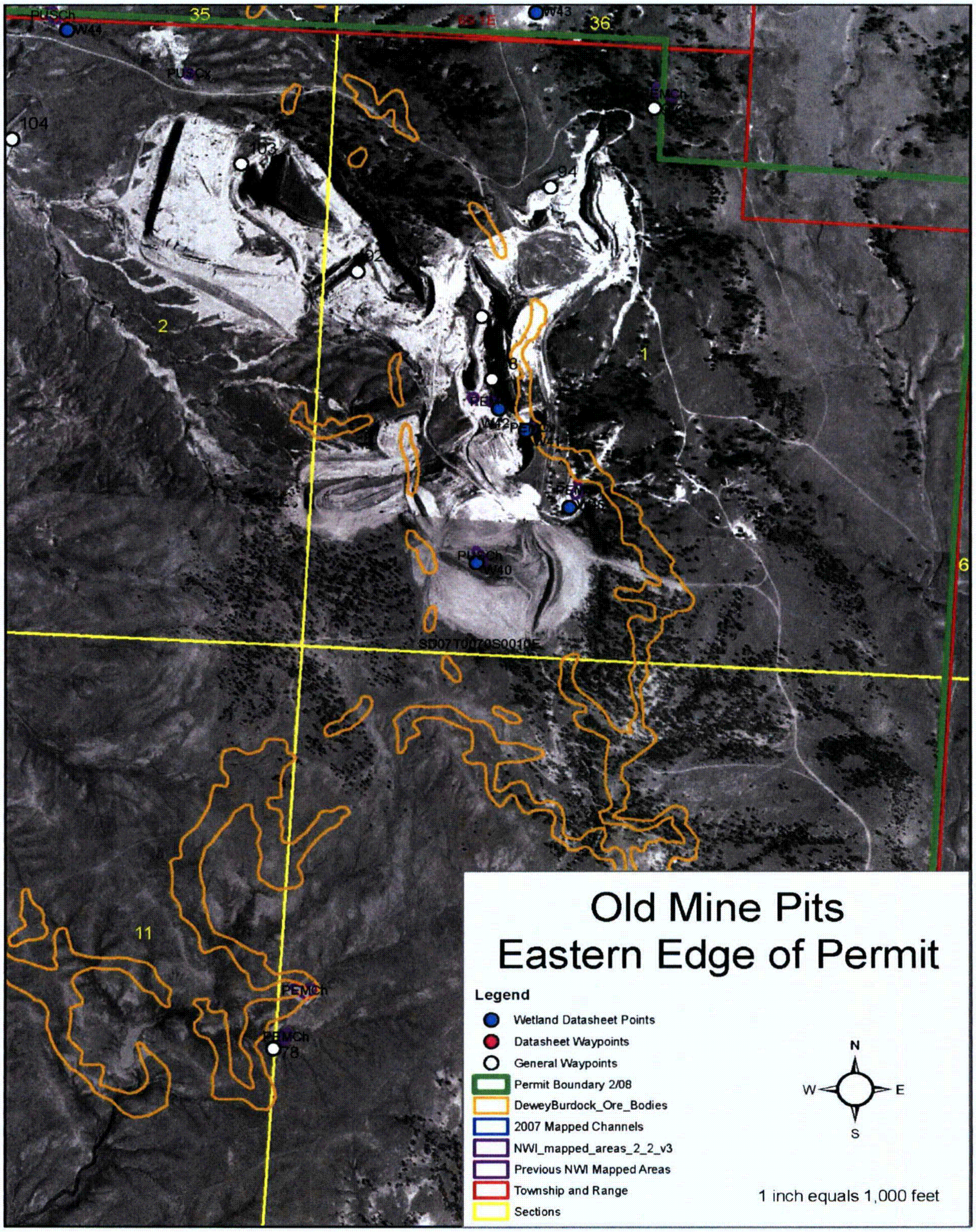

Figure 3.5-3: Old Mine Pits Eastern Edge of Permit

Natural Resources Conservation Service (NRCS) soils mapping for Custer and Fall River Counties, South Dakota, (2007) and BKS soil mapping of the PAA were reviewed for general soils information.

Potential wetlands (WoUS) and OWUS were initially identified via review of area maps to include the following:

- 1977 USFWS NWI mapping for the Dewey, Burdock and Twenty-one Quads
- Custer Quad Digital Elevation Model
- Burdock Quad Digital Elevation Model

Wetland indicator categories were identified for each dominant plant species noted through use of the National List of Vascular Plant Species that Occur in Wetlands, 1996 National Summary. Region 4 (North Plains) indicator categories were utilized for the PAA.

Field sample locations and resulting wetland boundaries were recorded with a hand-held Garmin GPSmap 60Cx Global Positioning System (GPS) unit in NAD 1983 UTM Zone 13. BKS provided drafting services for the Proposed Action.

3.5.5.2.2 Wetland Survey Results

The PAA was generally characterized by Big Sagebrush Shrubland, Greasewood Shrubland, and Ponderosa Pine Woodland with pockets of Upland Grassland and Agricultural land, mine pit, Silver Sagebrush Shrubland, Shale Outcrop, or Pass Creek. Beaver Creek had Agricultural land to the south and Greasewood Shrubland and Big Sagebrush Shrubland to the north. Agricultural land comprised 399.83 acres, Greasewood Shrubland comprised 2,252.15 acres and Big Sagebrush Shrubland comprised 2,738.85 acres. Beaver Creek had water present continuously in the drainage and wetland species near the banks. The upper banks were comprised mainly of *Artemisia tridentata* (big sagebrush), *Sarcobatus vermiculatus* (Greasewood), and *Elymus smithii* (Western wheatgrass). The wetland indicator status of these plants are UPL (upland), UPL, and FACU (facultative upland) respectively. The Pass Creek comprised of the Cottonwood Gallery vegetation community comprised mainly of *Bromus inermis* (smooth brome), western wheatgrass, and *Populus deltoides* (cottonwood trees). The wetland indicator statuses of these plants are UPL, FACU, and FAC (facultative) respectively. Please refer to Section 2.8.5.1 for further information regarding the vegetation within the PAA.

The PAA generally occurs on uplands, with inclusions of two main drainages, Beaver Creek and Pass Creek and several depressed areas. Beaver Creek and Pass Creek were evaluated using pedestrian reconnaissance, while the remaining small drainages were evaluated based on existing mapping. Wetlands were identified throughout the Beaver Creek drainage; however Pass Creek only had wetlands present near an old open flowing well close to PAA. Wetlands were also identified in the majority of the old mine pits as well as depressed areas throughout the PAA. The wetland classification along Beaver Creek was Riverine Lower Perennial Emergent (R2EM) and Palustrine Emergent (PEM) WoUS inPass Creek and other small drainages. The mine pits were primarily designated as Palustrine Unconsolidated Bottom (PUB) OWUS and depressions were typically PEM or PUB designations.

The proposed project may affect a total of 35.114 acres of R2EM, R4SB7 (Riverine Intermittent Streambed vegetated), and PEM stream channel, Palustrine Aquatic Bed Intermittently Flooded Diked (PABJh), Palustrine Unconsolidated Shore Temporarily Flooded (PUSA), PEM, PUB, PUS, and PEMC (seasonally flooded) isolated ponds, and open water (OW). The acreage of OW consists of approximately 9.451 acres.

The area had previously been mined for uranium through several open pit mines; some of the mines had been filled in with water. One livestock watering tank was identified on the survey.

Soils information for the PAA was obtained by NRCS Web Soil Survey for Custer and Fall River Counties, South Dakota, (2007).

There are two main drainage basins located in the PAA; each of the drainages had different soil types. Beaver Creek had Haverson loam, 0-2 percent slopes throughout the drainage. Pass Creek had Barnum silt loam in the south half of the drainage and Barnum-Winetti complex, 0-6 percent slopes. The old mine pits were also classified as Barnum silt loam and Barnum-Winetti complex.

None of the soil map units were found on the hydric soils list for Fall River County or Custer County, South Dakota.

Table 3.5-17 is a summary list of the wetlands in the PAA along with several details about each wetland, including location, delineation designation, geomorphic setting, comments, and jurisdictional recommendations. Table 3.5-18 provides of summary of the 2007 wetland delineation results.

Table 3.5-17: Summary of Wetlands within the PAA

Map and Plot ID (no Data Form if italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
W1	Sec 32 T6S R1E	R1 P1	Wetland	PEMC	0.005	Depression in tributary	--	Non-jurisdictional
W2	Sec 32, T6S R1E	No photos	Wetland	R2EM	0.017	Tributary to Beaver Creek, wetland channel	--	Jurisdictional
W3	Sec 32, T6S R1E	R1 P12 R1 P13	Non-wetland	--	--	Tributary to Beaver Creek	--	--
W4	Sec. 32, T6S R1E	R1 P2 R1 P3 R1 P4	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
W5	Sec 32, T6S R1E	R1 P5	Non- wetland	--	--	Drainage	Bank of Beaver Creek	--
W6	Sec. 32, T6S R1E	R1 P16	Non-wetland	--	--	Upland tributary	--	--
W7	Sec. 32, T6S R1E	R1 P17 R1 P18	Wetland	R4SB7	0.002	Upland tributary, wetland channel	--	Non-jurisdictional
W8	Sec. 31, T6S R1E	R1 P19 R1 P20	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
W9	Sec. 32, T6S R1E	R1 P23 R1 P24	Wetland	PABJh	0.26	Depression w/ berm	Previously mapped as PABFh	Non-jurisdictional
W10	Sec. 32, T6S R1E	R2 P1 R2 P2	Wetland	PUSA	0.03	Depression	Previously mapped as PEMF	Non-jurisdictional
W11	Sec. 32 T6S R1E	R2 P3 R2 P4	Non-wetland	--	--	Drainage by berm	Previously mapped as PEMF	--
W12	Sec. 32 T6S R1E	R2 P5 R2 P6	Non-wetland	--	--	Drainage	Previously mapped as PEMF	--
W13	Sec. 32 T6S R1E	No photos	Wetland	R4US	0.036	Drainage, wetland channel	Beaver Creek	Jurisdictional
W14	Sec. 32 T6S R1E	R2 P7 R2 P8 R2 P9	Wetland	R4US	0.012	Isolated Drainage, wetland channel	Tributary	Non-jurisdictional
W15	Sec. 30 T6S R1E	R2 P12 R2 P13	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional

Map and Plot ID (no Data Form if ☐ italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
W16	Sec. 31 T6S R1E	R2 P18 R2 P19	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
Map and Plot ID (no Data Form if italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
W17	Sec. 31 T6S R1E	R2 P22 R2 P23	Non-Wetland	--	--	Ditch around Agricultural area	Previously mapped as PEMA	--
W18	Sec. 31 T6S R1E	R3 P1 R3 P2	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
W19	Sec. 31 T6S R1E	R3 P3 R3 P4	Non-wetland	--	--	Low area	Previously mapped as PEMF	--
W20	Sec. 9 T7S R1E	R3 P8 R3 P9	Wetland	PEM	0.503	Drainage, wetland channel	Pass Creek	Non-jurisdictional
W21	Sec. 9 T7S R1E	R3 P10 R3 P11 R3 P12	Wetland					
W22	Sec. 9 T7S R1E	R3 P13 R3 P14	Wetland					
W23	Sec. 10 T7S R1E	R3 P17 R3 P18	Wetland					
W25	Sec. 34 T6S R1E	R4 P1 R4 P2	Non-wetland	--	--	Drainage	Pass Creek	--
W26	Sec. 34 T6S R1E	R4 P3 R4 P4	Non-wetland	--	--	Drainage	Pass Creek	--
W27	Sec. 34 T6S R1E	R4 P11 R4 P12	Non-wetland	--	--	Drainage	Pass Creek	--
W28	Sec. 34 T6S R1E	R4 P13 R4 P14	Non-wetland	--	--	Drainage	Pass Creek	--
W29	Sec. 3 T7S R1E	R4 P17 R4 P18	Non-wetland	--	--	Drainage	Pass Creek	--
W30	Sec. 10 T7S R1E	R4 P19 R4 P20	Non-wetland	--	--	Depression	--	--
W31	Sec. 10 T7S R1E	R4 P21 R4 P22	Wetland	PUB	1.801	Depression	--	Non-jurisdictional

Map and Plot ID (no Data Form if italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
W32	Sec. 10 T7S R1E	R4 P24 R4 P25	Wetland	PUB	1.475	Depression	--	Non- jurisdictional
W33	Sec. 14 T7S R1E	R5 P1 R5 P2	Wetland	PEM	1.417	Pond	--	Non- jurisdictional
W34	Sec. 14 T7S R1E	R5 P9 R5 P10	Non-wetland	--	--	Drainage	--	--
W35	Sec. 14 T7S R1E	R5 P11 R5 P12	Wetland	PUB	1.972	Depression	--	Non-jurisdictional
W36	Sec. 10 T7S R1E	R5 P20 R5 P21	Wetland	PEM	0.253	Outfall	Drainage	Non-jurisdictional
W37	Sec. 34 T6S R1E	R6 P6 R6 P7 R6 P8 R6 P9 R6 P10	Non-wetland	OW	7.635	Old Mine Pit	--	--
W38	Sec. 2 T7S R1E	R6 P13 R6 P14	Wetland	PUS	1.099	Depression	--	Non-jurisdictional
W39	Sec. 2 T7S R1E	R6 P16 R6 P17	Wetland	PUS	0.308	Depression w/ manmade berm	--	Non-jurisdictional
W40	Sec. 1 T7S R1E	R6 P18	Wetland	PEM	0.213	Pond	--	Non-jurisdictional
W41	Sec. 1 T7S R1E	R6 P19 R6 P20	Wetland	PUB	0.008	Old Mine Pit	--	Non-jurisdictional
W42	Sec. 1 T7S R1E	R6 P22 R6 P23 R6 P24	Wetland	PUB	0.167	Old Mine Pit	--	Non-jurisdictional
W43	Sec. 36 T6S R1E	Outside of PAA, deleted photographs from Appendix 3.5-F and datasheet from Appendix 3.5-G						
W44	Sec. 2 T7S R1E	R7 P24 R8 P1 R8 P2	Wetland	PEM	0.378	Depression near drainage	--	Non-jurisdictional

Map and Plot ID (no Data Form if italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
W45	Sec. 1 T7S R1E	R8 P4 R8 P5	Wetland	PEM	0.035	Depression	--	Non-jurisdictional
Wpt 3	Sec. 32 T6S R1E	R1 P6 R1 P7	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
Wpt 4	Sec. 32 T6S R1E	R1 P8 R1 P9	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
Wpt 22	Sec. 30 T6S R1E	R2 P14 R2 P15	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
Map and Plot ID (no Data Form if italicized)	**Legal Description**	**Roll # Photo #**	**2007 Delineation Designation**	**Cowardin Classification**	**Acreage of Cowardin Classification**	**Geomorphic Setting**	**Comments**	**Jurisdictional Recommendation**
Wpt 26	Sec. 31 T6S R1E	R2 P24	Wetland	R2EM	13.376 total	Drainage, wetland channel	Beaver Creek	Jurisdictional
Wpt 27	Sec. 31 T6S R1E	R3 P5	Non-wetland	--	--	Depression	Previously mapped as PEMFh, no longer present	--
Wpt 29	Sec. 30 T6S R1E	R3 P6 R3 P7	Non-wetland	--	--	Depression	Previously mapped as PEMC and PEMFx, no longer present	--
Wpt. 35	Sec. 3 T7S R1E	R3 P23 R3 P24	Non-wetland	--	--	Drainage	Cottonwood Drainage	--
Wpt. 56	Sec. 3 T7S R1E	R5 P3 R5 P4	Non-wetland	--	--	Depression	Previously mapped as PEMAf- not present	--
Wpt. 57	Sec. 14 T7S R1E	R5 P5	Non-wetland	--	--	Depression	--	--
Wpt. 58	Sec. 14 T7S R1E	R5 P8	Wetland	PEM	1.417	Pond	Same as W33	Non- jurisdictional
Wpt. 60 and Wpt. 61	Sec. 15 T7S R1E	R5 P13 R5 P14 R5 P15	Non-wetland	--	--	Depression	Salt Crust present	--
Wpt. 62	Sec. 10 T7S R1E	R5 P16 R5 P17	Non-wetland	--	--	Depression	Previously mapped as PEMCh, not present	

Map and Plot ID (no Data Form if italicized)	Legal Description	Roll # Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Wpt. 68	Sec. 10 T7S R1E	R5 P18 R5 P19	Wetland	PEM	0.253	Outfall	Same as W36	Non-jurisdictional
Wpt. 74	Sec. 11 T7S R1E	R6 P1 R6 P2	Non-wetland	--	--	Depression	Previously mapped as PEMCh, not present	
Wpt. 78	Sec. 12 T7S R1E	R6 P5	Non-wetland	--	--	Depression	Previously mapped as PEMCh, not present. Nor the PEMCh just north of the point.	
Map and Plot ID (no Data Form if italicized)	**Legal Description**	**Roll # Photo #**	**2007 Delineation Designation**	**Cowardin Classification**	**Acreage of Cowardin Classification**	**Geomorphic Setting**	**Comments**	**Jurisdictional Recommendation**
Wpt. 83	Sec. 2 T7S R1E	R6 P15	Wetland	PUS	0.308	Depression w/ manmade berm	Same as W39	Non-jurisdictional
Wpt. 88 and Wpt. 89	Sec. 1 T7S R1E	R7 P1 R7 P2	Non-wetland	--	--	Old Mine Pit	Dominated by rabbit brush and *Hordeum jubatum*	--
Wpt. 92	Sec. 1 T7S R1E	R7 P5 R7 P6 R7 P7	Non-wetland	OW	0.452	Old Mine Pit	Mine Pit filled with water	--
Wpt. 94	Sec. 1 T7S R1E	R7 P9	Non-wetland	--	--	Old Mine Pit	Mine pit is dry, no vegetation	--
Wpt. 97	Sec. 1 T7S R1E	R7 P14	Non-wetland	--	--	Depression	Previously mapped PEMCh not present	--
Wpt 103	Sec. 2 T7S R1E	R7 P20	Wetland	PEM and OW	2.364	Old Mine Pit	--	Non-jurisdictional
Wpt 104	Sec. 2 T7S R1E	R7 P21 R7 P22 R7 P23	Wetland	PUS	1.299	Depression	--	Non-jurisdictional

Table 3.5-18: Summary of 2007 Wetland Delineation Results

Summary		
Number of Features	**Name**	**Acres**
2	Wetland Channel (PEM)	0.756
2	Wetland Channel (R2EM)	13.393
1	Wetland Channel (R4SB7)	0.002
2	Wetland Channel (R4US)	0.048
4	PEM Isolated Ponds	2.043
1	PEMC Isolated Pond	0.005
1	PABJh Isolated Ponds	0.260
1	PUSA Isolated Ponds	0.030
3	PUB Isolated Depression	5.248
3	PUS Isolated Depression	2.706
5	Mine Pits PUB, PEM, OW	10.626
	Total	**35.114**
	Wetland Channel (PEM)	1,842.05 Linear Feet (0.35 mi)
	Wetland Channel (R2EM)	34,079.65 Linear Feet (6.45 mi)

<u>**Results**</u>:

<u>Beaver Creek</u>

Beaver Creek is located in the northwest of the PAA in Sections 30, 31, and 32 in T6S, R1E. The entire stretch of Beaver Creek within PAA is designated as a R2EM wetland, for a total of 13.376 acres. Seven data forms were filled out for the variety of lengths in the drainage as well as four photo waypoints. The most common vegetation that was identified along the drainage was *Spartina pectinata* (prairie cordgrass), *Juncus balticus* (Baltic rush), and *Schoenoplectus pungens* (common threesquare). These plants have an indicator status of FACW (facultative wet), FACW, and OBL (obligate) respectively.

<u>Pass Creek</u>

Pass Creek is centrally located within the PAA in T7S, R1E in Sections 3, 9, and 10, and T6S, R1E in Section 34. Pass Creek only had wetlands present in Section 9, primarily due to an old open flowing well on the other side of the road outside PAA. The wetland totaled 0.503 acres of PEM, a total of four datasheets were filled out. The common vegetation found within the wetland was prairie cordgrass and common threesquare. The remaining drainage was walked and delineated, however no other wetlands were present. Five non-wetland datasheets were filled out and photo points were taken. Refer to Table 3.5-17, Summary of Wetlands within the PAA for more details.

Previously Mapped Wetlands Confirmed as a Non-Wetland

There were several National Wetlands Inventory 1977 previously mapped wetlands that were confirmed as non-wetland or not present during the 2007 field survey. The areas generally lacked hydrophytic vegetation, hydric soils, and hydrology. Most areas had geomorphic position but often lacked another secondary indicator. Datasheets were filled out to confirm no presence of these wetlands and can be found in Table 3.5-17, Summary of Wetlands within the PAA for more details. Previously mapped wetlands that are no longer present do not appear on the map (Plate 3.5-3).

Old Mine Pits

There are seven old uranium open pits present within the PAA. Four of the mine pits were classified as non-wetland primarily due to lack of hydrophytic vegetation and/or hydrology presence. Two mine pits located in T7S, R1E in Section 1 were classified as PUB wetlands. The only mine pit in Section 2 was classified as both a PEM and Open Water (OW). The PEM is located along the bank of the pit and OW throughout the rest of the pit. The mine pit in Section 34 T6S R1E was classified as OW and totaled 7.635 acres another small mine pit located at waypoint 92 is Section 1 T7S R1E was classified as OW at 0.452 acres. There were approximately 1.172 acres of wetlands and 9.451 acres of open water within old mine pits in the PAA. Refer to Table 3.5-17, Summary of Wetlands within the PAA for more details.

Depressional Areas and Ponded Areas Identified as Wetlands

All the depressional areas identified as wetlands in 2007 were also previously identified during the 1977 NWI mapping. All of these wetlands are recommended to be non-jurisdictional based on the isolated nature of the wetlands. The wetlands were primarily classified as PEM, PEMC, PABJh, PUS, PUSA and PUB wetlands based primarily on the hydrology conditions of each waypoint. There were approximately 10.292 acres of wetland depressions and ponds present within the PAA. Refer to Table 3.5-17, Summary of Wetlands within the PAA for more details.

Beaver Creek Update

Beaver Creek is likely to have wetlands throughout the entire PAA as it is a major drainage and had a good flow of water when the surveys were conducted in 2007. The boundary change took out 1.956 acres of R2EM wetlands along Beaver Creek in the NW1/4 of Section 31 T6S R1E. The boundary change also added 4.81 acres of R2EM wetlands along Beaver Creek in the SE1/4 of Section 31 T6S R1E and E1/2 of Section 5, the SW1/4 of Section 4 of T7S R1E. The total acreage addition to the wetlands along Beaver Creek was 2.86 acres of R2EM.

Small PEM and PUB isolated wetlands may be found SW of the Beaver Creek Drainage is Section 5, T7S R1E; however accessibility to the area was not present to confirm. There are two depressions that can be seen on the map and based on the 2007 surveys of the PAA the likelihood of the depressions being classified as a wetland is rare.

Pass Creek Update

In 2007, Pass Creek had 0.503 acres of PEM wetlands surveyed along its stretch; however due to the recent boundary change there are now only 0.05 acres of wetlands present on Pass Creek. The boundary change moved the boundary east of W22, and now excludes the three wetland points of W20, W21, and W22. The wetlands present on Pass Creek are primarily due to an old open flowing well on the other side of the road outside PAA.

In 2007, Pass Creek was surveyed from the southern project boundary to the old mine pit and no wetlands were identified except near the spring. No surveys were conducted on Pass Creek in 2008 as the map indicated that the area is likely dry.

Old Mine Pits

No changes to the acreages on the 2007 identified old mine pits wetland occurrences.

Depressional Areas and Ponded Areas Identified as Wetlands

No changes to the acreages on the 2007 depressional areas and ponded areas identified as wetlands. As noted above there may be some isolated PUB or PEM depressional areas SW of Beaver Creek, but accessibility to the area was not present during the 2008 surveys. However, it is unlikely that the areas indicated contain wetlands as the 2007 surveys proved that many of the potential wetlands indicated on the map and NWI no longer existed.

Approved Jurisdictional Determination

A summary the Approved Jurisdictional Determinations from the Department of the Army, Corps of Engineers, Omaha District for 20 sites identified as wetlands associated with the Dewey-Burdock Project is provide in Appendix 3.5-H. Of the 20 sites identified, only four were deemed jurisdictional. They were Beaver Creek, Pass Creek and an ephemeral tributary to each. While it is not anticipated that the Proposed Action would require work in any of the jurisdictional waterbodies identified in the JDs, or any other waters of the United States, Powertech (USA) will seek authorization from the USACOE prior to conducting the work.

3.5.5.3 Wildlife

3.5.5.3.1 General Setting

Wildlife and aquatics sampling were conducted by ICF Jones & Stokes, of Gillette, Wyoming from July 2007 through early August 2008 to meet agency requirements of one year of baseline data, and to accommodate changes to the PAA boundary during that period.

Background information on terrestrial vertebrate wildlife species, and aquatic vertebrates and invertebrates in the vicinity of the Proposed Action was obtained from several sources, including records from SDGFP, BLM, USFWS, U.S. Forest Service (USFS), and the original Draft Environmental Statement (DES) prepared by the TVA in 1979. Previous site-specific data for the Proposed Action and surrounding perimeter were obtained from those same sources, with current data collected during regular site visits and targeted surveys conducted from July 2007 through early August 2008.

Current baseline wildlife information was collected for the Proposed Action from July 2007 through early August 2008. The survey area included the entire PAA (current as of September 2008), with additional surveys conducted on adjacent lands and in nearby riparian areas for certain species of concern. Due to changes in the PAA boundary after completion of the field surveys, a small portion of the northern-most perimeter was not included in the baseline surveys (refer to wildlife map). However, because those surveys were conducted in representative habitats throughout the PAA, and no new habitat types were included in expanded perimeter, it is the professional opinion of ICF Jones & Stokes that no information was lost for any unique or critical data by not having conducted certain surveys in the limited excluded portion of the one-mile perimeter. That area can be included in any future monitoring required by the SDGFP as a condition of future permitting actions, at their discretion.

Survey protocols and timing were developed collaboratively with SDGFP to meet species-specific requirements. The survey area included the PAA and one-mile perimeter for threatened and endangered (T&E) species, bald eagle winter roosts, all nesting raptors, upland game bird leks, and big game. Surveys conducted only in the PAA included other vertebrate species of concern tracked by the SDNHP, as well as bats, small mammals, lagomorphs, prairie dog (*Cynomys* spp.) colonies, breeding birds, predators, and herptiles (reptiles and amphibians). Aquatic sampling occurred at water gauge stations located in Beaver Creek upstream of the PAA, and in Beaver Creek and the Cheyenne River downstream of the area. In addition to these targeted efforts, incidental observations of all vertebrate wildlife species seen within the PAA were recorded during each site visit during the year-long baseline survey period. Surveys for black-footed ferrets (*Mustela nigripes*) were not required for this project due to a block clearance issued by the USFWS that includes the entire PAA and vicinity.

All surveys were conducted by qualified biologists using standard field equipment and appropriate field guides. Most observations were recorded from vantage points during pedestrian or vehicular surveys to avoid disturbing wildlife; exceptions included small mammal trapping and aquatic species sampling. Raptor nests, prairie dog colonies, and other features or observation points of special interest were mapped in the field using a hand-held GPS receiver to record the Universal Transverse Mercator (UTM, NAD27) coordinates.

3.5.5.3.2 Big Game

No crucial big game habitats or migration corridors are recognized by the SDGFP in the PAA or surrounding one-mile perimeter. Crucial range is defined as any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the PAA, and both are considered year-round residents. Elk (*Cervus elaphus*) and white-tailed deer (*O. virginianus*) are also present in the survey area, but only in small herds. The latter two species can also be seen in the survey area year-round, but may be more common during different times of the year.

The pronghorn is the most common big game species in the Proposed Action survey area, though no species is prevalent. The pronghorn is a browse species and sagebrush-obligate, using shrubs for both forage and cover (Fitzgerald et al. 1994). Pronghorn herds were most often observed in sagebrush stands just beyond the north-central boundary of the PAA during winter 2007-2008.

Conversely, herds were widely distributed throughout grassland habitats in the northwestern and southeastern portions of the survey area during spring, summer, and early fall 2008. In June, after the ground and water pools had dried up, water availability became a limiting factor and pronghorn began to move to, and concentrate around, more dependable water sources such as Beaver Creek and livestock tanks, and to draws with more succulent forage.

Mule deer use nearly all habitats, but prefer sagebrush-grassland, rough breaks, and riparian bottomland (Jones et al. 1983). Browse is an important component of the mule deer's diet throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). In the Proposed Action survey area, mule deer were observed as individuals or in small herds in ponderosa pine and cottonwood riparian habitats along Beaver and Pass Creeks, and in the pine breaks along the eastern edge of the PAA. They are considered year-round residents in the survey area.

By nature, elk are shy animals that are less accepting of human disturbance than pronghorn (Fitzgerald et al. 1994) or deer. Elk in the Proposed Action survey area share their range with pronghorn and domestic cattle from spring through fall. Because elk prefer grass to shrubs, the resident herd competes more directly with domestic cattle and wild horses than with pronghorn in the spring and summer months. A herd of six bull elk was observed in the survey area in ponderosa pine habitat on one occasion (June 2008) during the baseline survey period, but local residents report that elk are frequently seen in the pine stands, especially during fall and winter.

White-tailed deer are typically associated with forests, woodlands, and treed galleries along streams (Fitzgerald et al. 1994). Small numbers of white-tailed deer were observed in the Proposed Action survey area during the baseline survey period, predominantly in the cottonwood corridor along Pass Creek in the central portion of the PAA. Most sightings of white-tailed deer were actually in the cottonwood corridor along the Cheyenne River, approximately 2-2.5 miles south of the PAA. This species is considered an uncommon year-round resident in the survey area itself.

3.5.5.3.3 Other Mammals

A variety of small and medium-sized mammalian species have the potential to occur in the Proposed Action survey area, although not all were observed in the PAA itself during the baseline wildlife surveys. These potential species include a variety of predators and furbearers such as the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), bobcat

(*Lynx rufus*), badger (*Taxidea taxus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*).

Numerous prey species, including rodents (e.g., mice, rats, voles, gophers, ground squirrels, chipmunks, prairie dogs, etc.), jackrabbits (*Lepus* spp.), and cottontails (*Sylvilagus* spp.) can also be found in the Proposed Action survey area. These species are cyclically common and widespread throughout the region, and are important food sources for raptors and other predators. Each of these prey species, with the exception of chipmunks and rats, were either directly observed during the field surveys, or were known to exist through burrow formation or scat. Jackrabbit sightings were uncommon and cottontail sightings were below normal, suggesting these species are currently in a local downward trend. Observations of small mammals occurred most often near Beaver and Pass Creeks, in the northwestern and central portions of the survey area, respectively.

One black-tailed prairie dog (*Cynomys ludovicianus*) colony is located in the northwestern corner of the PAA, and two others are present in the southwestern portion of the one-mile perimeter. Local ranchers use shooting and other control methods to reduce and/or eradicate prairie dogs from the PAA (private surface) and surrounding private lands.

Other mammal species such as the striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), and various weasels (*Mustela* spp.) inhabit sage-steppe communities, but no sightings or confirmed scat were recorded for these species during the surveys. Infrequent, incidental bat sightings (species unknown) occurred during nocturnal amphibian surveys and spotlighting efforts at targeted ponds in the PAA during the baseline period.

Small mammal trapping was conducted during fall 2007 as part of the baseline survey requirements for the Proposed Action. Trapping occurred in nine transects spread among six habitat types: Upland Grassland, Ponderosa Pine, Greasewood, Cottonwood Gallery, Clay Breaks, and Pine/Sage Edge. Grassland habitats occupy the largest parcels throughout the area, and held four transects; the remaining habitats held one transect each. Each transect included a combination of 20 live traps, 10 snap traps, and 5 pitfall traps. All traps were baited daily, with cotton balls placed in the live and pitfall traps for nesting material. Each transect was run for three consecutive days and nights (per SDGFP). Total trap nights per habitat ranged from 105 to 420 (upland grassland only), with a total of 945 trap nights across all habitats.

The deer mouse (*Peromyscus maniculatus*) dominated the captures, with only six individuals of other species recorded (Table 3.5-20). Deer mice are known for their ubiquitous presence and generalized habitat use, and these survey results are similar to those from other recent trapping efforts in northwest South Dakota and northeastern Wyoming.

Lagomorph (hares and rabbits) surveys are also a common component of baseline wildlife inventories. Spotlight lagomorph counts were conducted on two consecutive nights in fall 2007. Cottontail abundance was twice that of jackrabbits, though neither count was especially high (Table 3.5-21). Results from lagomorph surveys conducted in northeast Wyoming annually since 1984 indicate that the regional lagomorph population is experiencing a downward trend in its regular cyclic pattern. Although no data is available from the PAA prior to 2007, its proximity to the annual survey area in Wyoming suggests that the population trend is similar in southwestern South Dakota.

Table 3.5-19: Small Mammal Abundance During Trapping within the PAA in September 2007

	Captures per 100 trap-nights*						
Species	**UG**	**PP**	**GW**	**CG**	**CB**	**P/S**	**Total**
Deer mouse *Peromyscus maniculatus*	6.67	22.86	5.71	16.19	17.14	15.24	11.53
Olive-backed pocket mouse *Perognathus fasciatus*	0.71	--	--	--	--	--	0.32
Northern grasshopper mouse *Onychomys leucogaster*	0.24	--	--	--	--	--	0.11
Western harvest mouse (*Reithrodontomys megalotis*)	0.24	--	0.95	--	--	--	0.21
Total Abundance	7.86	22.86	6.67	16.19	17.14	15.24	12.17
Total No. of Species	4	1	2	1	1	1	4

* Excludes recaptures.
CB = Clay Breaks
CG = Cottonwood Gallery
GW = Greasewood
PP = Ponderosa Pine
P/S = Pine/Sage Edge
UG = Upland Grassland

Table 3.5-20: Total Lagomorphs Observed During Spotlight Surveys and Abundance Indices within the PAA in September 2007

	Species		
	White-tailed jackrabbit	**Cottontail**	**Totals**
Total Count	12	28	40
Lagomorphs/Survey Mile	1.5	3.4	4.9

[1] Survey route totaled 8.2 miles.
[2] Number given is highest count per species from two survey nights.

3.5.5.3.4 Raptors

Raptor species observed during the Proposed Action baseline wildlife surveys included the bald eagle, red-tailed hawk (*Buteo jamaicensis*), golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), turkey vulture (*Cathartes aura*), Cooper's hawk (*Accipiter cooperii*), rough-legged hawk (*Buteo lagopus*), merlin (*Falco columbarius*), great horned owl (*Bubo virginianus*), and long-eared owl (*Asio otus*). Other raptor species could also occur in the survey area, particularly as seasonal migrants, but were not seen during the 2007 and 2008 inventories.

Raptor sightings were recorded frequently throughout the Proposed Action survey area during 2007 and 2008 in ponderosa pine, cottonwood riparian, and grassland habitats. Observations were most concentrated in proximity to Beaver Creek and Pass Creek, perhaps because of prey availability due to the presence of water and better vegetative cover along those drainages. Raptors were observed hunting, perching on nest trees, power poles, and topographic features, nest tending, incubating, and exhibiting nest defense. The bald eagle, red-tailed hawk, American kestrel, and northern harrier were the most commonly seen raptor species in the area. Raptor sightings for those species were recorded with regularity during all four seasons during the baseline survey period, though some of those species may leave the area under harsher winter conditions.

Biologists watched for active raptor nests and breeding behavior (territory defense, courtship flights, prey deliveries, etc.) during all site visits within the breeding season. Additional nest searches were conducted concurrent with other surveys completed during the non-breeding season. Nests were monitored from a distance using binoculars and a spotting scope early in the nesting season to avoid impacting active nests. All active nests were monitored throughout the breeding season to determine their success and production level.

Five confirmed, intact (i.e., material present) raptor nests and one potential nest site were documented in the PAA during the 2007-2008 baseline survey period; two additional nests were recorded in the one-mile survey perimeter (see Wildlife Features map). All eight nests are listed in Table 3.5-22, including their locations, and their status and productivity in 2008. Three raptor species tracked by the SDNHP nested in the PAA. The bald eagle and long-eared owl (*Asio otus*) successfully nested within the PAA. A merlin (*Falco columbarius*) was recorded at a potential nest site in the pine breaks east of the current License boundary. The bird exhibited defensive behavior near the nest site, but no young or signs of active use (e.g., droppings, prey remains, egg shells, etc.) were recorded there.

Table 3.5-21: Raptor Nest Locations and Activity in and Within One Mile of the PAA during Baseline Wildlife Surveys from mid-July 2007 through early August 2008

Species[1,2]	¼ Section	Township/Range	Habitat	Status	Location
LEOW	**SESW 35**	**6 South/1 East**	**Ponderosa Pine**	**1+ owl fledged**	**Permit area**
RTHA (2 nests)	SENE 29	6 South/1 East	Ponderosa Pine	1 hawk fledged	Permit area
RTHA	SESW34	6 South/1 East	Cottonwood-riparian	2 hawks fledged	Permit area
BAEA	**Mid-SW 30**	**6 South/1 East**	**Cottonwood-riparian**	**1 eagle fledged**	**Permit area**
MERL	**NWSW 36**	**6 South/1 East**	**Ponderosa Pine**	**Nest defense but no confirmed young**	**1-mile perimeter**
GHOW	SWNE 5	7 South/1 East	Lone, live cottonwood tree	Status unknown[3]	Permit area
Unk Buteo	NESW 28	41 North/60 West (Wyoming)	Lone, dead cottonwood tree	Inactive	1-mile perimeter

[1] **Bold** species are tracked by the South Dakota Natural Heritage Program – South Dakota Department of Game, Fish and Parks (SDGFP web page, last updated September 2, 2008).

[2] Species Codes:

BAEA = Bald eagle
GHOW = Great horned owl
LEOW = Long-eared owl
MERL = Merlin
RTHA = Red-tailed hawk
Unk Buteo = Unknown *Buteo* (soaring hawks) species

[3] One adult GHOW was observed in the nest tree, but no chicks, feathers, droppings, or prey items were observed in or on the nest, or on the ground under the nest.

3.5.5.3.5 Upland Game Birds

The wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaida macroura*) were the only upland game bird species observed in the Proposed Action survey area during baseline inventories conducted from July 2007 to August 2008. Both species are relatively common and occur in a variety of woodland and open habitats in the PAA.

Three grouse species could potentially occur in the PAA (license area and one-mile perimeter): the greater sage-grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Tympanuchus phasianellus*), and ruffed grouse (*Bonasa umbellus*). The greater sage-grouse is a species of great concern throughout the west, and is considered a “landscape species” due to its use of wide expanses of sagebrush as primary habitat during each phase of its life cycle. Searches for grouse leks were completed between April 7 and May 12, 2008. Surveys were conducted between first light and approximately one hour after sunrise. Biologists searched for displaying grouse by driving through the PAA and one-mile perimeter, and making frequent stops at vantage points to scan and listen for displaying birds. Although sage-grouse were historically recorded in the general vicinity (TVA DES 1979), no leks have been documented by agency biologists within 6 miles of the PAA in recent years. No grouse were observed during the entire year-long baseline survey period for this project. Potential habitat for sage-grouse is present, but only in small stands of sage surrounded by grasslands and pine breaks; such habitat is not conducive to supporting a population of sage-grouse.

3.5.5.3.6 Other Birds

Lists of avian species tracked by the SDNHP were obtained from Mr. S. Michals (SDGFP) in July 2007 and the SDGFP website in September 2008. Biologists watched for all vertebrate species of concern during each site visit to the PAA during the year-long baseline survey period. All observations were recorded, including notes on species, number of individuals, age and sex (when possible), location, habitat, and activity. Three species of special interest (i.e., tracked by the SDNHP) were observed while conducting other surveys during the baseline inventory period: the Cooper's hawk (*Accipiter cooperii*), golden eagle (*Aquila chrysaetos*), and Clark's nutcracker (*Nucifraga columbiana*). All three species were briefly observed flying over the PAA, but no known nesting or other targeted use was recorded by these species.

In addition to those incidental observations, targeted surveys for breeding birds (primarily passerines) were conducted in the same habitats and along the same general transects within the PAA as the small mammal trapping. Four transects were surveyed in Upland Grassland, and one each in the remaining five habitat types. Breeding bird surveys were conducted using belt transects measuring 100 m wide by 1,000 m long. Transects were surveyed by slowly walking through the center of each line and stopping at least every 50 m to watch and listen for birds. Individuals observed while walking were also recorded, with efforts made to avoid double counting birds. Each transect was surveyed on three consecutive mornings in June 2008. To reduce bias, surveys started in a different habitat type each morning. Surveys began between dawn and sunrise, and were completed within four hours. All birds were identified to species. Flyovers and birds seen and heard beyond the transect boundaries were recorded as incidentals, but were not included in the analysis. Surveys were not conducted during inclement weather (precipitation, moderate to heavy winds, etc.).

Weather conditions during all surveys were mostly calm and clear, with a light breeze and approximately 25 percent high, thin cloud cover. Thirty-six species were observed within the breeding bird transects during spring 2008, with two additional unknown species logged (Table 3.5-23). The western meadowlark (*Sturnella neglecta*) was the most common species, followed by the mourning dove. The dove was the only species recorded in all six habitat types. The long-billed curlew (*Numenius americanus*) was the only species of the 36 observed that is tracked by the SDNHP. As expected, several species were associated with specific habitat types. For example, the curlew was only seen in the grassland transects (Table 3.5-23). Likewise, several species typically associated with trees were only observed in or immediately adjacent to the Cottonwood Gallery or Ponderosa Pine transects: the chipping sparrow (*Spizella passerina*), mountain bluebird (*Sialia currucoides*), black-capped chickadee (*Poecile atricapillus*), and yellow-rumped warbler (*Dendroica coronata*), among others. Similar associations were noted between other species and habitats.

Table 3.5-22: Breeding Bird Species Richness and Relative Abundance in Six Habitat Types within the PAA in June 2008

Species[2]	Average Number of Birds per Habitat Type[1]						
	BB	COT GAL	G	GW	P-SB Edge	PP	AVG #/PLOT
Western meadowlark (*Sturnella neglecta*)	3.0	1.7	2.9	7.0	2.0	---	2.8
Mourning dove (*Zenaida macroura*)	5.0	1.7	1.9	0.7	0.3	2.0	1.9
Long-billed curlew (*Numenius americanus*)	---	---	**1.9**	---	---	---	**0.9**
Chipping sparrow (*Spizella passerina*)	---	---	---	0.3	4.0	1.6	0.6
Lark sparrow (*Chondestes grammacus*)	3.7	---	---	---	1.7	---	0.6
Grasshopper sparrow (*Ammodramus savannarum*)	---	---	0.1	4.3	---	---	0.5
Northern flicker (*Colaptes auratus*)	---	4.3	---	0.3	---	---	0.5
Mountain bluebird (*Sialia currucoides*)	---	---	---	---	2.3	2.0	0.5
Brewer's blackbird (*Euphagus cyanocephalus*)	---	3.7	---	---	---	---	0.4
Spotted towhee (*Pipilo maculatus*)	---	1.3	---	0.3	0.7	1.0	0.4
American kestrel (*Falco sparverius*)	0.3	2.3	0.2	---	---	---	0.4
Brown-headed cowbird (*Molothrus ater*)	---	0.3	---	---	2.0	1.0	0.4
House wren (*Troglodytes aedon*)	---	2.7	---	---	---	---	0.3
Yellow warbler (*Dendroica petechia*)	---	2.0	---	---	---	---	0.2
Say's phoebe (*Sayornis saya*)	---	0.3	---	---	1.3	---	0.2
Bullock's oriole (*Icterus bullockii*)	---	1.7	---	---	---	---	0.2
Unknown flycatcher	---	---	---	---	---	1.7	0.2
Eastern kingbird (*Tyrannus tyrannus*)	---	1.3	---	---	---	---	0.1
Red-tailed hawk (*Buteo jamaicensis*)	---	0.3	0.1	0.3	---	---	0.1
Black-capped chickadee (*Poecile atricapillus*)	---	0.3	---	---	---	0.7	0.1
Yellow-rumped warbler (*Dendroica coronata*)	---	0.3	---	---	---	0.7	0.1

Table 3.5-23: Breeding Bird Species Richness and Relative Abundance in Six Habitat Types within the PAA in June 2008 (concl.)

	Average Number of Birds per Habitat Type[1]						
Species[2]	BB	COT GAL	G	GW	P-SB Edge	PP	AVG #/PLOT
European starling (*Sturnus vulgaris*)	---	1.0	---	---	---	---	0.1
Great horned owl (*Bubo virginianus*)	---	1.0	---	---	---	---	0.1
Vesper sparrow (*Pooecetes gramineus*)	---	---	0.3	---	---	---	0.1
American crow (*Corvus brachyrhynchos*)	---	---	0.1	---	---	0.3	0.1
Red-headed woodpecker (*Melanerpes erythrocephalus*)	---	0.7	---	---	---	---	0.1
Rock wren (*Salpinctes obsoletus*)	0.7	---	---	---	---	---	0.1
Western kingbird (*Tyrannus verticalis*)	I	0.7	---	---	---	---	0.1
American robin (*Turdus migratorius*)	---	0.3	---	---	---	---	<0.1
Common nighthawk (*Chordeiles minor*)	---	I	---	---	---	0.3	<0.1
Indigo bunting (*Passerina cyanea*)	---	0.3	---	---	---	---	<0.1
Killdeer (*Charadrius vociferous*)	---	---	0.1	---	---	---	<0.1
Lazuli bunting (*Passerina amoena*)	---	0.3	---	---	---	---	<0.1
Western wood peewee (*Contopus sordidulus*)	---	---	---	---	0.3	---	<0.1
Yellow-breasted chat (*Icteria virens*)	---	0.3	---	---	---	---	<0.1
Red-winged blackbird (*Agelaius phoeniceus*)	---	---	I	---	---	---	I
Turkey vulture (*Carthartes aura*)	I	I	---	---	---	---	I
Average # Birds/Transect	12.3	29.0	7.7	13.3	15.3	10.7	12.4
TOTAL SPECIES	5	23	10	7	10	10	36

BB = Bentonite breaks
COT GAL = Cottonwood Gallery
G = Grassland
GW = Greasewood
P-SB = Pine-sagebrush
PP = Ponderosa pine
I = Incidental flyover during breeding bird survey (not counted in totals)

[2] **Bold** species are tracked by the South Dakota Natural Heritage Program – South Dakota Department of Game, Fish and Parks (SDGFP web page, last updated September 2, 2008).

3.5.5.3.7 Waterfowl, Shorebirds

Under natural conditions, the PAA provides limited seasonal habitat for waterfowl and shorebirds. As described previously, natural aquatic habitats in the PAA occur mainly in Beaver Creek and Pass Creek, with a few scattered stock reservoirs also present. Because of the limited precipitation in the area, such habitats are available primarily during the spring migration period, with less reliable nesting and brood-rearing habitat in the area.

Although specific surveys for waterfowl and shorebirds were not required for the uranium project, biologists recorded all birds seen during the year-long survey period. Eight species associated specifically with water and/or wetlands were observed during the baseline inventories: the American white pelican (*Pelecanus erythrorhynchos*), great blue heron (*Ardea herodias*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), American wigeon (*Anas americana*), killdeer (*Charadrius vociferus*), long-billed curlew, and upland sandpiper (*Bartramia longicauda*). The pelican, heron, and curlew are tracked by the SDNHP.

3.5.5.3.8 Reptiles and Amphibians

The aquatic resources present within the PAA and surrounding perimeter have been thoroughly described in previous sections. Water is a limiting factor throughout the survey area and surrounding lands, with only one perennial stream passing through the western extent of the PAA and all other natural flow categorized as intermittent or ephemeral. Even the perennial Beaver Creek experiences extended periods of low volume and flow in most years. The creeks are meandering streams with extended reaches of muddy soil substrates and intermittent riparian vegetation. Aquatic species are not locally common inhabitants of the PAA. The lack of deep-water habitat and multiple perennial water sources limits the presence of fish, and decreases the potential for other aquatic species to exist.

Three aquatic or semi-aquatic amphibian species and one aquatic reptile were recorded during the 2007 and 2008 surveys PAA: the boreal chorus frog (*Pseudacris triseriata*), Woodhouse's toad (*Bufo woodhousei*), great plains toad (*B. cognatus*), and western painted turtle (*Chrysemys picta*). All four species were heard and/or seen in Beaver Creek as it flows through the western portion of the PAA, or near stock reservoirs. All four species are common to the PAA, and the region as a whole. One additional aquatic reptile was recorded in the perimeter surrounding the PAA, the western spiny softshell (*Trionyx spiniferus*). That observation also occurred in Beaver Creek, during the July 2008 fisheries sampling session.

Lizards (species unknown) were often observed sunning themselves on rocks and on sandy soil in the summer months during all except the early morning hours. These sightings were widespread throughout the survey area, with observations increasing as the summer progressed and the days got hotter. The shed remains of a snake skin were found in the north central portion of the survey perimeter in early May, 2007. The skin was at the base of a rock outcrop and looked as though it may have belonged to a bullsnake (*Pituophis cantenifer*).

3.5.5.4 Threatened, Endangered, or Candidate Species and Species Tracked by SDNHP

3.5.5.4.1 Federally Listed Species

No federally listed vertebrate species were documented in the Proposed Action survey area (current PAA and one-mile perimeter) during the year-long survey period. The black-footed ferret was the only federal T&E vertebrate species that could potentially occur in the PAA (http://www.sdgfp.info/Wildlife/Diversity/RareAnimal.htm 9/25/08). The U.S. Fish and Wildlife Service issued a block-clearance for ferrets throughout the entire state of South Dakota in recent years, including the Proposed Action survey area in extreme southwestern Custer County and northwestern Fall River County (C. Bessken, USFWS Biologist-SD, personal communication to G. McKee, Jones & Stokes, July 2, 2008). The only exception to that clearance is in Custer State Park in northern Custer County. Although ferret surveys were not required for the Proposed Action, they were conducted in the general vicinity of the PAA during monitoring performed for the TVA DES in fall 1977 (TVA DES 1979). No ferrets or evidence of their presence (e.g., trenching, tracks, or scat) were observed during those historic surveys, or during the recent project survey period. As described previously, one black-tailed prairie dog colony is located in the northwestern corner of the PAA, and two others are present in the southwestern portion of the one-mile perimeter. Local ranchers use shooting and other control methods to reduce and/or eradicate prairie dogs from the PAA (private surface) and surrounding private lands.

3.5.5.4.2 State Listed Species

The State of South Dakota lists 23 vertebrate species as threatened or endangered:

- Threatened: 4 fish, 4 birds, 2 mammals, 1 snake, and 1 turtle
- Endangered: 5 fish, 4 birds, 1 mammal, and 1 snake

The current list of these state species is available on the SDGFP website: http://www.sdgfp.info/Wildlife/Diversity/TES.htm.

Only 1 of those 23 state-level T&E species was documented within the PAA or one-mile perimeter during the survey period (mid-July 2007 through early August 2008). Although the bald eagle was removed from the federal listing process in August 2007, it is still considered as a threatened species at the state level in South Dakota. Bald eagles were repeatedly observed along Beaver Creek in the western portion of the proposed permit area and perimeter during winter roost surveys conducted in late 2007 and early 2008. One active bald eagle nest is located in the northwestern portion of the revised permit area in mid-SW¼ Section 30, Township 6 South, Range 1 East. The nest is in a cottonwood tree along Beaver Creek. The nest fledged one young in 2008.

A northern river otter (*Lontra canadensis*) carcass was unexpectedly discovered at the upstream fisheries sampling point along the Wyoming reach of Beaver Creek in April 2008. The upstream Beaver Creek sampling station (BVC04) was located just east of Highway 85 where it crosses Beaver Creek south of milepost 212 south of Newcastle, Weston County, Wyoming, approximately 12 stream miles (3 linear miles) northwest of the PAA boundary. The otter may have come downstream from Wyoming or upstream from the Cheyenne River during the flooding that occurred in early April. The cause of death was not apparent. The carcass was gone by the July sampling period, presumably washed back downstream with the next flood event. Otters are listed as threatened by the State of South Dakota, and are tracked by the SDNHP.

3.5.5.4.3 Species Tracked by SDNHP

As described in previous sections, current lists of other vertebrate species of interest or concern tracked by the SDNHP were obtained from SDGFP through personal contacts (July 2007) and from the agency's website (September 2008).

Six vertebrate sensitive species or species of local concern other than the bald eagle were documented within the current (September 2008 configuration) PAA during the baseline survey period: the long-billed curlew, great blue heron, golden eagle, Cooper's hawk, American white pelican, and long-eared owl. The long-eared owl and curlew are known or are suspected to have nested in the permit area, based on evidence (young present) or persistent defensive behavior, respectively. The heron, golden eagle, Cooper's hawk, and pelican were merely observed flying over the area; those four species were recorded only once each.

These six species of special interest are considered as secure populations within their respective overall ranges, though one or more could be less common in parts of a given range, especially in the periphery. Likewise, all six are considered to be either rare and local throughout their statewide ranges, or locally abundant in restricted portions of those ranges.

Three additional vertebrate species of concern were documented at least once each in the one-mile perimeter: the merlin, Clark's nutcracker, and plains topminnow (*Fundulus sciadicus*). The birds were described in preceding sections of this document. The topminnow was captured during fisheries sampling efforts in Beaver Creek, beyond all permit boundary outlines, in July 2008. Additional information about those survey efforts and results is presented in section 1.3.5.3.10 (Aquatic Resources), below.

3.5.5.5 Aquatic Resources

The fisheries sampling locations correlated with water sampling stations that were selected by a South Dakota permitting contractor for the Proposed Action and approved by SDGFP. That contractor monitored the water stations on a monthly basis for at least one year prior to this licensing application. This co-sampling effort was intended to provide information regarding stream flow and other physical characteristics relative to fish and macro-invertebrate composition.

3.5.5.5.1 Aquatic Species and Habitats

3.5.5.5.1.1 Aquatic Species and Habitats-Survey Methods

Because Beaver Creek is the only perennial stream in the PAA, and is the receiving water for drainage from the portions of the PAA identified for proposed future ISL activities, it was the focus of aquatic habitat monitoring efforts conducted for this project. Some sampling was also conducted in the Cheyenne River downstream of the PAA to obtain additional site data. Beaver Creek is listed as impaired under Section 303(d) of the federal Clean Water Act for the following constituents: oil, specific conductivity, temperature, total dissolved solids, and total suspended solids (EPA 2008).

Baseline monitoring stations were located at sites that were previously established as water quality monitoring locations on Beaver Creek and the Cheyenne River. Using these sites allows a comparison with past and ongoing water quality records. One site (BVC04) is located upstream and the other (BVC01) is downstream of the proposed ISL activities (see Figure 6.1-27). Fish sampling for species, abundance, and radiological testing was conducted at both

Beaver Creek sites, and at a site on the Cheyenne River downstream of the Beaver Creek confluence (site CHR05).

Baseline sampling of aquatic habitat, benthic macro-invertebrates, and fish was conducted according to protocols developed by the South Dakota Department of Environment and Natural Resources (SDDENR 2002) and the SDPFG (S. Michals, personal communication 2008). Aquatic data collected at the two Beaver Creek sites during the baseline sampling included: stream habitat description; aquatic benthic macro-invertebrate community composition; the variety, condition, and relative abundance of fish species; and radiological analysis of fish collected. As indicated, fish sampling also occurred at CHR05, though SDGFP did not require the other aquatic sampling efforts to be conducted at that location.

Habitat, invertebrate, and fish sampling was conducted during spring (April) and summer (July) conditions in 2008 to provide a baseline for semi-annual monitoring described in NRC Guide 4.14 (NRC 1990). This timing was selected to capture seasonal differences, including high and base flow conditions. However, the late spring and early summer of 2008 were unusually wet and, as a result, the flow during both seasonal events was similar. Consequently, neither sampling effort represented the low summer flow conditions that have typically occurred at these sites in recent years (M. Hollenbeck, personal communication 2008).

The habitat description and invertebrate collection efforts followed the SDDENR protocol (SDDENR 2002). Eleven cross-section transects were established at equidistant intervals from the downstream end of each sample site. The longitudinal distance of each survey reach was established as the distance equal to 30 average channel widths as determined by 10 preliminary width measurements.

Fish sampling was accomplished by blocking and seining a 100-m survey reach downstream of each sample site, according to SDPFG guidelines (S. Michals, personal communication 2008). Due to obstacles in the stream, it was not feasible to seine an entire reach in one sweep, so three separate sweeps were made at a given sample site and fish were collected on shore at three locations within each 100-m reach. All fish captured were identified, counted, measured, and weighed. Individuals that were less than 100 millimeters (mm) in length were combined for a composite weight by species.

Numerous fish were collected for radiological testing during each of the spring and summer flow sampling events. The initial target at each sample site was six individual fish, preferably from six different species (i.e., 6 fish per sample site, 18 total fish), though fewer fish were retained if the target was not achieved. Many of the specimens collected in April 2008 contained no detectable Uranium. In an effort to improve the protocol to better represent conditions in sampled fish populations, up to five individuals of each of six species (i.e., 30 fish per sample site, 90 total fish) were collected in July (when available in the catch) and processed for radiology.

Live fish were bagged, frozen, and kept frozen until they were analyzed for the following:

- Uranium (mg/kg)
- Uranium (μCi/kg)
- Thorium-230 (μCi/kg)
- Radium-226 (μCi/kg)
- Lead-210 (μCi/kg)
- Polonium-210 (μCi/kg)

These analytes are specified in NRC Guide 4.14. Analysis was conducted by Energy Laboratories Inc., in Casper, Wyoming. Lab results are included in Appendix 3.5-I, and are summarized in Table 3.5-24.

Table 3.5-23: Beaver Creek Baseline Radiological Analysis of Whole Fish

Site	Species	No.	Length[a] mm	Sample Weight[b] g	U mg/kg	U uCi/Kg	Po 210 uCi/Kg	Pb 210 uCi/Kg	Th 230 uCi/Kg	Ra 226 uCi/Kg
BVC01 - April	GRS	1	120	22.96	ND	ND	u	u	u	0.0003
	PLK	1	48	1.77	ND	ND	u	0.02[c]	0.0002	u
	LND	1	48	0.64	ND	ND	0.002	u	0.0001	u
	FHM	1	30-60	4	ND	ND	0.0004	u	u	u
BVC04-April	PLK	1	40-60	0.72	ND	ND	u	u	u	u
	RIC	1	111	18.79	ND	ND	0.0004	u	0.00002	u
	GRS	1	50	2.16	ND	ND	0.0006	u	0.0008	u
	FHM	1	30-70	~1.2	ND	ND	u	u	0.00001	0.0004
	CHC	1	215	72	0.05	30	0.0009	u	0.00002	u
CHR05-April	RIC	1	97	13.73	ND	ND	0.0008	u	u	u
	GRS	1	98	13.67	ND	ND	0.00008	u	0.00001	u
	SRS	1	169	55.05	ND	ND	0.0002	u	0.00002	u
	CRC	1	30-70	2.92	ND	ND	u	u	u	u
	PLK	1	32-74	1.51	ND	ND	u	u	0.0001	u
	SAS	1	30-60	1.51	ND	ND	u	u	0.001	u
BVC01-July	FHM	5	42-67	~8	0.026	0.000018	0.0004	u	u	u
	CAP	1	171	73	0.0098	0.0000067	0.00078	u	u	u
	SAS	5	46-62	7	0.031	0.000021	0.00023	u	0.000098	u
	PLK	5	57-71	9	0.035	0.000024	0.00047	u	u	u
	PLT	5	48-71	12	0.021	0.000014	0.00035	u	0.0001	u
BVC04-July	SAS	5	45-58	~6.7	0.024	0.000016	0.00054	u	0.000027	u
	FHM	5	42-61	~3.7	0.031	0.000021	0.00018	u	u	u
	CAP	1	260	237	0.014	0.0000094	0.00015	u	0.0000023	u
	PLK	5	48-68	~7.2	0.019	0.000013	u	u	0.000094	u

Site	Species	No.	Length[a] mm	Sample Weight [b] g	U mg/kg	U uCi/Kg	Po 210 uCi/Kg	Pb 210 uCi/Kg	Th 230 uCi/Kg	Ra 226 uCi/Kg
	SRS	1	136	130	0.0072	0.0000049	0.00017	u	u	u
CHR05-July	FHM	5	38-60	~0.7	0.024	0.000016	0.00042	u	u	u
	SAS	5	42-60	~1.5	0.04	0.000027	0.00049	u	0.00014	u
	CAP	1	135	31	0.01	0.0000069	0.00074	u	0.000017	u
	RIC	4	381-415	5150	0.031	0.000021	u	u	u	0.000008
	SRS	2	146-160	78	0.0066	0.0000044	0.00005	u	0.0000032	u
	PLK	4	46-68	~7.4	0.017	0.000012	0.00047	u	u	u
	CHC	3	181-290	265	0.017	0.000012	0.00016	u	0.000009	u

3.5.5.5.1.2 Aquatic Species and Habitat-Survey Results

3.5.5.5.1.2.1 Habitat

Compiled habitat data forms may be found in Appendix 3.5-J. Summaries of results by site are described below.

Site BVC04

Site BVC04 is located downstream of the Old Highway 85 bridge over Beaver Creek in Weston County, WY (see Figure 6.1-27). This site was selected as the background site as it is upstream of all proposed activity. At BVC04, Beaver Creek is a low gradient prairie stream that is deeply incised in places, is subject to large fluctuations in flow, and shows significant evidence of active erosion (bank slumping, bare soil) and sediment deposition on stream banks and in slow moving pools.

April

The preliminary average channel width at BVC04 was 7.35 m. Sample transects were located 18.5 m apart, with a total surveyed reach length of 185 m. During the April habitat survey, water temperature varied from 7.0 degrees Celsius (C) to 16.0 degrees C, indicating that stream temperature is highly variable during the day. In general, riparian vegetation is limited to herbaceous and short shrubs, with only occasional trees. With the exception of the bridge, there was no shade present in the center of the channel. As a result, the creek is subject to substantial solar heating during the day. Water was clear during the survey, although specific conductivity was high (5,109 μS/cm), indicating a high concentration of dissolved solids typical of prairie streams in this region. Discharge at BVC04 was 7.31 cfs on April 14.

Within the BVC04 survey reach, habitat included two large pools, two glides, and 3 riffles. The total length of riffles was 54.6 m.

Beaver Creek carries a heavy sediment load during high flow, resulting in a deep layer (up to 2 feet) of fine silt deposited in pools. Silt dominates the sediment composition of the reach, although sand, gravel and cobbles dominate the substrate of the faster moving riffle and glide areas. The cumulative and proportional particle distribution of sediment in the BVC04 reach during the April survey is shown in Figure 3.5-4. This distribution indicates a predominance of silt and sand, with gravel in the riffle areas. Large wood in the reach was located in riffle and glide areas and was generally comprised of small (0.1- to 0.25-m diameter) pieces in the portion of the channel between the wetted channel and the bank full elevation.

Beaver Creek is significantly incised. Bank slumpage was observed at eight transects and erosion at ten of the eleven transects in this reach. The wetted stream width during the survey was 4.2 to 10.7 m; bank-full width ranged from 5.3 to 11.3 m; and the width at the top of bank was 10.7 to 17.1 m. Bank height was up to 2.0 m. Riparian land use is rangeland with no riparian buffer, cattle have access to the stream, especially in the vicinity of the bridge. Woody vegetation has probably been sparse along Beaver Creek stream banks for many years, which may have contributed to channel down-cutting and erosion, and a general lack of large woody debris and cover in the channel. Examples of channel dimensions in pool, riffle, and run habitat types of the upstream (BVC04) site are shown in Figures 3.5-5, 3.5-6, and 3.5-7, below.

As mentioned previously, pools contained a large volume of silt. This silt reduces the depth and volume of the pools, reducing the quality and quantity of available fish habitat. Due to pool filling and lack of cover, pool quality is poor.

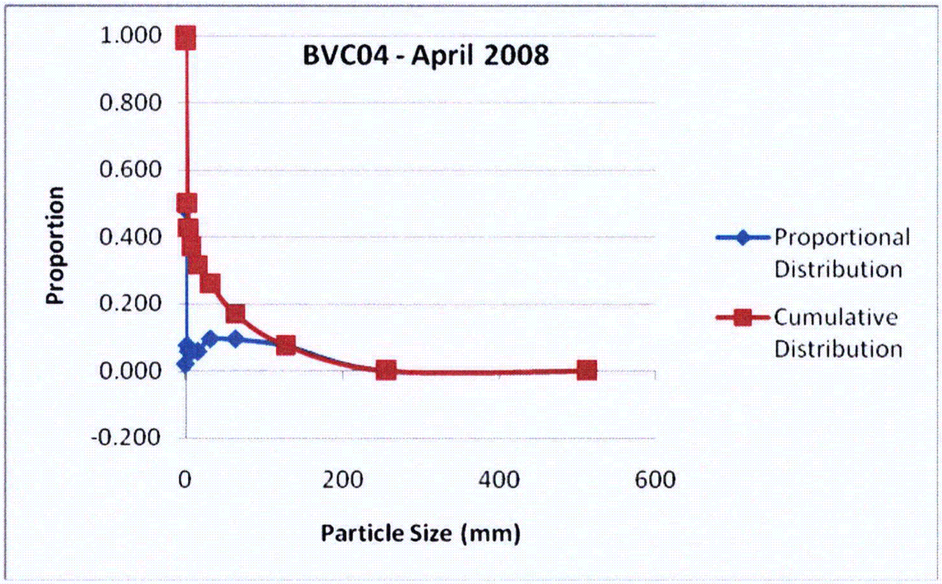

Figure 3.5-4: Cumulative and Proportional Sediment Particle Distribution at Site BVC04, Transects 1 through 11 Combined, April 2008

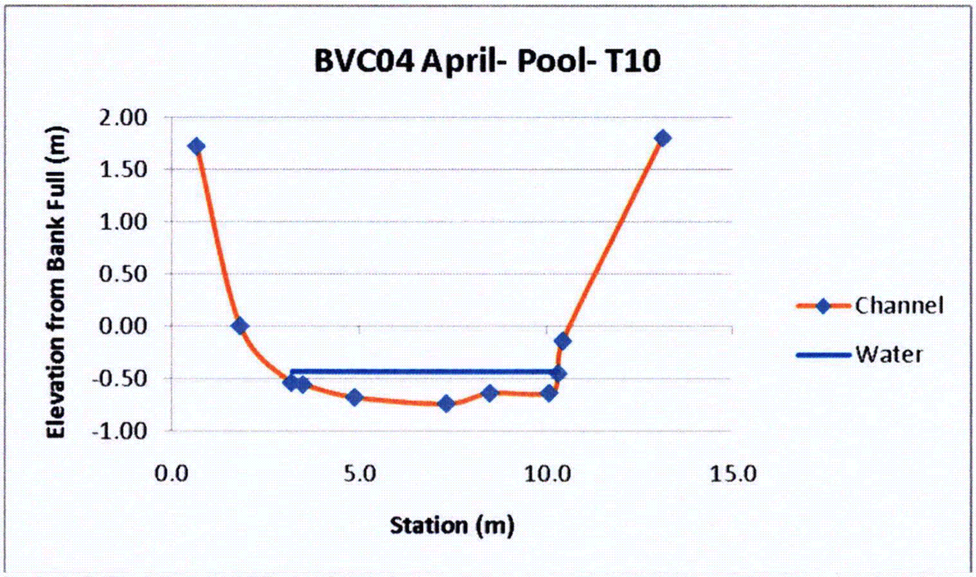

Figure 3.5-5: Channel Dimensions in Pool Habitat, Transect 10

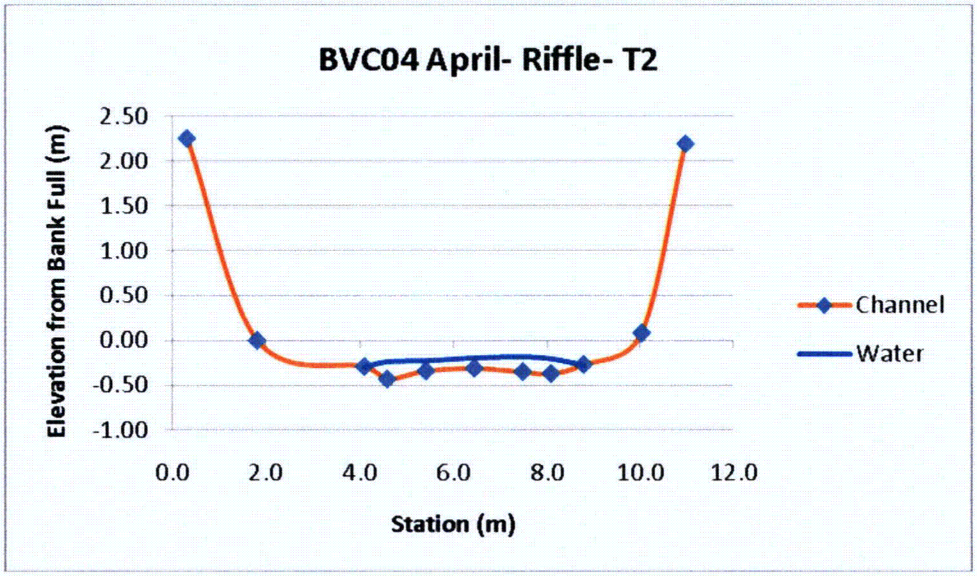

Figure 3.5-6: Channel Dimensions in Riffle Habitat, Transect 2

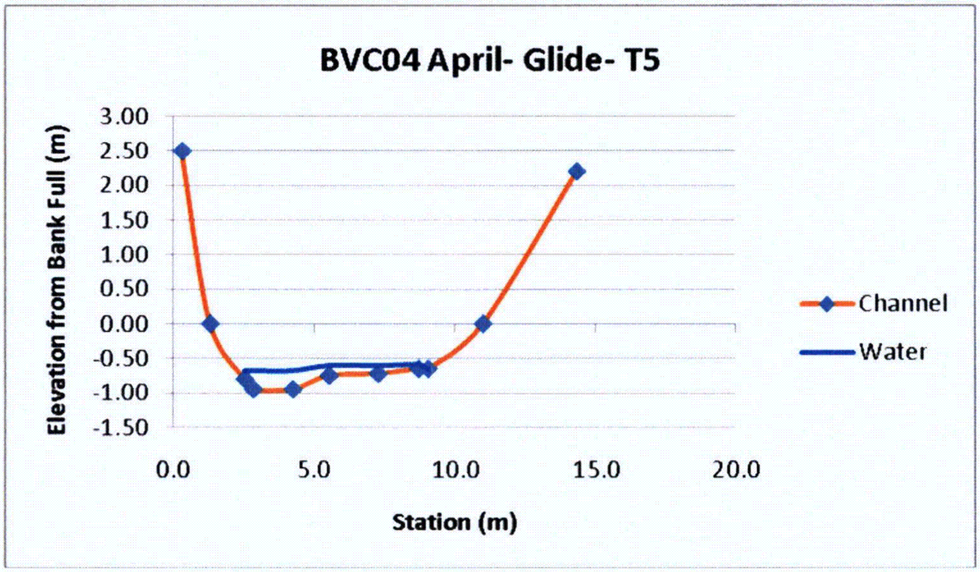

Figure 3.5-7: Channel Dimensions in Glide Habitat, Transect 5

July

In July 2008, the channel dimensions were essentially the same as measured during April, with some localized changes. Between the April and July field visits Beaver Creek experienced high flows that appeared to have resulted in somewhat less fine sediment in the pools, and transport of woody debris out of the survey reach. Stream discharge in July was 12.3 cfs, approximately 5 cfs higher than in April. The average wetted width measured was 6.9 m in April and 7.5 min July.

The July air temperature reached 25 degrees to 35 degrees C and water temperatures were quite warm at 23 degrees C to 24 degrees C. As during April, riparian vegetation was limited to herbaceous and short shrubs, with only occasional trees. Shade along the banks was greater in July, since trees were generally bare in April and fully leafed-out in July. However, most of the stream channel itself was unshaded during both site visits indicating a high degree of solar warming is typical in Beaver Creek.

Within the BVC04 survey reach, habitat included one pool, three glides, and three riffles. The total length of riffles was 59.9, although two riffle segments ran to either side of an island. If these two are considered together, the riffle length measured 43.9 m.

As described under spring conditions, fine silt dominated the sediment composition of the reach and filled the larger part of the pools in at this site. Sand, gravel and cobbles dominate the substrate of the faster moving riffle and glides. The cumulative and proportional particle distribution of sediment for the BVC04 reach during the summer survey is shown in Figure 3.5-8 demonstrating a slightly higher proportion of gravel in the overall substrate composition than in April.

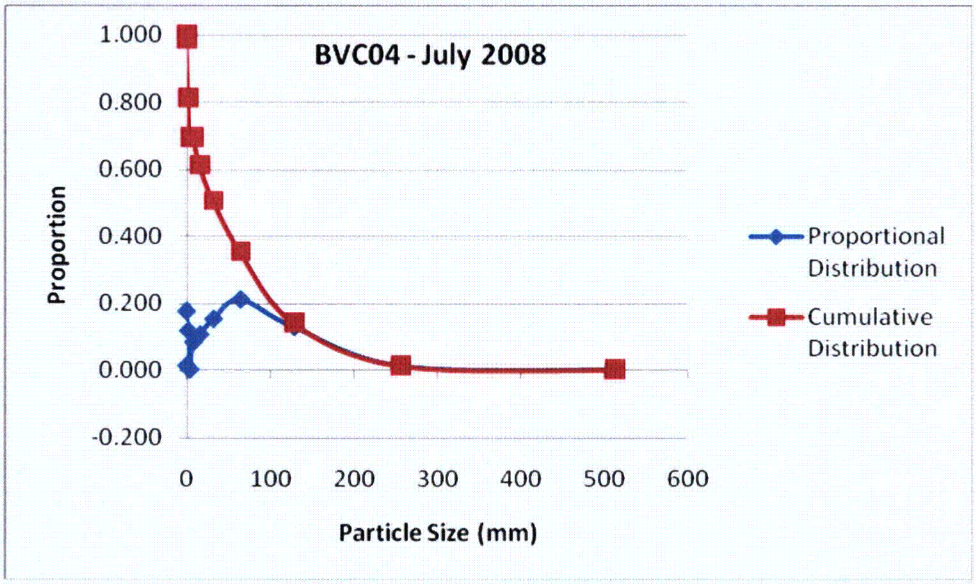

Figure 3.5-8: Cumulative Sediment Particle Distribution at Site BVC04, Transects 1 through 11 Combined during July

Large wood in the reach was essentially absent in July. Small pieces that had been present in April apparently were washed out of the survey reach during the peak flows that occurred in June.

The wetted stream width during the summer survey was 4.3 to 10.1 m; bank-full width ranged from 6.0 to 11.2 m; and the width at the top of bank was 15.0 to 21.0 m. Bank height was 2.1 to 3.9 m.

As mentioned previously, pools contained a large volume of silt. This silt reduces the depth and volume of the pools, reducing the quality and quantity of available fish habitat. Due to pool filling and lack of cover, pool quality is poor.

<u>Site BVC01</u>

Site BVC01 is located upstream of the Argentine Road bridge over Beaver Creek in Fall County, SD. This site was selected as the test site as it is downstream of most proposed production activity and all proposed process water land application sites.

At BVC01, Beaver Creek is still a low gradient, incised prairie stream as it is at BVC04. However, the stream gradient is slightly higher and banks are generally lower. Riparian habitat along BVC01 is more actively managed for cattle grazing than BVC04 and there are fewer trees and shrubs and more grass at BVC01 than at BVC04. Fine sediment was present in pools. However, there appeared to be less fine sediment in July indicating that high flows transported sediment out of this reach.

April

The preliminary average channel width at BVC01 was 7.35 m. Sample transects were located 22 m apart, with a total surveyed reach length of 220 m.

During the April habitat and fish surveys, water temperature varied from 11.8 degrees C to 16.9 degrees C, indicating that stream temperature at this site is also variable during the day. As was the case at site BVC04, riparian vegetation at BVC01 was limited to herbaceous and short shrubs, with only a single boxelder tree in the survey reach. With the exception of the bridge, there was no shade present in the center of the channel and the creek is subject to substantial solar heating during the day.

Water was clear during the survey, although specific conductivity was high (7,186 μS/cm); somewhat higher than observed at BVC04. Discharge at BVC01 was 5.08 cfs on April 14, 2008.

Within the BVC01 survey reach, habitat included three pools, two glides, and three riffles. The total length of riffles was 28 m.

Overall, gravel dominated the sediment composition of the BVC01 reach. The cumulative and proportional particle distribution of sediment for the BVC01 reach during the April survey is shown in Figure 3.5-9. This distribution indicates a predominance of gravel with some fine sediment. The fine sediment was primarily confined to pool areas.

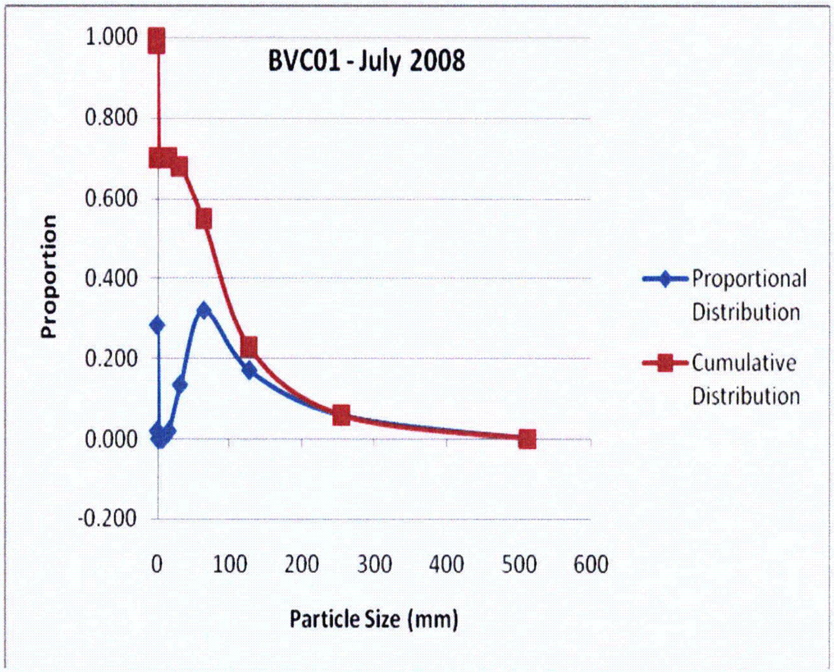

Figure 3.5-9: Cumulative and Proportional Sediment Particle Distribution at Site BVC01, Transects 1 through 11 Combined, April 2008

Beaver Creek is significantly incised along the BVC01 reach, although bank height was generally lower than at the upstream (BVC04) site. Bank slumpage was observed at nine transects and erosion at seven of the eleven transects in this reach. The wetted stream width during the April survey was 3.5 to 7.8 m; bank-full width ranged from 6.5 to 10.2 m; and the width at the top of bank was 12.0 to 17.4 m. Bank height was 1.3 to 2.0 m. Riparian land use is rangeland with no riparian buffer, cattle have access to the stream, especially in the vicinity of the bridge and transect 1. Woody vegetation is nearly absent from the vicinity of BVC01 and no woody debris was observed in the BVC01 survey reach.

Examples of channel dimensions in pool, riffle, and run habitat types are shown in Figures 3.5-10, 3.5-11, and 3.5-12 below.

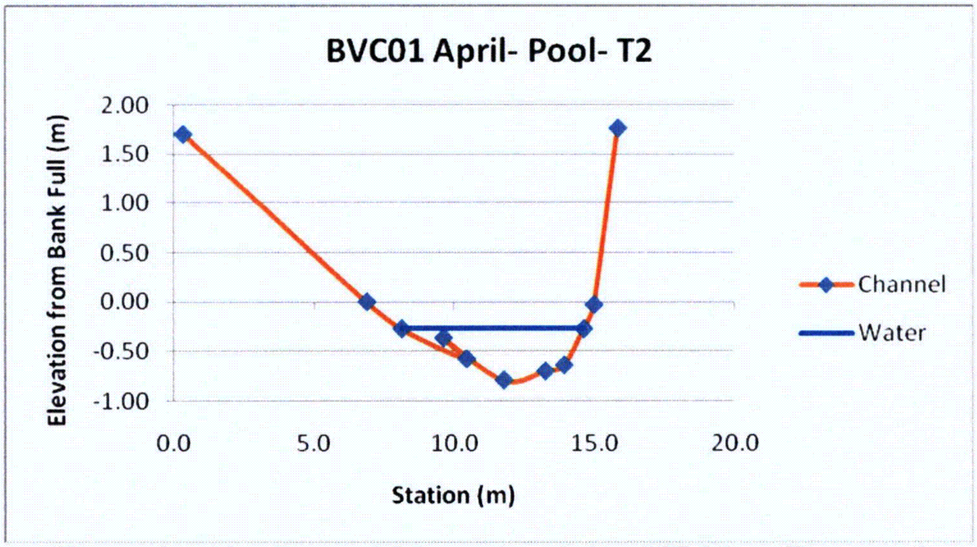

Figure 3.5-10: Channel Dimensions in Pool Habitat, Transect 2

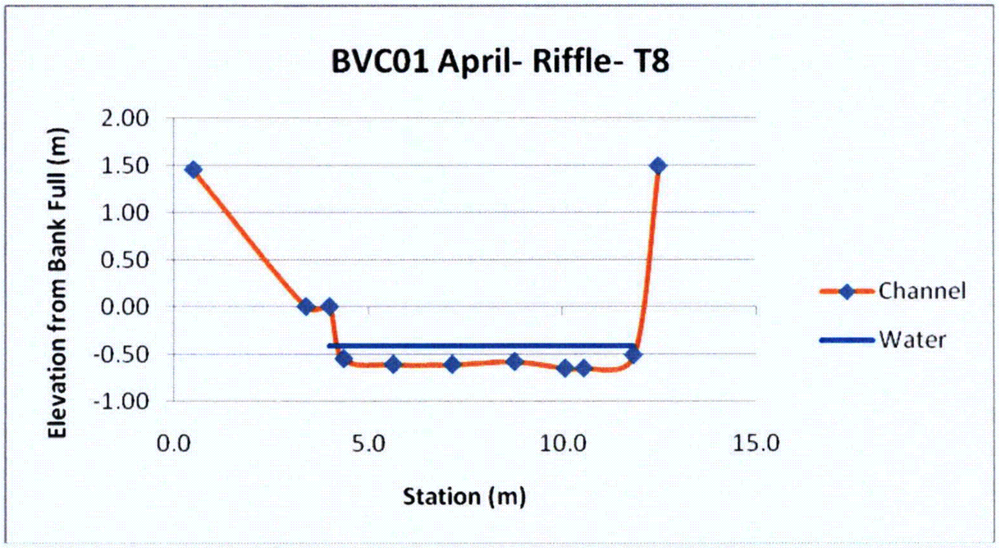

Figure 3.5-11: Channel Dimensions in Riffle Habitat, Transect 8

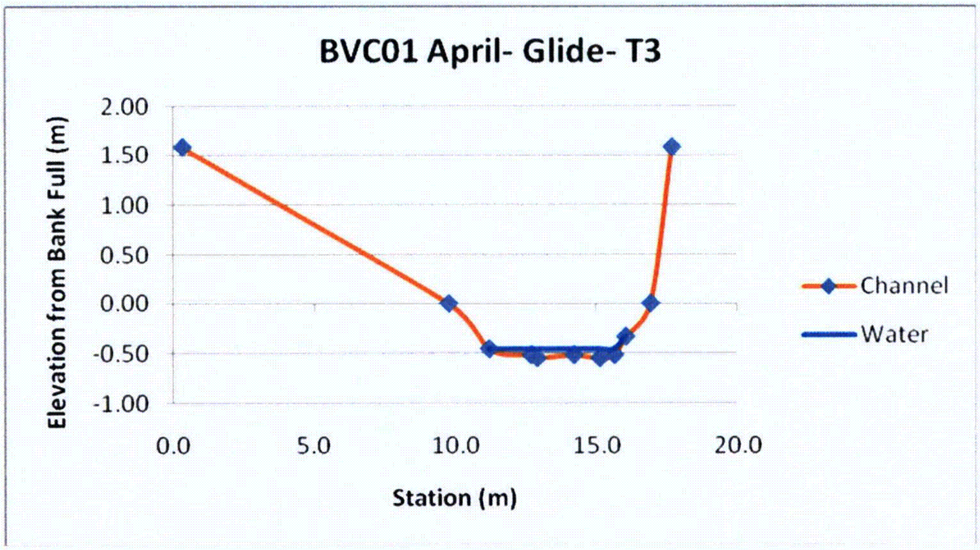

Figure 3.5-12: Channel Dimensions in Glide Habitat, Transect 3

Pools in reach BVC01 were not as deep or long as those in BVC04 and therefore were less conducive to fine sediment deposition. Due to shallow pool depth and lack of cover, pool quality was poor.

July

In July, 2008, the channel dimensions were essentially the same as measured during April, with some localized changes. The high flows that Beaver Creek experienced between the April and July field visits appeared to have resulted in somewhat less fine sediment in the pools. Stream discharge in July was 7.5 cfs, approximately 48 percent higher than in April. In both April and July, discharge was higher at the upstream site (BVC04) than at the downstream site (BVC01). The average wetted width 6.2 m in April and 7.5 m in July.

In July the air temperature at BVC01 a water temperatures of 24 degrees C was recorded at 9:20 am. Although trees were generally bare in April and fully leafed-out in July, the one tree in the riparian buffer was too far from the stream to provide shade to the wetted portion of the channel.

Within the BVC01 survey reach, habitat included two pools, one glide, and two riffles during July. The total length of riffles was 70.8 m. This represented a change from what was observed in April that was due to increased flow and probably some redistribution of gravel substrate in the channel during high flows.

In contrast to April conditions, very little silt was observed within BVC01 during July. Where fine sediment was present it was restricted to slow moving water in pools and along banks. The cumulative and proportional particle distribution of sediment for the BVC01 reach during the summer survey is shown in Figure 3.5.13, demonstrating the dominance of gravel in the particle size distribution.

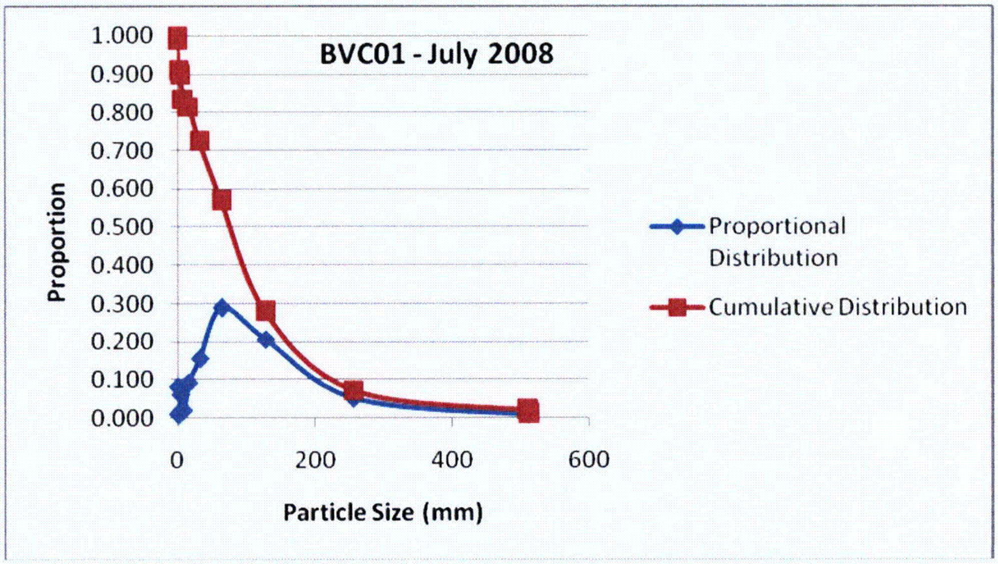

Figure 3.5-13: Cumulative Sediment Particle Distribution at Site BVC01, Transects 1 through 11 Combined during July

Large wood in the reach was essentially absent in July as in April.

The wetted stream width during the summer survey was 4.1 to 8.2 m; bank-full width ranged from 6.8 to 11.3 m; and the width at the top of bank was 12.6 to 18.9 m. Bank height was 1.5 to 2.8 m.

As mentioned previously, pools were considered poor due to lack of depth and cover. Emergent rushes (Juncus spp.) and submerged stonewort (Chara spp.) were observed growing along the banks in pools during the July survey providing some cover for small fish and substrate for aquatic invertebrates.

3.5.5.5.1.2.2 Habitat/Species Relationships

Benthic Invertebrates

Benthic invertebrates can be useful indicators of habitat quality, providing an index of quality that is integrated over time. Different taxa of aquatic invertebrates (primarily insects, crustaceans, and mollusks) exhibit different habitat requirements, feeding strategies, and tolerances to environmental perturbation. Therefore, there are several metrics of benthic invertebrate community composition that are indicative of aquatic habitat quality. Several of the most indicative and most commonly described of these metrics are summarized in Table 3.5-25.

The invertebrate communities sampled indicate poor habitat conditions in Beaver Creek. The counts of each taxa are shown in Table 3.5-26, and a synopsis of the Community composition metrics is shown in Table 3.5-27. The total number of invertebrates and the taxonomic richness (number of species) were both very low at both Beaver Creek sites. Ephemeroptera (mayflies) and plecoptera (stoneflies) were absent from both sites, indicating an impaired condition. Most taxa collected were moderately tolerant taxa. One individual of a sensitive taxa, Lepidostoma, and one individual of a very tolerant taxa, Culiciodes, were collected at the downstream site (BVC01) in April. All other taxa collected are considered moderately tolerant.

The downstream site, BVC01, had very low abundance, particularly in the July samples. During the month of June 2008, very high flows occurred in Beaver Creek. It is likely that the high flows mobilized a large volume of sediment and probably resulted in considerable scouring of the sediment, particularly at this site. The reduced macro-benthos present in July may have been due, at least in part, to the high flows that occurred in June.

During a year with more moderate flows, the macro-benthos would likely show an increase in abundance and taxonomic richness throughout the growing season, while a year with drought conditions might have no flow in the riffles where the greatest diversity of benthic invertebrates is typically seen.

High pH, conductivity, and temperatures; and a high volume of fine sediment all may contribute to the de-pauperate invertebrate communities observed in Beaver Creek.

Table 3.5-24: Benthic Invertebrate Community Composition Metrics and Predicted Direction of Response to Perturbation

Category	Metric	Definition	Predicted response to increasing perturbation
Richness measures	Total taxa	Measures the overall variety of the macroinvertebrate assemblage	Decrease
	EPT taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies)	Decrease
	Ephemeroptera taxa	Number of mayfly taxa (usually genus or species level)	Decrease
	Plecoptera taxa	Number of stonefly taxa (usually genus or species level)	Decrease
	Trichoptera taxa	Number of caddisfly taxa (usually genus or species level)	Decrease
Composition measures	% EPT	Percent composite of mayfly, stonefly, and caddisfly taxa	Decrease
	% Ephemeroptera	Percent of mayfly nymphs	Decrease
Tolerance/Intolerance measures	No. of Intolerant taxa	Taxa richness of those organisms considered to be sensitive to perturbation	Decrease
	% Tolerant organisms	Percent of macrobenthos considered to be tolerant of various types of perturbation	Increase
	% Dominant taxon	Measures the dominance of the single most abundant taxon. Can be calculated as dominant 2, 3, 4, or 5 taxa.	Increase
Feeding measures	% Filterers	Percent of the macrobenthos that filter fine organic particulate matter from the water column or sediment.	Variable
	% Grazers and Scrapers	Percent of the macrobenthos that scrape or graze upon periphyton	Decrease
Habitat measures	Number of clinger taxa	Number of taxa of clinging insects	Decrease
	% Clingers	Percent of insects having fixed retreats or adaptations for attachment to surfaces in flowing water.	Decrease

Source:Barbour et al. 1999

Table 3.5-25: Benthic Macroinvertebrate Counts for Composite Samples Collected April and July 2008

Taxa	Site and Date			
	BVC01 14-Apr-08	BVC04 14-Apr-08	BVC01 9-Jul-08	BVC04 9-Jul-08
Phylum:Mollusca				
Class:Gastropoda				
Order: Bassommatophora				
Family: Physidae	2		2	1
Phylum: Arthropoda				
Class: Insecta				
Order: Diptera				
Family: Ceratopogonidae				
Genus: *Culiciodes*	1			
Family: Chironomidae				
Subfamily: Orthocladiinae	14	33		2
Subfamily: Chironomnae		11		1
Subfamily: Tanypodinae			4	23
Family: Siluliidae				
Genus: *Simulium*	2			1
Order: Trichoptera				
Family: Hydropsychidae				
Genus: *Cheumatopsyche*				76
Family: Lepidostomadtidae				
Genus: *Lepidostoma*	1			
Family: Limnephilidae				
Genus: *Limnephilus*	3	2		
Order: Coleoptera				
Family: Elmidae			1	3

Table 3.5-26: Community Composition Metrics for Benthic Macro-invertebrates Collected at the Beaver Creek Sites

Measures	Taxa	Tolerance	Functional Feeding Group Primary	Functional Feeding Group Secondary	Habitat/ Behavior Primary	Habitat/ Behavior Secondary	Abundance BVC01 April	Abundance BVC04 April	Abundance BVC01 July	Abundance BVC04 July
Taxa	Physidae	8	SC				2		2	1
	Culicoides	10	PR	GC	bu		1			
	Orthocladiinae	5	GC		bu		14	33		2
	Chironominae	6	GC					11		1
	Tanypodinae	7	PR		bu				4	23
	Simulium	6	FC				2			1
	Cheumatopsyche	5	FC							76
	Lepidostoma	1	SH				1			
	Limnephilus	5	SH		sp		3	2		
	Elmidae (early instar)	4	GC		cn	bu			1	3
Abundance	Abundance						23	46	7	107
Richness	Total Taxa						6	3	3	7
	EPT Taxa						3	1	0	1
	Ephemeroptera Taxa						0	0	0	0
	Plecoptera Taxa						0	0	0	0
	Trichoptera Taxa						3	1	0	1
Composition	% EPT Taxa						17.4%	4.3%	0.0%	71.0%
	% Ephemeroptera						0%	0%	0%	0%
Tolerance	Number of Intolerant Taxa						1	0	0	0
	% Tolerant Macrobenthos						13.0%	0.0%	28.6%	0.9%
	% Dominant Taxa						60.9%	71.7%	0.0%	1.9%
Feeding	% Filterers						8.7%	0.0%	0.0%	72.0%
	% Grazers & Scrapers						69.6%	95.7%	42.9%	6.5%
Habitat	Number of Clinger Taxa						0	0	0	0
	% Clingers						0%	0%	20%	3%

Notes: SC=Scraper, PR = Predator, GC = Gatherer collector, FC = Filterer/collector, SH = Shredder
bu = burrower, sp = sprawler, cn = clinger
Tolerance scores on scale of 1-10 with 1 being most sensitive, and 10 most tolerant of environmental stressors

Fish

A total of 12 fish species were collected from the three sampling locations: BVC04–Beaver Creek upstream of the PAA; BVC01–Beaver Creek downstream of the PAA; and CHR05–Cheyenne River downstream of the confluence of Beaver Creek. The species, trophic category, and habitat notes are summarized in Table 3.5-28. The abundance (presented as catch per unit effort or fish per m of stream length), and average sizes of fish are shown in Table 3.5-29. Fish collection data forms are presented in Appendix 3.5-K.

Table 3.5-27: Fish Species and Trophic Categories

Species Code	Common Name	Latin Name	Trophic Category	Notes
SAS	Sand shiner	*Notropis stramineus*	Omnivore	
CRC	Creek chub	*Semotilus atromaculatus*	Primarily carnivorous omnivore	
PLM	Plains Minnow	*Hybognathus placitus*	Primarily herbiverous	Generally in slower water and side channels of turbid streams. Eats benthic algae & other plant material.
CAP	Common carp	*Cyprinus carpio*	Omnivore	Introduced species. Bottom feeder.
LND	Longnosed dace	*Rhynichthys cataractae*	Primarily carnivorous omnivore	Primarily in riffles
FHM	Fathead minnow	*Pimephales promelas*	Primarily herbiverous	Widely cultivated for bait, and extensively used in toxicological studies
RIC	River Carpsucker	*Carpoides carpio*	Bottom feeding omnivore	
SHR	Shorthead Redhorse Sucker	*Moxostoma macrolepidotum*	Bottom feeding carnivore	
CHC	Channel Catfish	*Ictalurus punctatus*	Bottom feeding omnivore	Species most likely to be eaten by humans.
PLT	**Plains topminnow**	***Fundulus sciadicus***	**Surface feeding carnivore**	
PLK	Plains Killifish	*Fundulus zebrinus*	Surface feeding carnivore	
GRS	Green sunfish	*Lepomis cyanellus*	Carnivore	Palatable but generally too small for human consumption

Bold species are tracked by the South Dakota Natural Heritage Program – South Dakota Department of Game, Fish and Parks (SDGFP web page, last updated September 2, 2008).

Table 3.5-28: Summary of Fish Size and Abundance

Location	Date	Common Name	CPUE (fish/m)	Average total length (mm)	Average weight (g)
CHR05 – Cheyenne River at Marietta	4/15/08	Green sunfish	0.01	98	20
		Sand shiner	0.53	48	4.6
		Creek chub	1.00	47	0.9
		River Carpsucker	0.01	97	13
		Shorthead Redhorse Sucker	0.14	145	115
		Plains topminnow	**0.01**	**51**	**<1**
		Plains killifish	0.48	49	1.5
CHR05 – Cheyenne River at Marietta	7/09/08	Common carp	0.01	135	31
		Longnosed dace	0.01	74	4
		Fathead minnow	0.10	47	0.7
		Sand Shiner	0.45	49	1.5
		Shorthead Redhorse Sucker	0.14	153	39
		River Carpsucker	0.04	407	1,038
		Channel catfish	0.03	222	88
		Plains killifish	0.07	58	1.9
BVC01 – Beaver Creek at Argentine Road	4/16/08	Fathead minnow	0.64	48	1.3
		Plains killifish	0.02	45	4
		Longnosed dace	0.01	48	<1
		Green sunfish	0.01	120	25
BVC01 – Beaver Creek at Argentine Road	7/10/08	Common carp	0.01	171	73
		Sand Shiner	0.10	50	1.1
		Fathead minnow	0.33	50	1.5
		Longnosed dace	0.01	59	2
		Plains minnow	0.01	73	1
		Plains topminnow	**0.06**	**56**	**2**
		Plains killifish		60	1.8
BVC04 – Beaver Creek at old Hwy 85 Bridge	4/16/08	Common carp	0.03	75	9.3
		Fathead minnow	0.84	45	1.1
		Channel catfish	0.01	215	72
		Plains killifish	0.10	44	1.4
		Green sunfish	0.04	66	7.5
BVC04 – Beaver Creek at old Hwy 85 Bridge	7/10/08	Common carp	0.01	260	230
		Sand Shiner	0.26	52	1.3
		Fathead minnow	0.47	50	1.4
		Longnosed dace	0.02	63.5	2.5
		Shorthead redhorse sucker	0.01	136	130
		Plains killifish	0.09	55	1.4

Notes: 1CPUE = Catch per unit effort.
Bold species are tracked by the South Dakota Natural Heritage Program – South Dakota Department of Game, Fish and Parks (SDGFP web page, last updated September 2, 2008).

3.5.5.5.1.2.2.1 Locally Significant Fish Species

Recreational anglers fish Beaver Creek, although the Cheyenne River and Angostura Reservoir provide greater fishing opportunities in the area. Channel catfish is the species most likely to be caught and eaten from Beaver Creek.

Hampton (1998) calculated the relative weight index (Wr) for channel catfish in the Cheyenne River to assess the condition of this species in the Cheyenne River. Hampton (1998) reported a curvilinear relationship between weight and length (Ws=63.75 +5,780/L where Ws= standard weight, and L= total length). Comparing the weight/length ratio of channel catfish collected in this study to the standard weight (Ws) described above, the relative weight (Wr=100*W/Ws) can be used as an indicator of fish condition. Generally, relative weights greater than 100 indicate better than average condition and those less than 100 indicate poorer than average condition. The weight of the largest (290 mm) channel catfish collected from the Cheyenne River had a very high relative weight (Wr = 198) while the other catfish collected from the Cheyenne River had low relative weights (Wr = 51 and 52), and the one channel catfish collected from Beaver Creek (at BVC04) had a moderately low relative weight (Wr=79). Although the average Wr for the Cheyenne River channel catfish (100.8) indicates good agreement with Hampton's (1998) modeled relationship, the weight/length ratio of individual fish varied considerably. A larger sample size would be needed to draw any conclusions about the relative condition of fish from these sites.

Relative weights are shown in Table 3.5-30, below.

Table 3.5-29: Relative weight index for channel catfish collected at Beaver Creek and Cheyenne River

Site	Date	Length	Weight	Standard Weight (Ws)	Relative Weight (Wr)
BVC04	Apr-08	215	72	90.6	79.4
CHR05	Jul-08	290	166	83.6	198.4
CHR05	Jul-08	186	50	94.8	52.7
CHR05	Jul-08	181	49	95.6	51.2
CHR05 Average					100.8

3.5.5.5.1.2.2.2 Threatened and Endangered Aquatic Species

No threatened or endangered aquatic species are known to inhabit Beaver Creek, particularly within 1.0 mile of the permit boundary.

The plains topminnow (*Fundulus sciadicus*) was captured in July at the downstream Beaver Creek site (BVC01). This species is tracked by SDNHP.

3.5.5.5.1.2.3 Radiological Testing

The channel catfish was the only species collected in April that contained detectable Uranium (0.05 mg/kg, and 3 X 10-5μCi/kg) (Table 3.5-31). Unfortunately this species was only collected from the downstream Beaver Creek site (BVC04) during that session. In July, channel catfish were only collected from the Cheyenne River site (CHR05). The channel catfish is the only species collected in the PAA that is typically caught for human consumption.

Uranium was detected in all of the fish collected in July 2008 due, in large part, to increased sample sizes (Table 3.5-31). As indicated, April samples showed little, if any, detectable Uranium, however, the detection limits were higher during that sampling effort due to matrix interference. Therefore, it is not possible to determine if there was an actual seasonal difference in fish tissue Uranium concentration. Uranium concentrations and uranium radioactivity were generally low and similar across sample sites when compared by species. Radioactivity from Polonium-210, Thorium-230, and Radium-226 was detectable, but low in most samples. Lead-210 was only detected in one specimen (plains killifish [Fundulus zebrinus]) collected in April at the downstream Beaver Creek site (BVC01). Although this measurement was relatively high (0.02 μCi +0.02 μCi), it should be noted that, due to matrix interference, the precision was limited on this sample. Lead-210 was not detected in any of the other samples.

Table 3.5-30: Beaver Creek Baseline Radiological Analysis of Whole Fish

Site	Species	No.	Length[a] mm	Sample Weight[b] g	U mg/kg	U uCi/Kg	Po 210 uCi/Kg	Pb 210 uCi/Kg	Th 230 uCi/Kg	Ra 226 uCi/Kg
BVC01 - April	GRS	1	120	22.96	ND	ND	u	u	u	0.0003
	PLK	1	48	1.77	ND	ND	u	0.02[c]	0.0002	u
	LND	1	48	0.64	ND	ND	0.002	u	0.0001	u
	FHM	1	30-60	4	ND	ND	0.0004	u	u	u
BVC04-April	PLK	1	40-60	0.72	ND	ND	u	u	u	u
	RIC	1	111	18.79	ND	ND	0.0004	u	0.00002	u
	GRS	1	50	2.16	ND	ND	0.0006	u	0.0008	u
	FHM	1	30-70	~1.2	ND	ND	u	u	0.00001	0.0004
	CHC	1	215	72	0.05	30	0.0009	u	0.00002	u
CHR05-April	RIC	1	97	13.73	ND	ND	0.0008	u	u	u
	GRS	1	98	13.67	ND	ND	0.00008	u	0.00001	u
	SRS	1	169	55.05	ND	ND	0.0002	u	0.00002	u
	CRC	1	30-70	2.92	ND	ND	u	u	u	u
	PLK	1	32-74	1.51	ND	ND	u	u	0.0001	u
	SAS	1	30-60	1.51	ND	ND	u	u	0.001	u
BVC01-July	FHM	5	42-67	~8	0.026	0.000018	0.0004	u	u	u
	CAP	1	171	73	0.0098	0.0000067	0.00078	u	u	u
	SAS	5	46-62	7	0.031	0.000021	0.00023	u	0.000098	u
	PLK	5	57-71	9	0.035	0.000024	0.00047	u	u	u
	PLT	5	48-71	12	0.021	0.000014	0.00035	u	0.0001	u
BVC04-July	SAS	5	45-58	~6.7	0.024	0.000016	0.00054	u	0.000027	u
	FHM	5	42-61	~3.7	0.031	0.000021	0.00018	u	u	u
	CAP	1	260	237	0.014	0.0000094	0.00015	u	0.0000023	u
	PLK	5	48-68	~7.2	0.019	0.000013	u	u	0.000094	u
	SRS	1	136	130	0.0072	0.0000049	0.00017	u	u	u
CHR05-July	FHM	5	38-60	~0.7	0.024	0.000016	0.00042	u	u	u
	SAS	5	42-60	~1.5	0.04	0.000027	0.00049	u	0.00014	u
	CAP	1	135	31	0.01	0.0000069	0.00074	u	0.000017	u
	RIC	4	381-415	5150	0.031	0.000021	u	u	u	0.000008
	SRS	2	146-160	78	0.0066	0.0000044	0.00005	u	0.0000032	u
	PLK	4	46-68	~7.4	0.017	0.000012	0.00047	u	u	u
	CHC	3	181-290	265	0.017	0.000012	0.00016	u	0.000009	u

Notes: GRS = Green Sunfish, PLK = Plains Killifish; LND = Longnosed Dace; RIC = River Carpsucker; FHM = Fathead Minnow; CHC = Channel Catfish; SRS = Shorthead Redhorse Sucker; CRC = Creek Chub; SAS = Sand Shiner. U = Uranium; Po = Polonium; Pb = Lead; Th = Thorium; RA = Radium. ND = Not Detected at the reporting limit, u = Not detected at minimum detectable concentration. [a]Lengths reported as a range when multiple specimens were combined as a composite sample, or when the individual processed for radiology was not recorded separately. [b] Approximate sample weights from field average weights for the species measured in the field. [c]Due to matrix interference, the precision of this measurement was equal to the detected concentration (i.e. 0.02 μCi ±0.02 μCi).

3.6 Meteorology

3.6.1 Introduction

The proposed project is located in an area in southwestern South Dakota that can be characterized as a semiarid or steppe climate. It lies adjacent to the southwestern extension of the Black Hills. The area experiences abundant sunshine, low relative humidity, and sustained winds which lead to high evaporative demand. There are also large diurnal and annual variations in temperature.

Precipitation in the PAA is generally light. Migratory storm systems that originate in the Pacific Ocean release a majority of their moisture over the Rocky or Cascade Mountains. Major precipitation events can occur when these systems regain moisture already present in the area or moisture advected from the Gulf of Mexico. Localized summer convective storms, caused by the Black Hills, can produce heavy precipitation events.

To complete the site-specific analysis, a weather station was installed in coordination with the South Dakota State Climatology office at approximately the center of the PAA in July 2007. This site collects temperature, humidity, solar radiation, wind speed/direction, barometric pressure, and precipitation at 1-minute, 5-minute, and hourly time steps. To determine whether this period of data collection (July 18, 2007, to July 17, 2008) was representative of long-term meteorological conditions, weather data from the nearest National Weather Service (NWS) site at Chadron, Nebraska, for the same period was compared to data collected at the site from years 1978–2007.

The data compiled from several sites (listed in Table 3.6-1 and shown in Figure 3.6-1) surrounding the PAA from the High Plains Regional Climate Center (HPRCC) and South Dakota State University (SDSU) was used to represent the long-term meteorological conditions of the Proposed Action region. All the sites were used to characterize regional trends of temperature and precipitation along with growing, heating, and cooling degree days. Only the SDSU sites had sufficient data available to analyze regional patterns of humidity, and only the Oral, South Dakota, site had adequate data to characterize wind speed/direction and evapotranspiration.

Data were analyzed at each site by time of day, month, and season of the year. The seasons for this analysis are defined as: winter (December, January, February), spring (March, April, May), summer (June, July, August), and fall (September, October, November).

Table 3.6-1: Meteorological Stations Included in Climatology Analysis

Name	Data Source	X	Y	Z (ft)	Years of Operation
Redbird	NCDC[(a)]	10,417	4,315	3,890	1948–2006
Oral	SDSU[(b)]	10,316	4,324	2,960	1971–2007
Oelrichs	NCDC	10,314	4,311	3,340	1948–2007
Newcastle	NCDC	10,414	4,351	4,380	1918–2006
Edgemont	NCDC	10,349	4,318	3,440	1948–2007
Custer	NCDC	10,336	4,346	5,330	1926–2007
Ardmore	NCDC	10,339	4,304	3,550	1948–2007
Angostura	NCDC	10,326	4,322	3,140	1948–2007
Jewel Cave	SDSU	10,349	4,343	5,298	2004–2008

Source: High Plains Regional Climate Center, 2008; South Dakota State University, 2008

(a) National Climatic Data Center.

(b) South Dakota State University Climate Web site.

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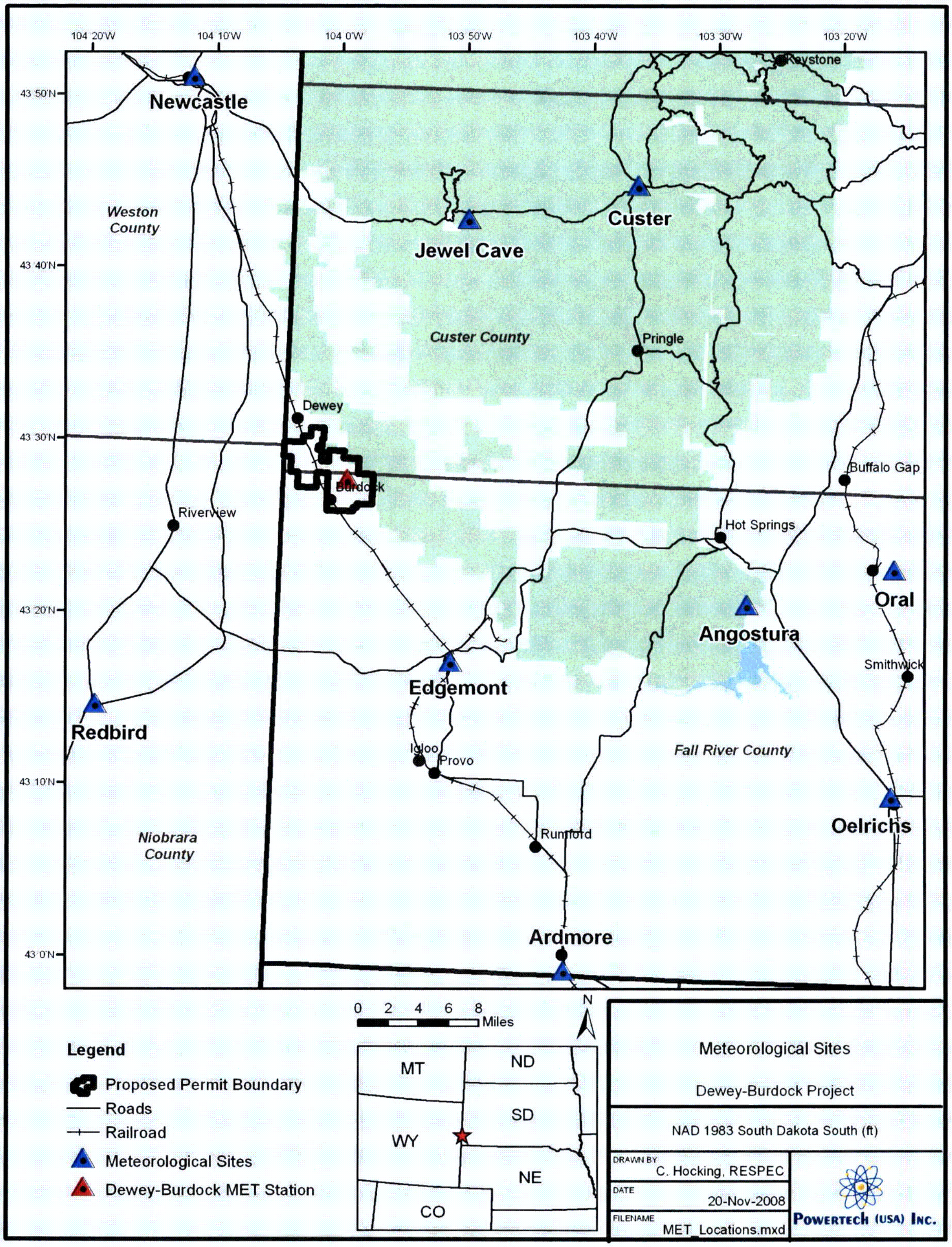


Figure 3.6-1: Meteorological Sites

3.6.2 Regional Overview

Meteorological data from the NWS site at Chadron, Nebraska, were collected from the HPRCC and analyzed to determine whether the past year's data (July 18, 2007, to July 17, 2008) was representative of long-term meteorological conditions (January 1, 1978, to July 17, 2008) in the area. The parameters analyzed were average daily temperature, wind speed, and precipitation.

The average daily temperature over the last (current) year was 47.8 degrees F, which is slightly cooler than the 30-year average (historic) daily temperature of 50.5 degrees F. Figure 3.6-2 displays a boxplot of the current and historic temperature data. The interquartile range for the current data is from 30.3 degrees F to 64.5 degrees F with a median value of 48.2 degrees F, compared to the historic data that has an interquartile range from 35.3 degrees F to 68.3 derees F and a median value of 50.5 degrees F. When looking at the data on a month-by-month basis, the mean value of the current data lies within one standard deviation of the mean value of the historic data (see Appendix 3.6-A).

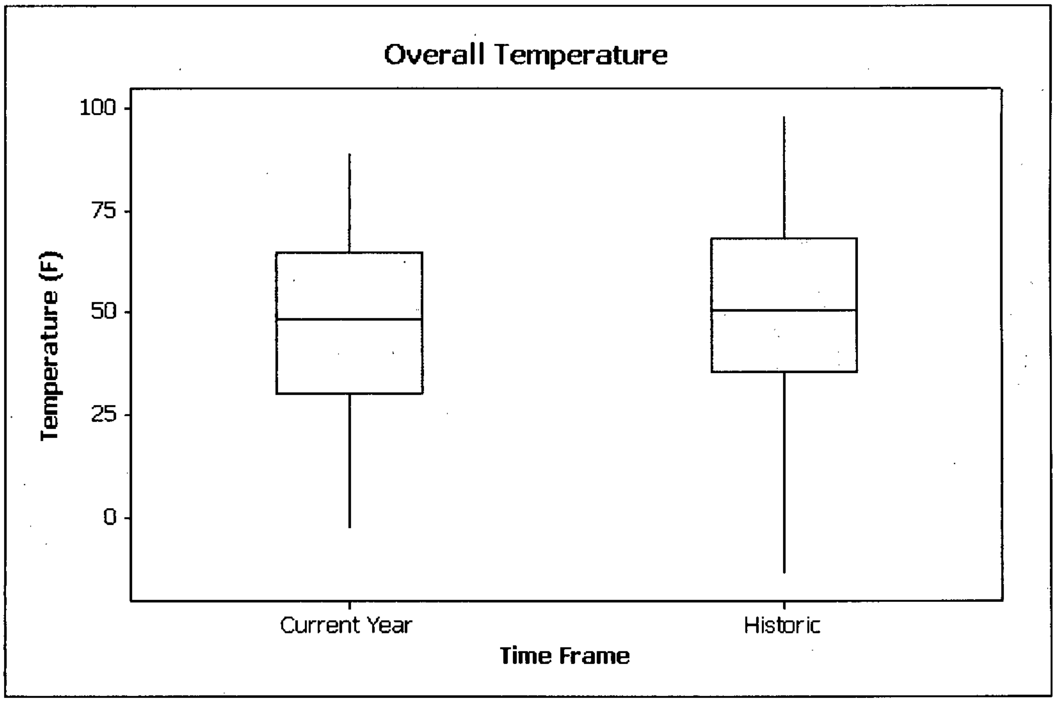


Figure 3.6-2: Temperature at Chadron, Nebraska, National Weather Service Site

The average daily wind speed over the current year was approximately 1 mph less than historically (9.8 to 10.8 mph). Figure 3.6-3 displays a boxplot of monthly wind speed for the current and historic data. The median value lies with the interquartile range for all months.

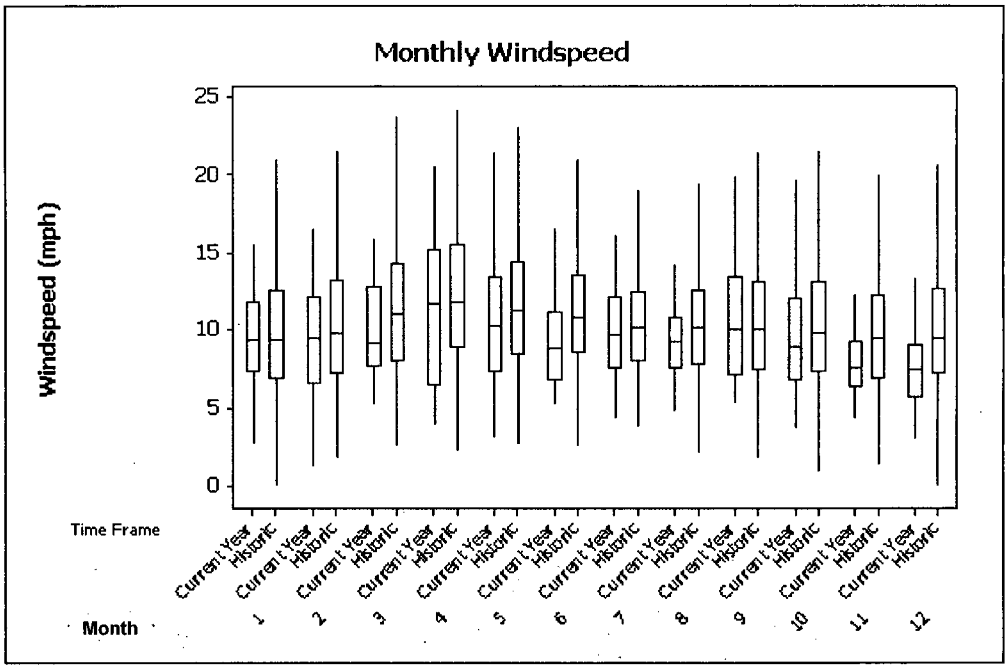
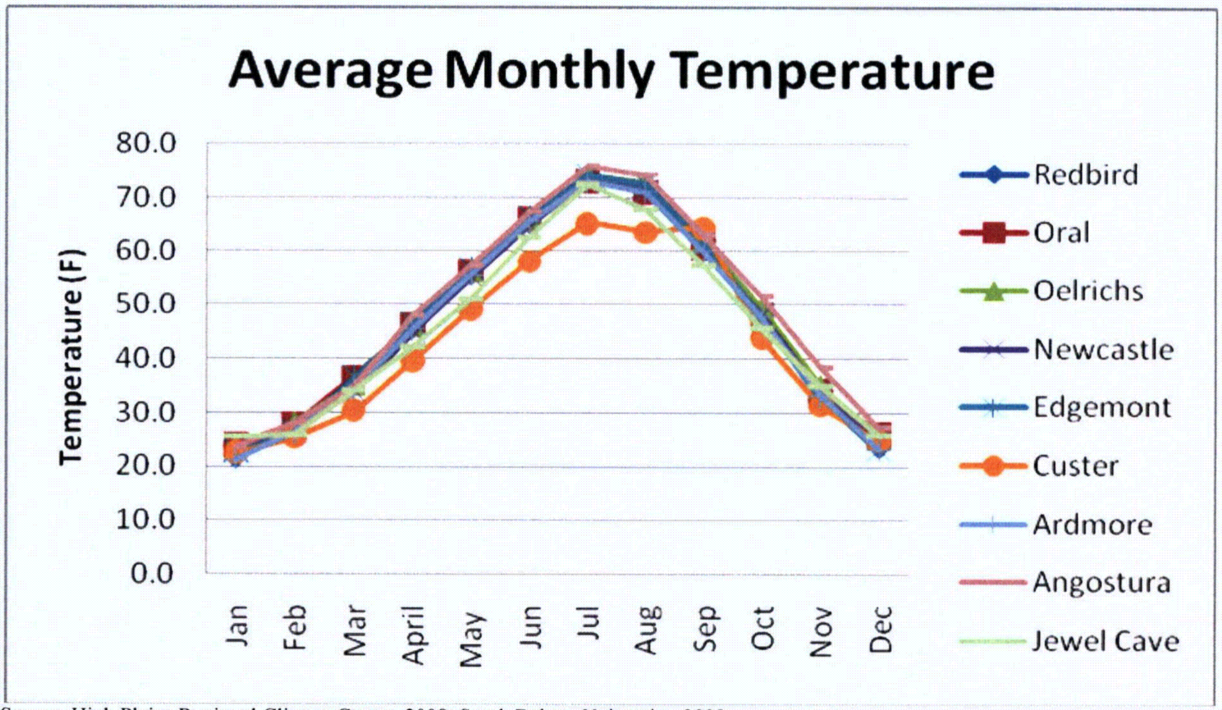


Figure 3.6-3: Monthly Wind Speed at Chadron, Nebraska, National Weather Service Site

The current year had well above the average amount of yearly precipitation. The current year had 32.8 inches of precipitation compared to the average yearly historic precipitation of 18.2 inches.

3.6.2.1 Temperature

The annual average temperature in this region is 46.7 degrees F. Figure 3.6-4 and Table 3.6-2 display the monthly, annual, and seasonal average temperatures. This region has some of its warmest days in the summer months with the hottest month being July (average temperature of 72.8 degrees F). The coldest month of the year is January, with an average temperature of 23.0 degrees F. The differences seen between sites can be attributed to elevation. Custer and Jewel Cave have the lowest average temperature primarily because these sites are nearly 1,000 feet higher in elevation than all other sites.



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

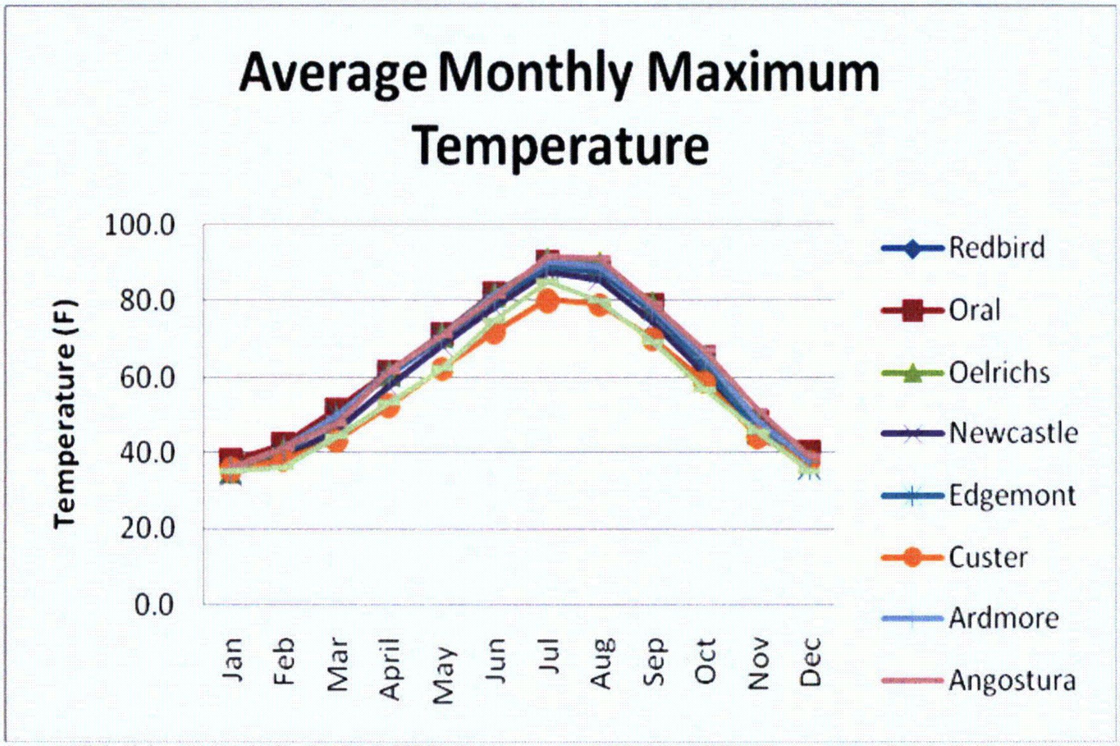
Figure 3.6-4: Average Monthly Temperatures for Regional Sites

Table 3.6-2: Average Monthly, Annual, and Seasonal Temperatures for Regional Sites

Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	21.8	27.3	35.1	45.8	55.8	65.5	73.3	71.4	60.4	47.9	33.1	23.8	46.8	24.3	45.6	70.1	47.2
Oral	24.1	27.9	36.6	46.3	56.6	66.2	73.2	71.1	60.7	48.3	34.3	26.1	47.6	26.1	46.5	70.2	47.8
Oelrichs	23.2	28.0	35.4	46.3	56.5	66.3	74.2	72.8	62.1	49.5	35.0	25.7	47.9	25.7	46.1	71.1	48.9
Newcastle	22.8	26.7	34.1	44.9	55.3	64.9	73.3	71.3	60.5	48.2	33.9	25.4	46.8	25.0	44.7	69.8	47.5
Edgemont	22.5	26.3	36.6	46.5	56.8	66.4	74.1	72.3	61.4	47.7	32.9	23.1	47.2	24.0	46.6	70.9	47.3
Custer	22.5	25.3	30.3	39.6	49.1	58.2	65.4	63.8	64.5	43.9	31.4	24.8	42.4	24.2	39.7	62.5	43.3
Ardmore	21.3	26.5	34.8	45.5	55.7	65.6	73.1	71.2	60.2	47.8	33.4	23.3	46.5	23.7	45.3	70.0	47.1
Angostura	23.5	28.1	34.9	47.9	57.5	67.4	75.9	74.3	63.3	51.8	38.4	27.3	49.2	26.3	46.8	72.5	51.2
Jewel Cave	25.5	25.8	34.0	42.2	51.1	62.7	72.5	67.9	57.6	45.6	35.0	25.7	45.5	25.7	42.4	67.7	46.1
Regional Average	23.0	26.9	34.6	45.0	54.9	64.8	72.8	70.7	61.2	47.9	34.2	25.0	46.7	25.0	44.9	69.4	47.4

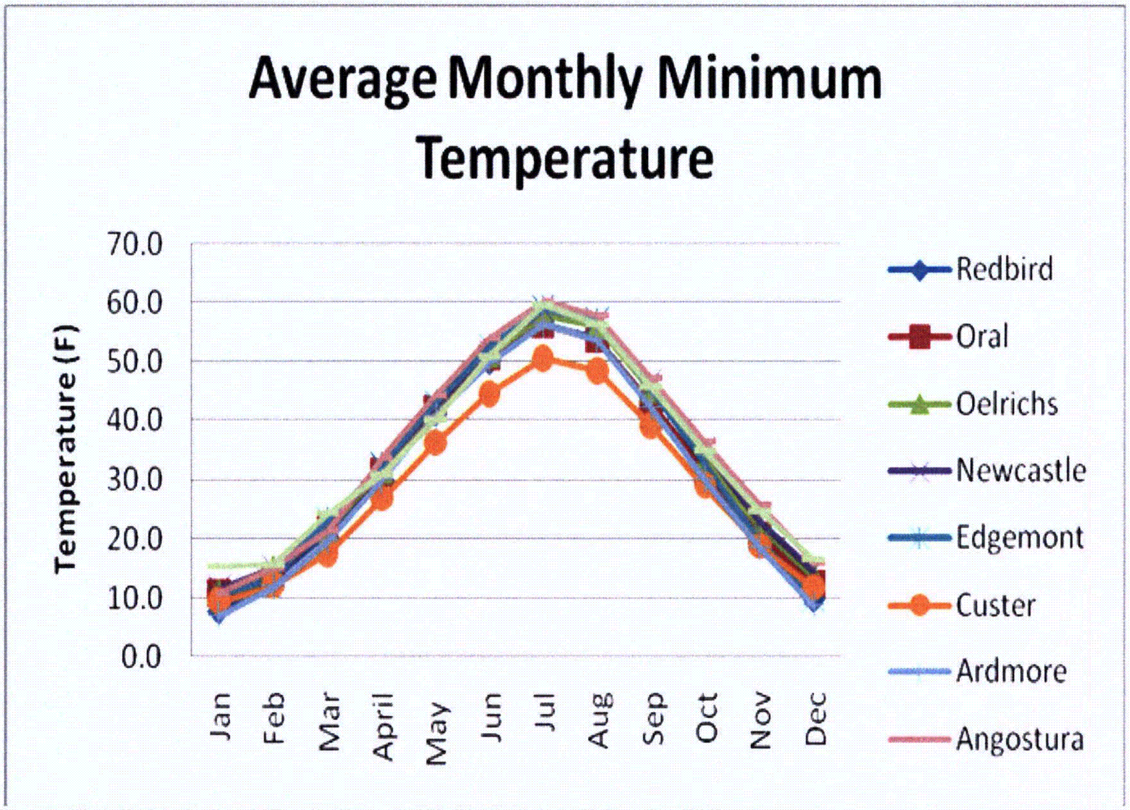
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figures 3.6-5 and 3.6-6 show the average maximum and minimum temperatures in the region. The average maximum temperature is 60.7 degrees F annually, while the annual average minimum temperature is 32.7 degrees F, as shown in Tables 3.6-3 and 3.6-4. The highest average maximum temperatures in the region usually fall during the month of July (88.3 degrees F). The lowest minimum temperatures can be found in January with a regional average of 10.4 degrees F.



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-5: Average Monthly Maximum Temperatures for Regional Sites



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-6: Average Monthly Minimum Temperatures for Regional Sites

Table 3.6-3: Average Monthly, Annual, and Seasonal Maximum Temperatures for Regional Sites

Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	35.8	41.3	49.3	60.7	70.6	81.1	90.2	88.9	78.2	65.0	47.4	37.9	62.2	38.3	60.2	86.7	63.5
Oral	37.7	42.2	51.4	61.2	71.2	81.8	90.1	88.5	78.8	65.0	48.3	40.1	63.0	40.0	61.3	86.8	64.0
Oelrichs	35.3	40.8	49.0	60.9	71.0	81.5	90.6	89.7	79.3	65.5	48.0	37.8	62.5	38.0	60.3	87.3	64.2
Newcastle	34.2	38.4	46.0	57.5	68.1	78.2	87.7	85.7	74.3	61.1	45.0	36.3	59.4	36.3	57.2	83.9	60.1
Edgemont	35.2	39.3	49.9	60.6	70.3	80.4	89.0	87.7	77.1	62.8	45.9	36.2	61.2	36.9	60.3	85.7	61.9
Custer	35.5	38.2	43.2	52.4	62.1	71.8	80.2	79.1	69.9	58.7	44.2	37.5	56.1	37.1	52.5	77.0	57.6
Ardmore	35.6	41.2	49.7	61.2	70.8	81.4	90.1	88.9	78.2	65.4	48.4	37.8	62.4	38.2	60.5	86.8	64.0
Angostura	36.2	41.2	47.7	61.6	70.8	80.9	91.4	91.0	79.1	67.2	51.4	39.4	63.2	38.9	60.0	87.8	65.9
Jewel Cave	35.4	36.2	44.3	53.3	62.4	74.6	85.1	80.0	69.2	56.8	45.9	35.4	56.5	35.6	53.3	79.9	57.3
Regional Average	35.7	39.9	47.8	58.8	68.6	79.1	88.3	86.6	76.0	63.1	47.2	37.6	60.7	37.7	58.4	84.7	62.1

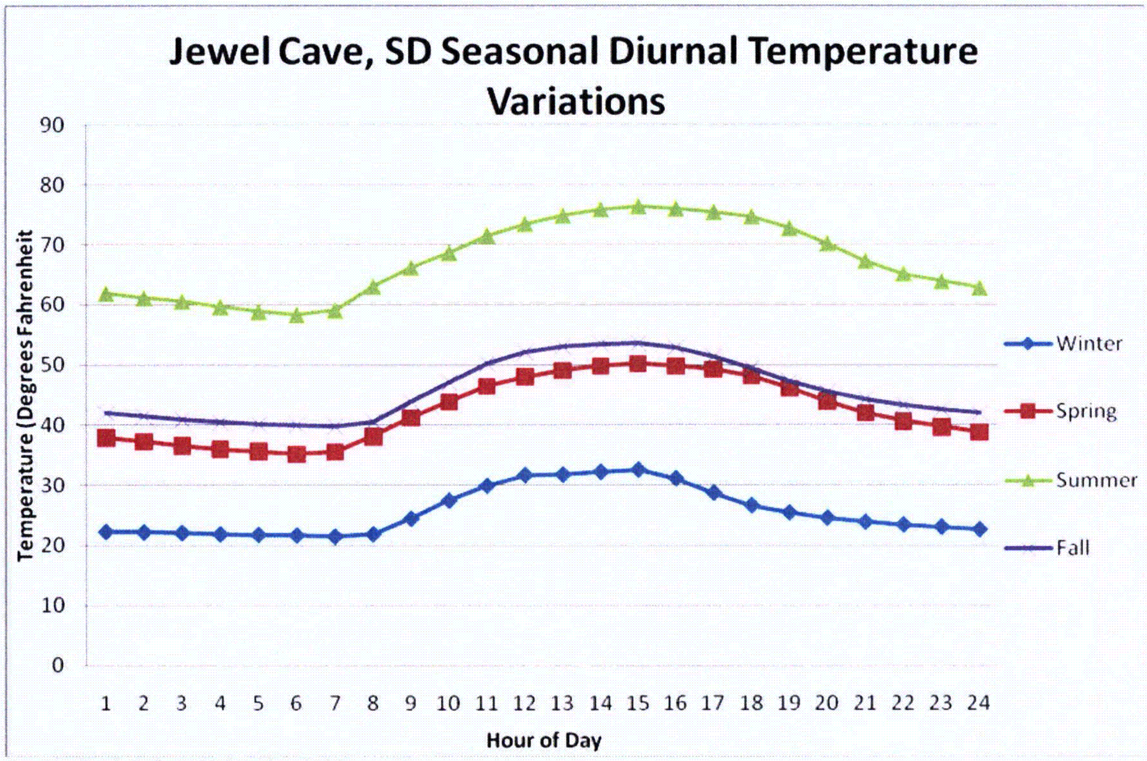
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Table 3.6-4: Average Monthly, Annual, and Seasonal Minimum Temperatures for Regional Sites

Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Winter	Spring	Summer	Fall
Redbird	7.8	13.2	21.0	30.8	41.1	49.9	56.3	53.9	42.6	30.9	18.8	9.8	31.4	10.3	31.0	53.4	30.8
Oral	10.6	13.8	22.2	31.3	41.9	50.7	56.4	53.7	42.7	31.6	20.4	12.3	32.3	12.2	31.8	53.6	31.6
Oelrichs	11.1	15.0	21.7	31.7	42.0	51.2	57.7	55.9	45.2	33.6	21.9	13.6	33.4	13.3	31.8	54.9	33.6
Newcastle	11.5	15.0	22.2	32.2	42.4	51.5	59.1	57.0	46.6	35.3	22.8	14.5	34.2	13.6	32.3	55.9	34.9
Edgemont	10.0	13.4	23.2	32.5	43.2	52.4	59.1	56.9	45.6	32.7	19.7	9.9	33.2	11.1	33.0	56.1	32.7
Custer	9.4	12.2	17.4	26.8	36.2	44.6	50.7	48.5	39.2	29.1	18.7	11.8	28.7	11.1	26.8	47.9	29.0
Ardmore	7.0	11.9	19.7	30.0	40.7	49.7	56.2	53.5	42.2	30.2	18.4	8.7	30.7	9.2	30.2	53.1	30.2
Angostura	10.8	15.1	21.5	33.7	44.3	53.9	60.3	57.8	47.4	36.5	25.9	16.0	35.3	14.0	33.2	57.3	36.6
Jewel Cave	15.4	15.7	24.5	31.1	40.0	51.0	59.7	56.3	45.9	35.1	24.8	16.6	34.7	15.9	31.9	55.7	35.3
Regional Average	10.4	13.9	21.5	31.1	41.3	50.5	57.3	54.8	44.2	32.8	21.3	12.6	32.7	12.3	31.3	54.2	32.7

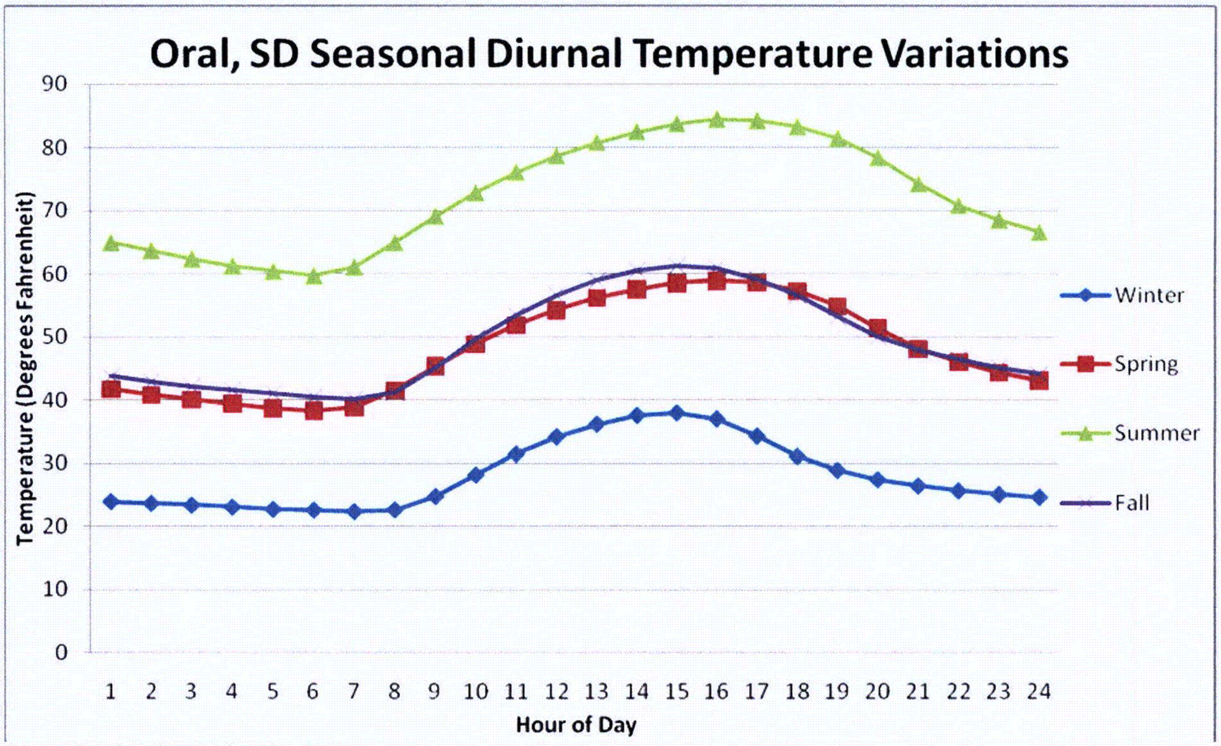
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figures 3.6-7 and 3.6-8 display diurnal temperature variations by season for the Jewel Cave and Oral sites. These sites were used because they were the only sites that recorded hourly temperatures near the Proposed Action. As the figures show, there are large variations in diurnal temperature, especially during the summer months.



Source: South Dakota University, 2008

Figure 3.6-7: Jewel Cave, South Dakota, Seasonal Diurnal Temperature Variations

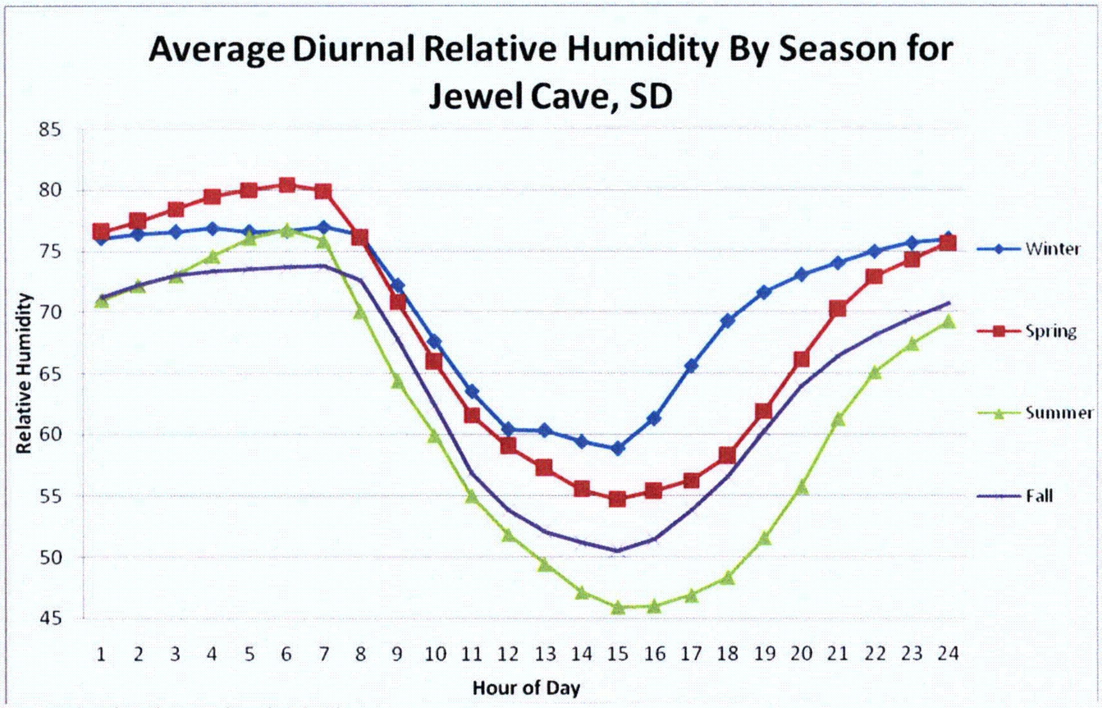


Source: South Dakota University, 2008

Figure 3.6-8: Oral, South Dakota, Seasonal Diurnal Temperature Variations

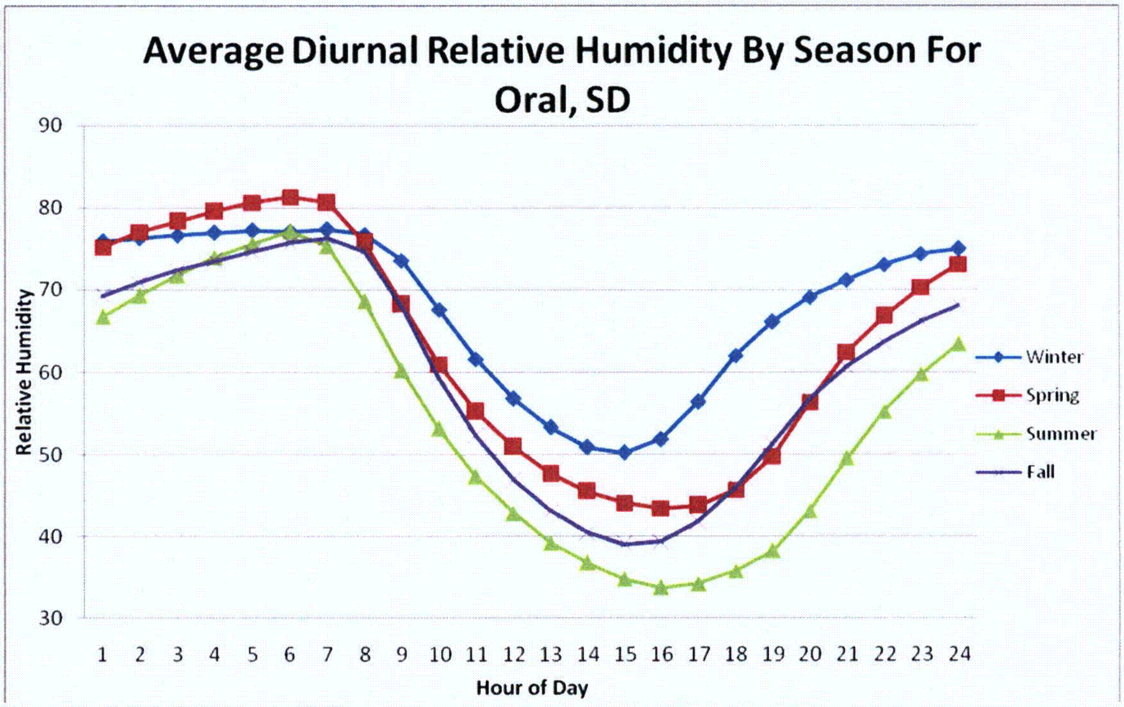
3.6.2.2 Relative Humidity

Relative humidity measures the fraction of moisture in the air to saturated moisture content at a certain temperature. This parameter was analyzed for both the Jewel Cave and Oral sites. Figures 3.6-9 and 3.6-10 display the relationship of relative humidity to the season and time of day for each site. The figures show that the summer has the lowest relative humidity, averaging 60 percent, while winter has the highest relative humidity, averaging 69 percent.



Source: South Dakota University, 2008

Figure 3.6-9: Average Diurnal Relative Humidity by Season for Jewel Cave, South Dakota



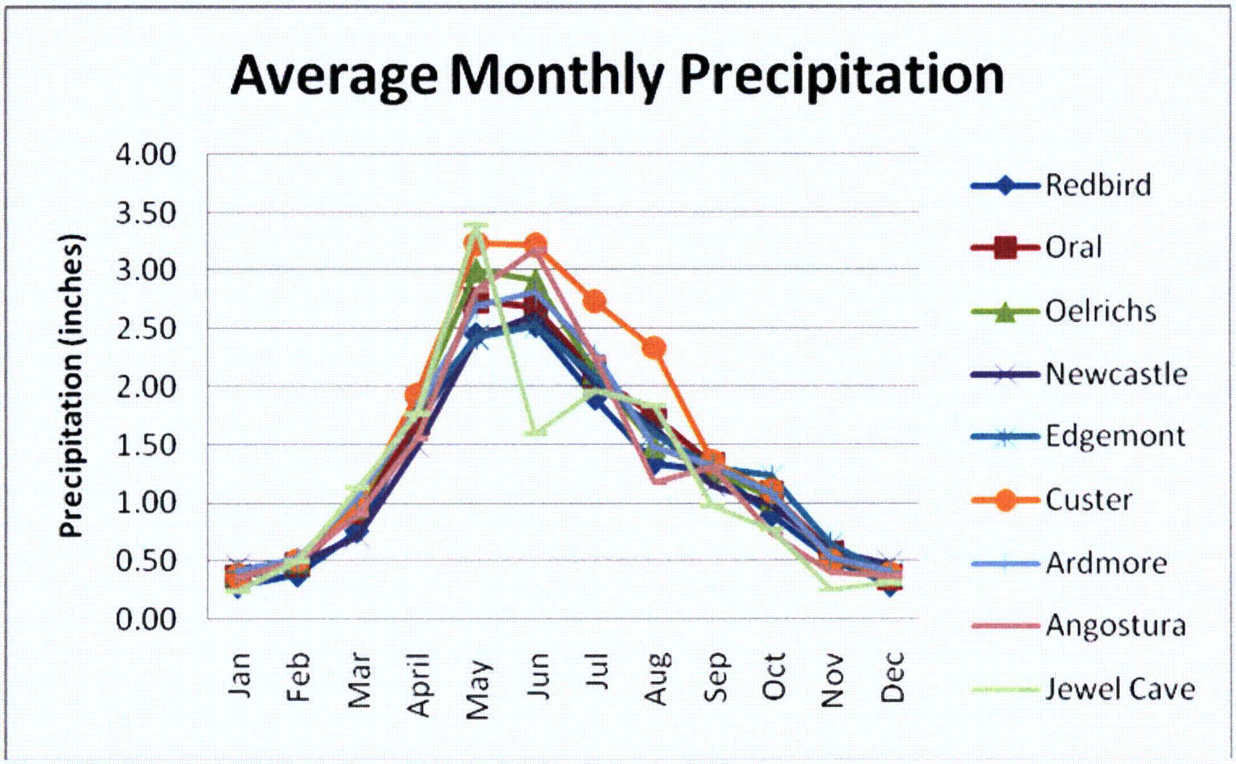
Source: South Dakota University, 2008

Figure 3.6-10: Average Diurnal Relative Humidity by Season for Oral, South Dakota

The relative humidity in this region peaks out in the morning at around 6:00 am with the minimum falling in the afternoon around 3:00 pm. The readings during the peak time average 77 percent at Jewel Cave and 78 percent at the Oral site. The readings with the lowest relative humidity during the day average 53 percent and 42 percent at Jewel Cave and Oral, respectively.

3.6.2.3 Precipitation

Figure 3.6-11 and Table 3.6-5 show that this area can be very dry at times with a regional annual average precipitation of 16.5 inches. Most of the precipitation accumulates during May, June, and July (48 percent of the annual). Typically, May is the wettest month of the year for this region with an average accumulation of 2.8 inches. Winter receives roughly 8 percent of the annual accumulated precipitation. January is the driest month of the year with an average accumulation of 0.36 inches of precipitation.



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

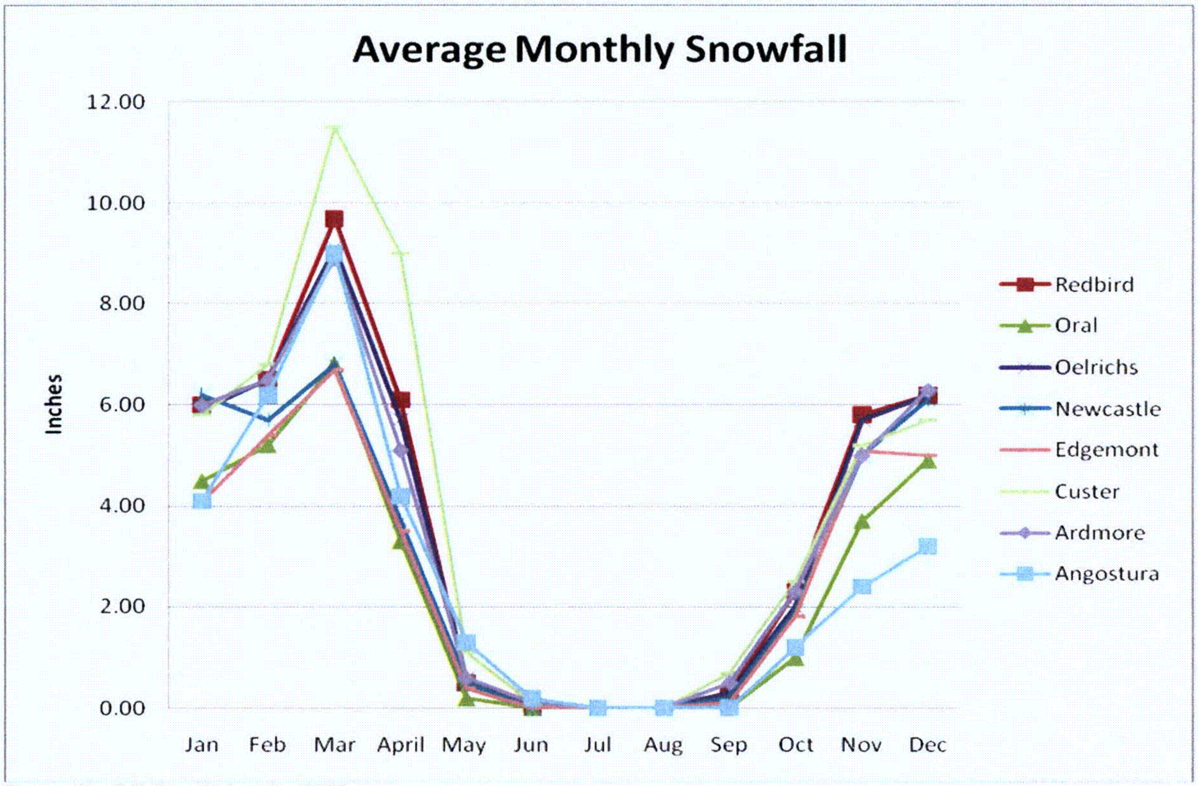
Figure 3.6-11: Average Monthly Precipitation for Regional Sites

Table 3.6-5: Average Seasonal and Annual Precipitation for Regional Sites

Name	Annual	Winter	Spring	Summer	Fall
Redbird	14.29	0.95	4.89	5.77	2.68
Oral	16.10	1.19	5.37	6.54	3.00
Oelrichs	16.50	1.28	5.83	6.54	2.85
Newcastle	15.11	1.41	4.65	6.32	2.73
Edgemont	15.87	1.22	5.26	6.20	3.19
Custer	18.66	1.27	6.15	8.28	2.96
Ardmore	16.35	1.34	5.54	6.56	2.91
Angostura	15.51	1.22	5.26	6.59	2.44
Jewel Cave	20.00	6.30	6.30	5.40	2.00
Region Average	16.49	1.80	5.47	6.47	2.75

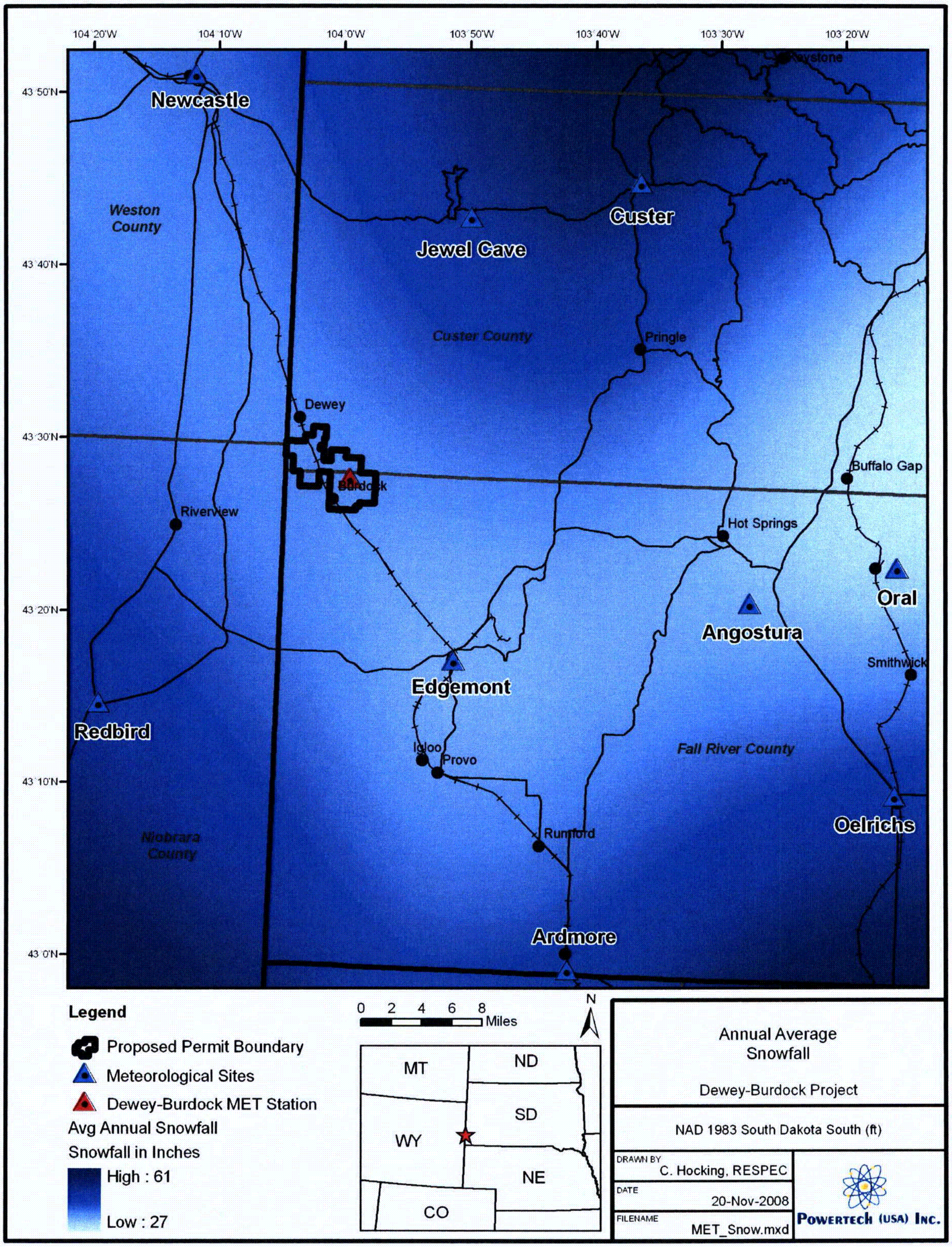
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

This region receives an average of 38 inches of snowfall each year. As shown in Figure 3.6-12, most snowfall accumulates during the month of March with a regional average of 8.5 inches. Custer receives the most annual snowfall (48 inches). This can be attributed to the higher elevation and the influence of the Black Hills that surround it (Figure 3.6-13).



Source: South Dakota University, 2008

Figure 3.6-12: Average Monthly Snowfall at Regional Sites

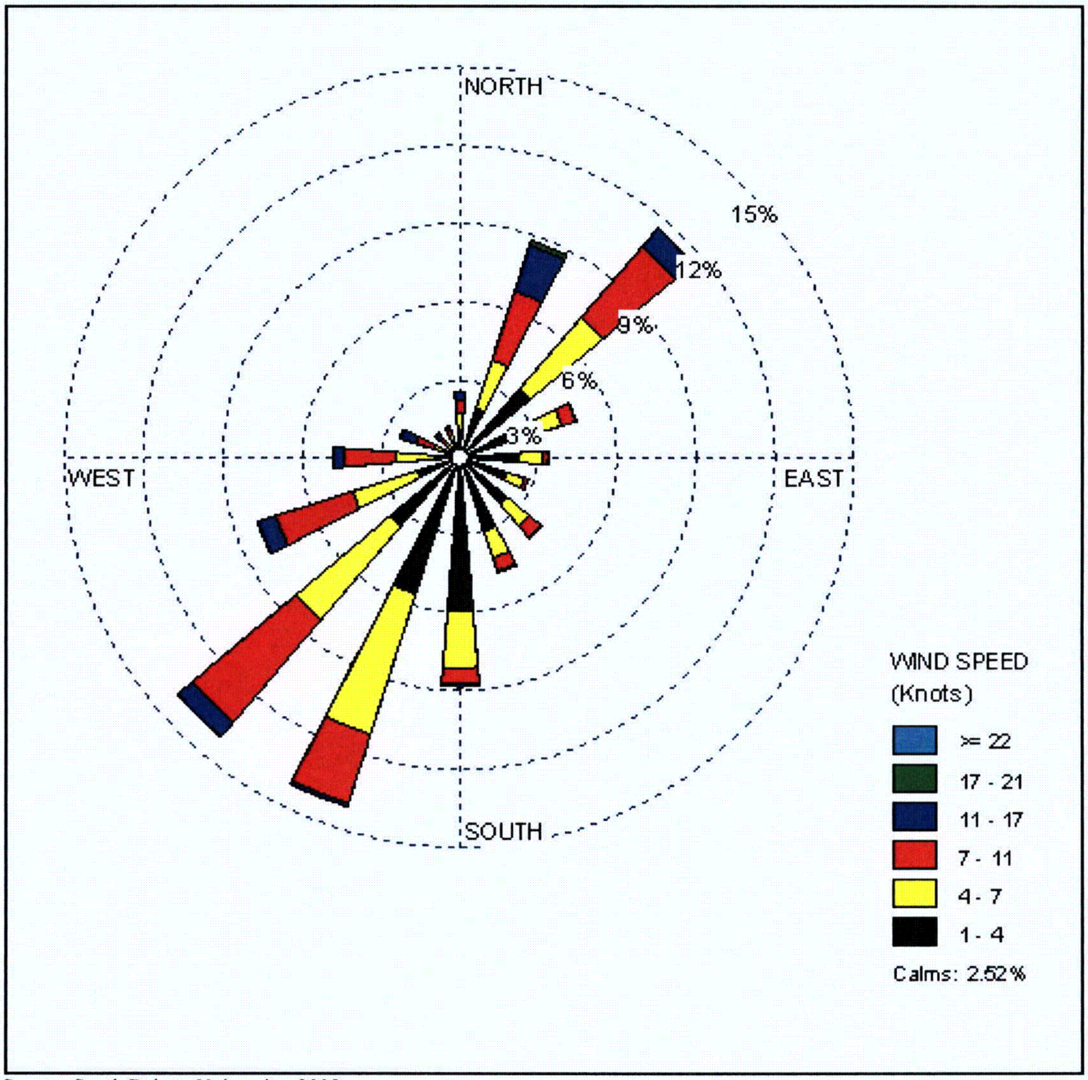


Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-13: Average Snowfall Accumulation throughout the Region

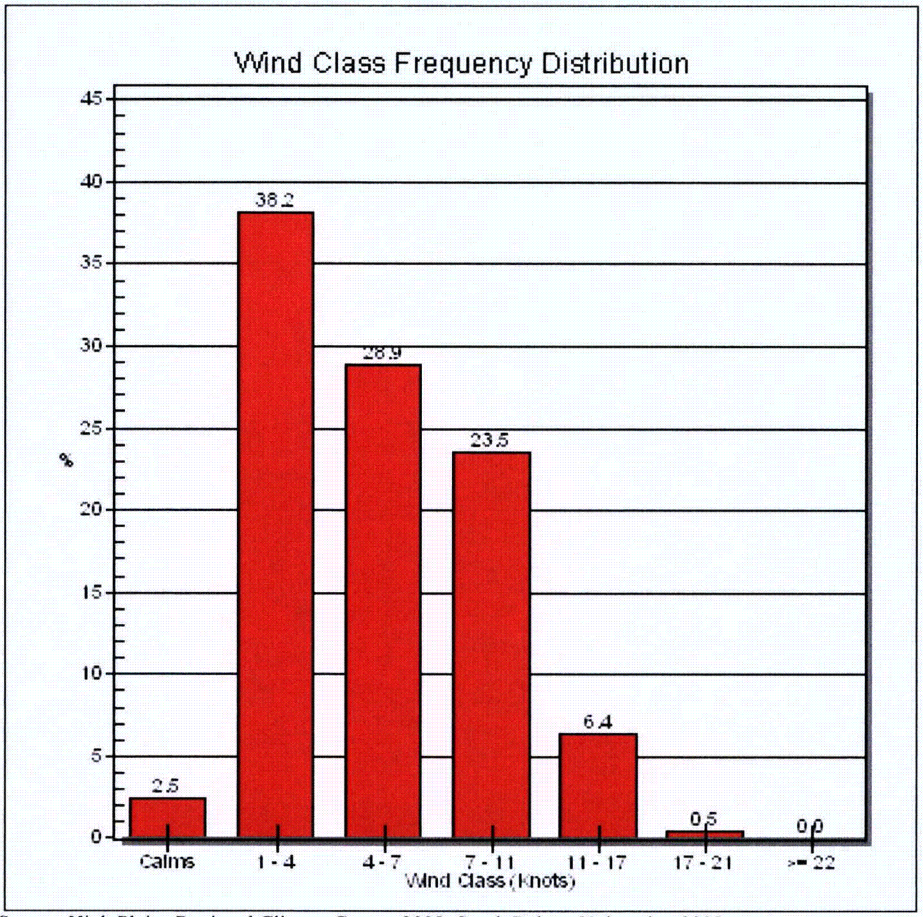
3.6.2.4 Wind Patterns

The Oral site was the only site in the region with representative data for wind speed and direction. The wind speed averaged 6.4 mph over the entire period of record with approximately 51 percent of the winds blowing from the southwest (Figure 3.6-14). Over 38 percent of the wind is between 1.2 and 4.6 mph (1 to 4 knots) with calm winds (less than 1.2 mph or 1 knot) occurring 2.5 percent of the time (Figure 3.6-15).



Source: South Dakota University, 2008

Figure 3.6-14: Wind Rose of Data from Oral, South Dakota

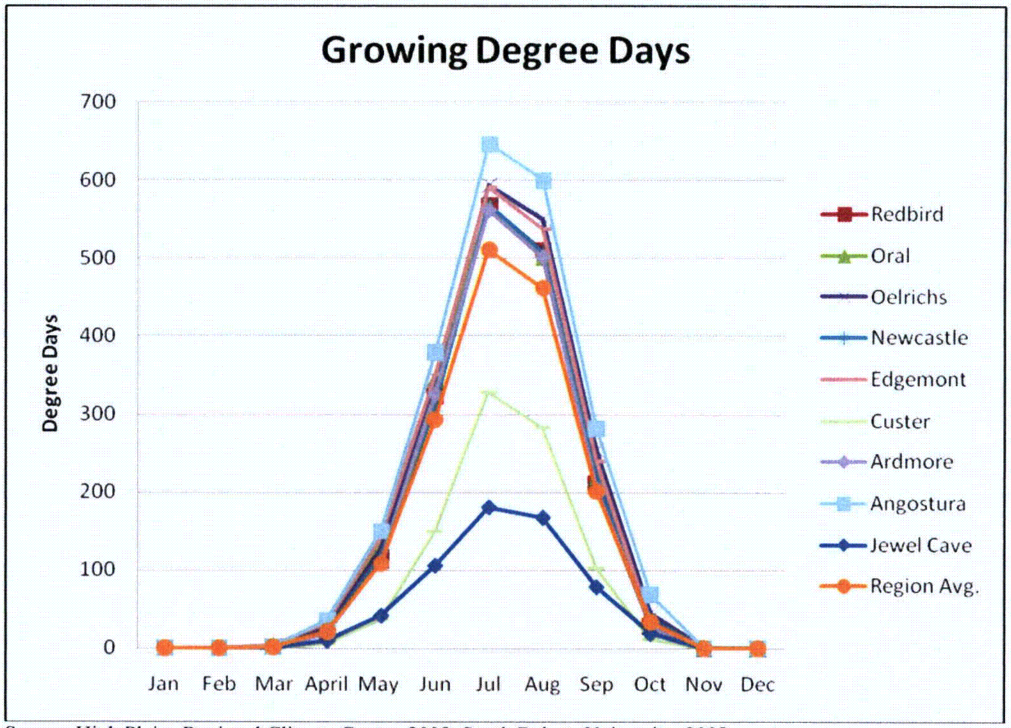


Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-15: Wind Class Frequency Distribution for Oral, South Dakota, from November 2002 – July 2008

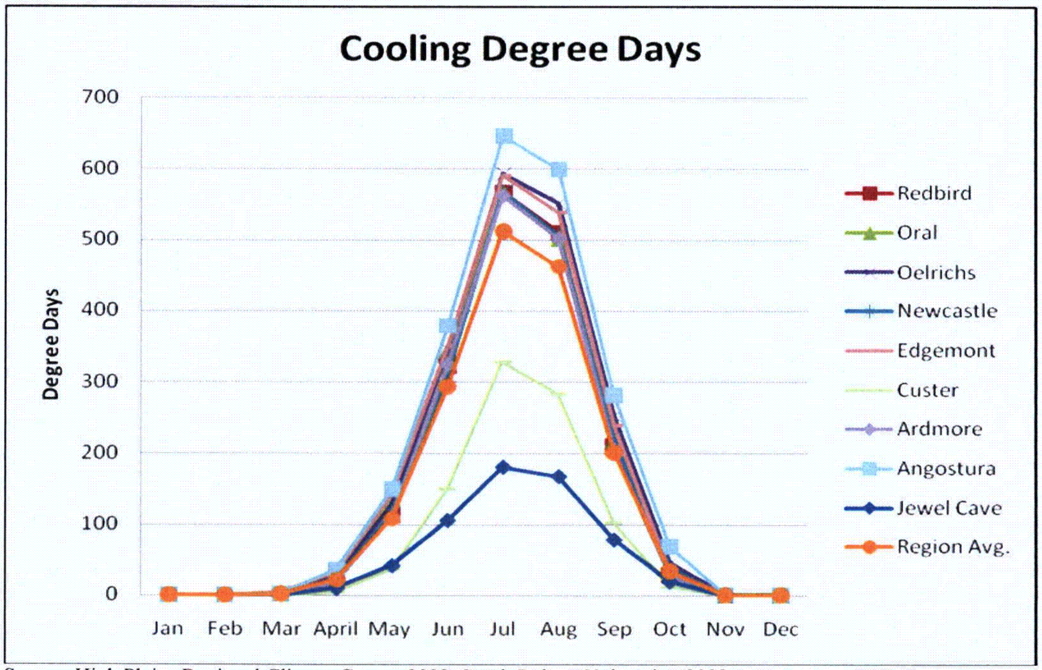
3.6.2.5 Cooling, Heating and Growing Degree Days

The graphs shown in Figures 3.6-16, 3.6-17, and 3.6-18 summarize the growing degree, cooling, and heating days for the nine meteorological sites in the area. The data show a similar pattern for all three parameters throughout the sites with the exception of the Jewel Cave and Custer sites, which is likely caused by the higher relative elevation of these two sites.



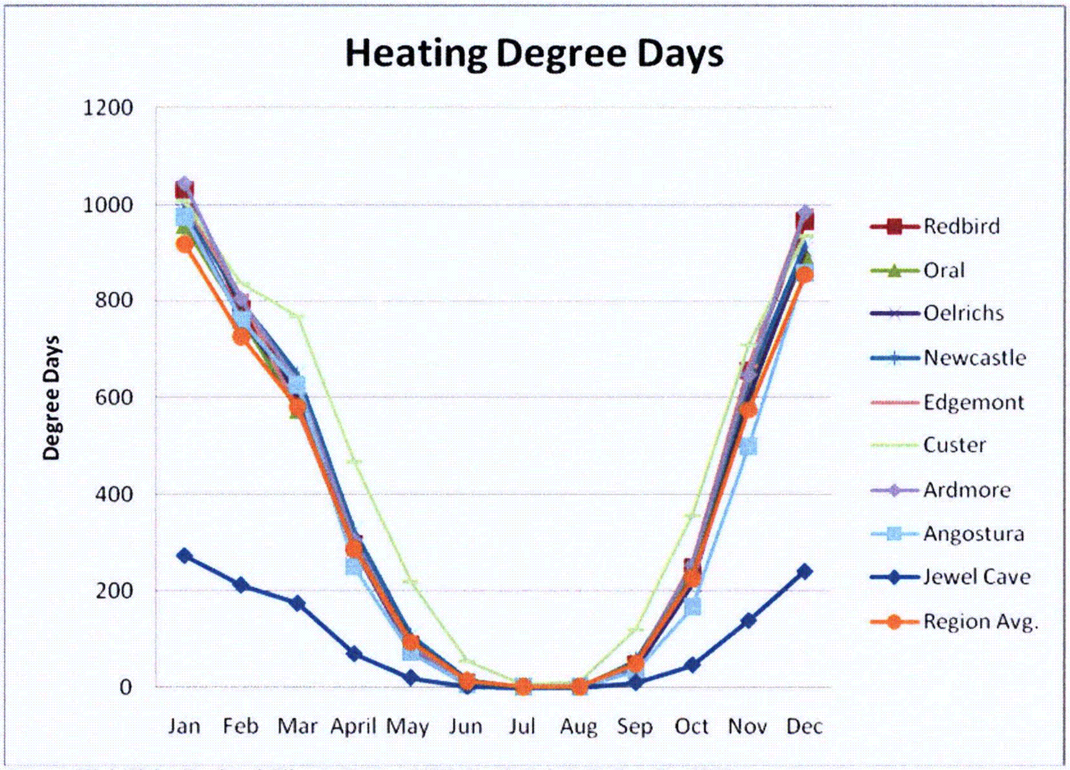
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-16: Growing Degree Days for Regional Sites



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-17: Cooling Degree Days for Regional Sites



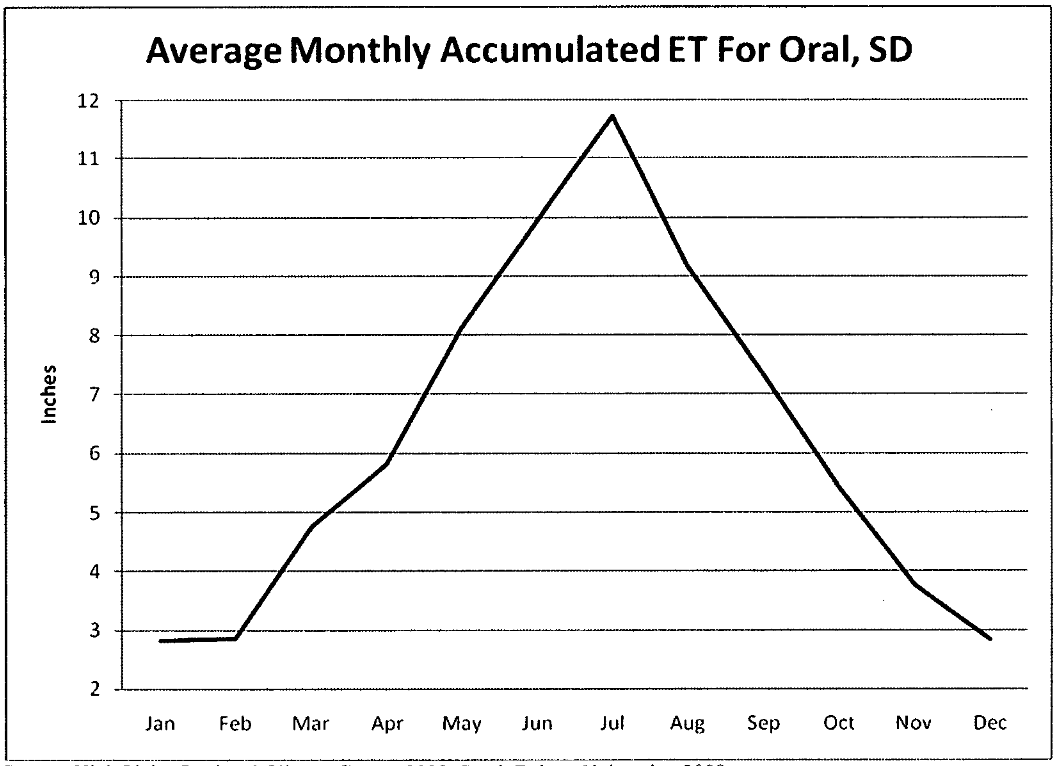
Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-18: Heating Degree Days for Regional Sites

All degree days calculations used a base temperature of 55 degrees F. Heating and cooling degree days are included to show deviation of the average daily temperature from the chosen base temperature. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The number of growing degree days and cooling degree days is computed in the opposite fashion where the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

3.6.2.6 Evapotranspiration

The American Society of Civil Engineers (ASCE) Standardized Reference Evapotranspiration Equation was used to calculate daily evapotranspiration (ET) using a tall reference crop coefficient. The weather parameters needed to calculate ET using this method are daily maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. The Oral site was the only one in the region with all these weather parameters being sampled, and was, therefore, the site used for this analysis. The data were available from May 8, 2003, to July 20, 2008. Figure 3.6-19 displays a graph of the average accumulated ET for each month. Most ET occurs during the summer months of June, July, and August with an average monthly accumulation of 10.3 inches. During the winter months, low ET (2.8 inches) occurs because of low temperatures and low solar radiation.



Source: High Plains Regional Climate Center, 2008; South Dakota University, 2008

Figure 3.6-19: Average Monthly Accumulated Evapotranspiration for Oral, South Dakota

3.6.3 Site Specific Analysis

The site-specific analysis was completed using data collected from a weather station installed in approximately the center of the proposed permit boundary. The station is located on a site that is representative of the area within the boundary. Twelve months of data from July 18, 2007, to July 17, 2008, are used for this analysis.

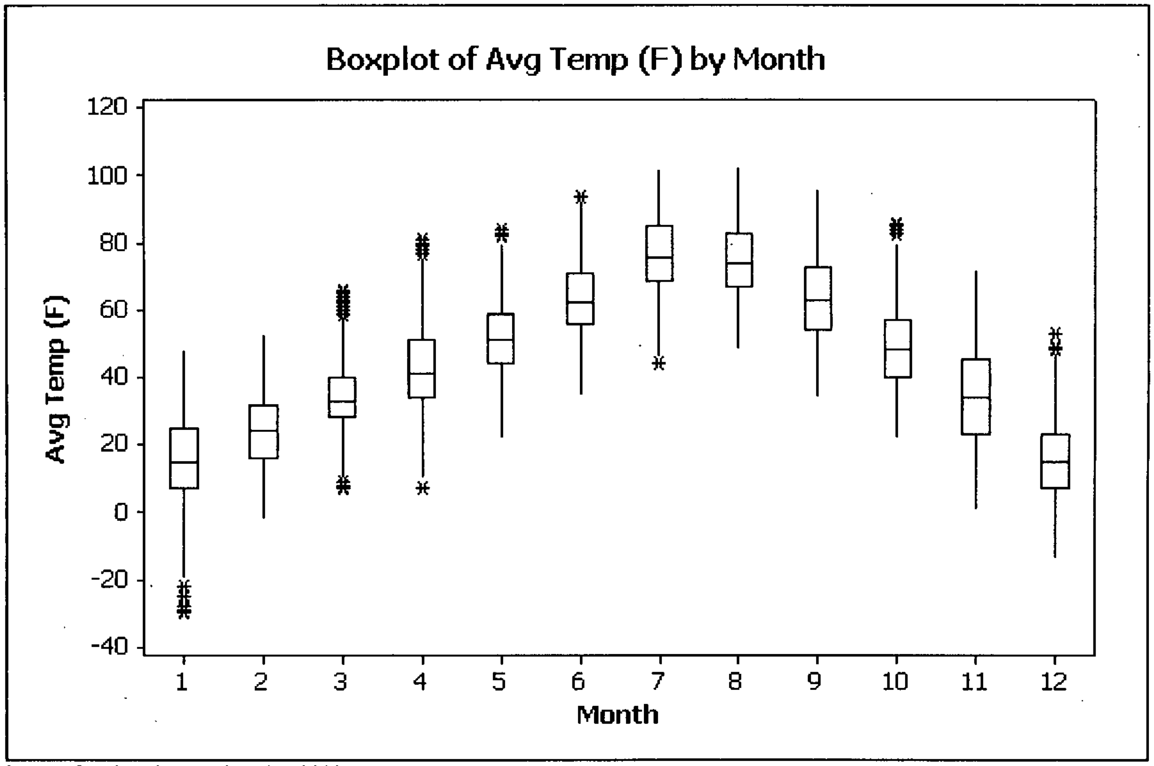
This site was installed in cooperation with the South Dakota State Climatology office according to the standards they use to install their Automatic Weather Data Network (AWDN) stations. The parameters being sampled at the site are air temperature, solar radiation, humidity, precipitation, and wind speed/direction at both 3- and 10-m heights (9.8 and 32.8 feet). Table 3.6-6 lists the model number and specifications of the sensors that were installed. The accuracy of all the sensors used is within the standards required by the NRC. All results of the statistical analysis, completed using Minitab software version 14.0 for the parameters analyzed, are included in Appendix 3.6-B.

Table 3.6-6: Specifications for Weather Instruments Installed to Perform Site-Specific Analysis

Measurement	Model	Manufacturer	Accuracy	Operating Temperature
Precipitation	VR6101	Vaisala	0.01 inch	–40°C to 60°C
Wind Direction	024A	Met-One	±5 degrees	–50°C to 70°C
Wind Speed	014A	Met-One	0.25 mph (0.11 m/s)	–50°C to 70°C
Temperature and RH	HMP45C	Vaisala	±2% for 10–90% RH; ±3% of 90–100% RH	–40°C to 60°C
Solar Radiation	L1200X	Lt-Cor	Absolute error in natural daylight is ±5% max; ±3% typical	–40°C to 65°C

3.6.3.1 Temperature

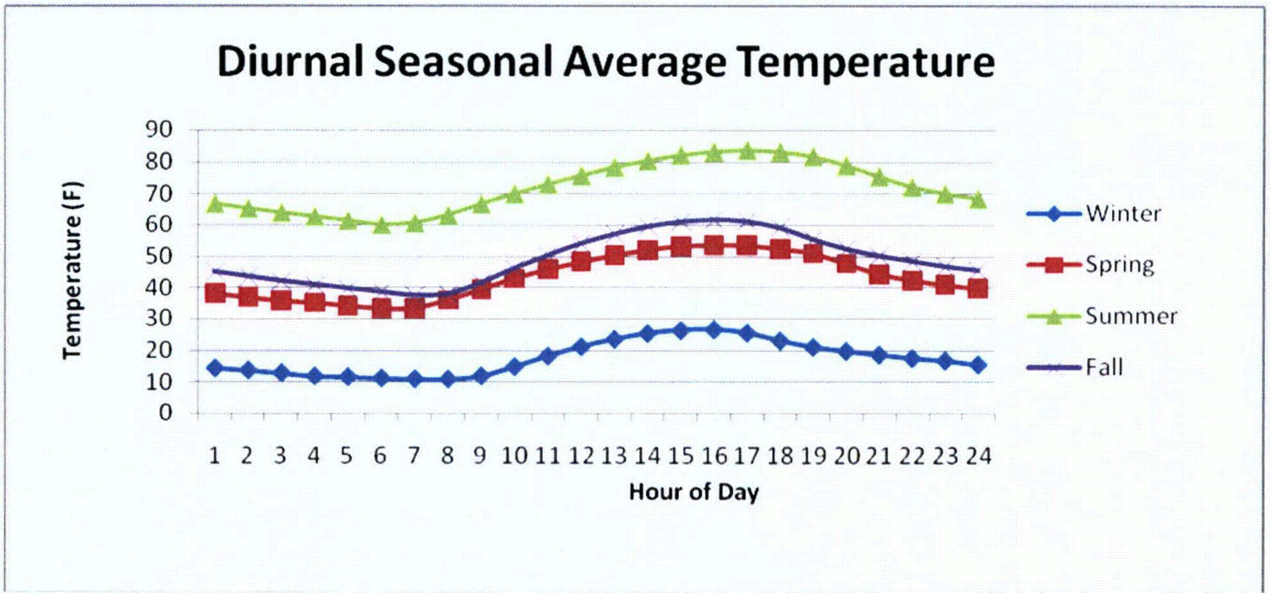
The average hourly temperature over the year for the site was 45.5 degrees F. A maximum temperature of 104 degrees F was reached on both July 21, 2007, and August 13, 2007, while the minimum temperature for the period of record was –28 degrees F on January 22, 2008. A boxplot of the average temperature by month is shown in Figure 3.6-20. July was the warmest month with a median temperature of 76 degrees F with a first quartile of 69 degrees F and a third quartile value of 85 degrees F. Conversely, December and January were the coolest months with a median temperature of 15 degrees F.



Source: South Dakota University, 2008

Figure 3.6-20: Average Temperature (degrees Fahrenheit) by Month from the PAA Meteorological Site

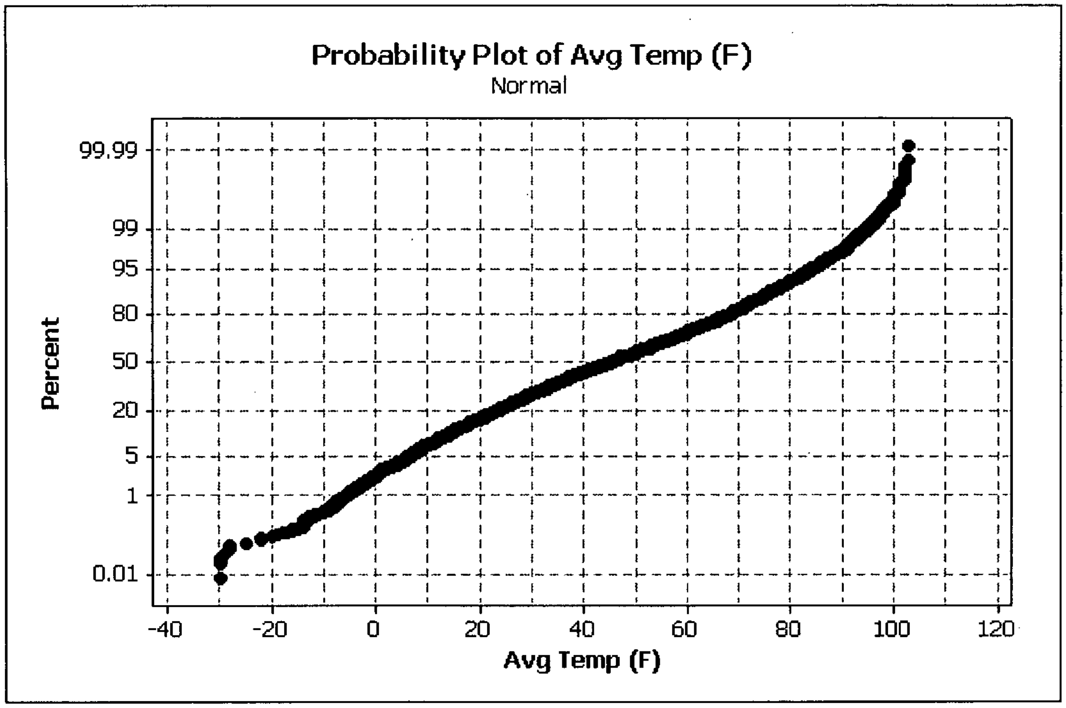
There were large variations in seasonal and diurnal temperature (Figure 3.6-21). In the summer season, average temperatures were as low as 60 degrees F at 6:00 am to 83.6 degrees F at 5:00 pm. In the winter season, temperatures varied from an average of 11 degrees F between 7:00 am and 8:00 am and rose to nearly 27 degrees F at 4:00 pm. The diurnal variations are the result of the lack of relative humidity in the atmosphere at the site, which causes the earth's surface to rapidly absorb and release the energy supplied by the sun.



Source: South Dakota University, 2008

Figure 3.6-21: Diurnal Average Temperature for the PAA Meteorological Site by Season

Figure 3.6-22 shows a probability plot of average hourly temperature for the year. Temperatures above or below 46 degrees F were expected at the site 50 percent of the time, and temperatures dipped below the freezing mark of 32 degrees F 31 percent of the time.



Source: South Dakota University, 2008

Figure 3.6-22: Probability Plot of Average Temperature from the PAA Meteorological Site

3.6.3.2 Wind Patterns

Wind speed and direction was measured in the field using Met-One 014A and 024A model sensors. Statistical analysis and visualization of wind data were performed using WRPLOT View Version 5.3 distributed by Lakes Environmental. All data analysis outputs are included in Appendix 3.6-C. The average wind speed over the period of record was approximately 5 mph, while calm winds occurred only 1.8 percent of the time.

As shown in Table 3.6-7, a majority of the winds (51 percent) come from the southeast and approximately 55 percent of all winds were less than 4.6 mph. December had the least amount of wind with 7.66 percent of the total winds being classified as calm and having an average wind speed of 2.8 mph. In contrast, May was the windiest month with only 0.41 percent of calm winds and an average wind speed of 6.9 mph. Southeasterly winds were prevalent in the winter months (38 percent of total shown in Figure 3.6-23) as well as the summer months (56 percent of total shown in Figure 3.6-24).

Table 3.6-7: Normalized Frequency Distribution of Wind at the PAA Meteorological Site

Frequency Distribution (Normalized)							
Wind Direction	Knots						
	1–4	4–7	7–11	11–17	17–21	≥ 22	Total
348.75–11.25	0.000345	0.000115	0.000000	0.000000	0.000000	0.000000	0.000459
11.25–33.75	0.002526	0.000804	0.000459	0.000115	0.000000	0.000000	0.003904
33.75–56.25	0.012517	0.003790	0.003790	0.000804	0.000230	0.000230	0.021360
56.25–78.75	0.028250	0.016996	0.021475	0.003330	0.000459	0.000000	0.070510
78.75–101.25	0.057074	0.037322	0.018489	0.001263	0.000000	0.000000	0.114148
101.25–123.75	0.069936	0.025609	0.011713	0.000000	0.000000	0.000000	0.107258
123.75–146.25	0.070740	0.022738	0.007350	0.000115	0.000115	0.000000	0.101056
146.25–168.75	0.071199	0.015618	0.001378	0.000345	0.000000	0.000000	0.088539
168.75–191.25	0.057533	0.004364	0.000459	0.000230	0.000000	0.000000	0.062586
191.25–213.75	0.035829	0.004364	0.000345	0.000115	0.000000	0.000000	0.040652
213.75–236.25	0.035140	0.005397	0.002182	0.001034	0.000000	0.000000	0.043753
236.25–258.75	0.030202	0.006890	0.004593	0.001493	0.000115	0.000000	0.043294
258.75–281.25	0.032269	0.014469	0.004364	0.001952	0.000000	0.000000	0.053055
281.25–303.75	0.027905	0.034566	0.019982	0.002986	0.000000	0.000000	0.085439
303.75–326.25	0.017570	0.040652	0.052710	0.015962	0.000230	0.000000	0.127124
326.25–348.75	0.004364	0.006546	0.006775	0.001263	0.000115	0.000000	0.019063
Subtotal	**0.553399**	**0.240239**	**0.156063**	**0.031006**	**0.001263**	**0.00023**	**0.973702**
Calms							**0.017646**
Missing/Incomplete							**0.008652**
Total							**1.000000**

Source: South Dakota University, 2008

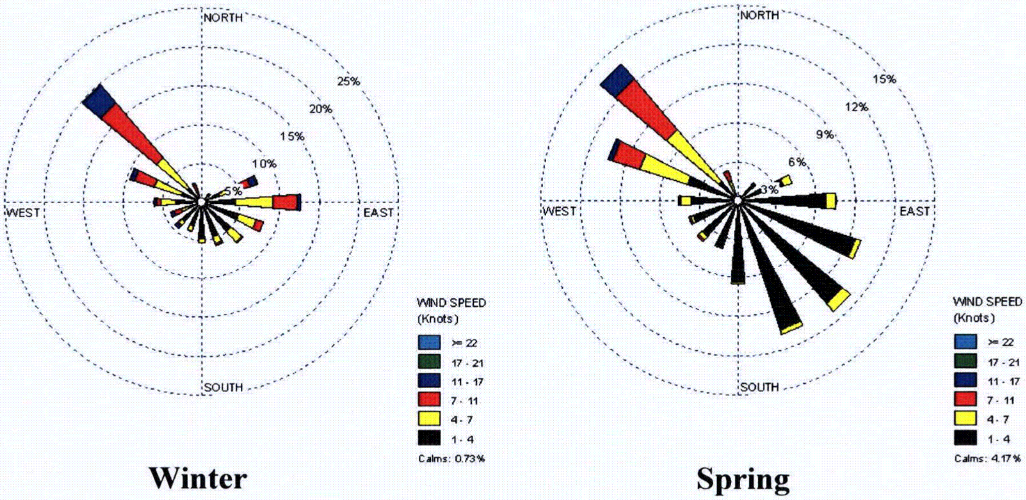


Figure 3.6-23: Winter and Spring Wind Roses

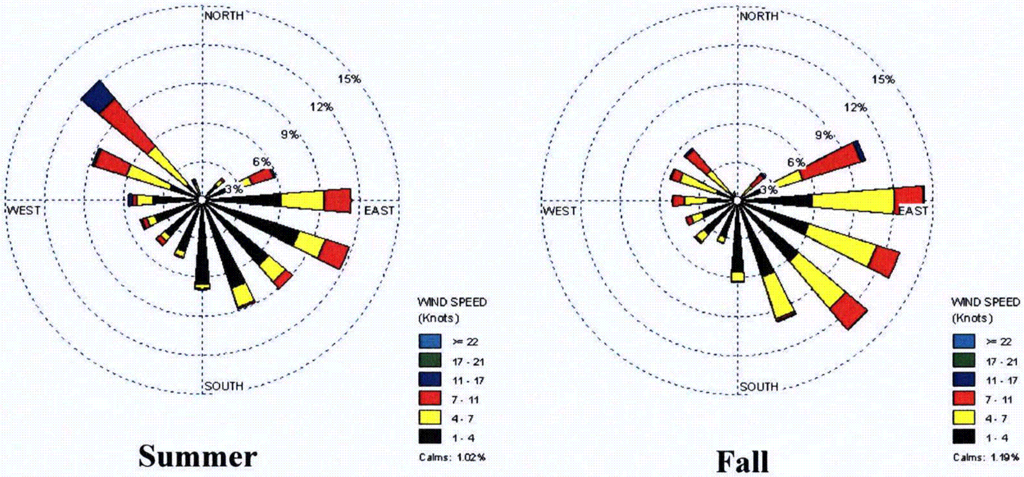
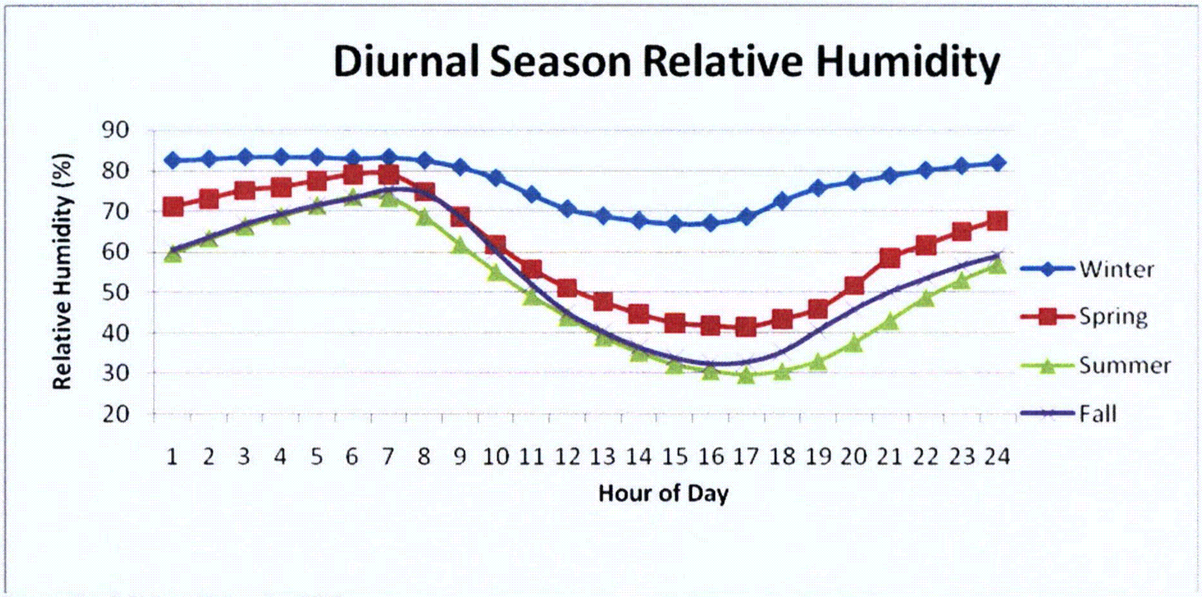


Figure 3.6-24: Summer and Fall Wind Roses

3.6.3.3 Relative Humidity

As mentioned in previous sections, the relative humidity at the site is low. Mean values range from a low of 51 percent in the summer months compared to a high of 77 percent in the winter months. Relative humidity values varied greatly throughout the day, especially in the summer and spring months. On average, during the spring, summer, and fall months, relative humidity reached its maximum from 5:00 am to 7:00 am and then declined steadily until 4:00 pm to 5:00 pm when it began its evening ascent (Figure 3.6-25). During the winter months, the diurnal relative humidity range was much less because of less intense and shorter duration solar radiation.

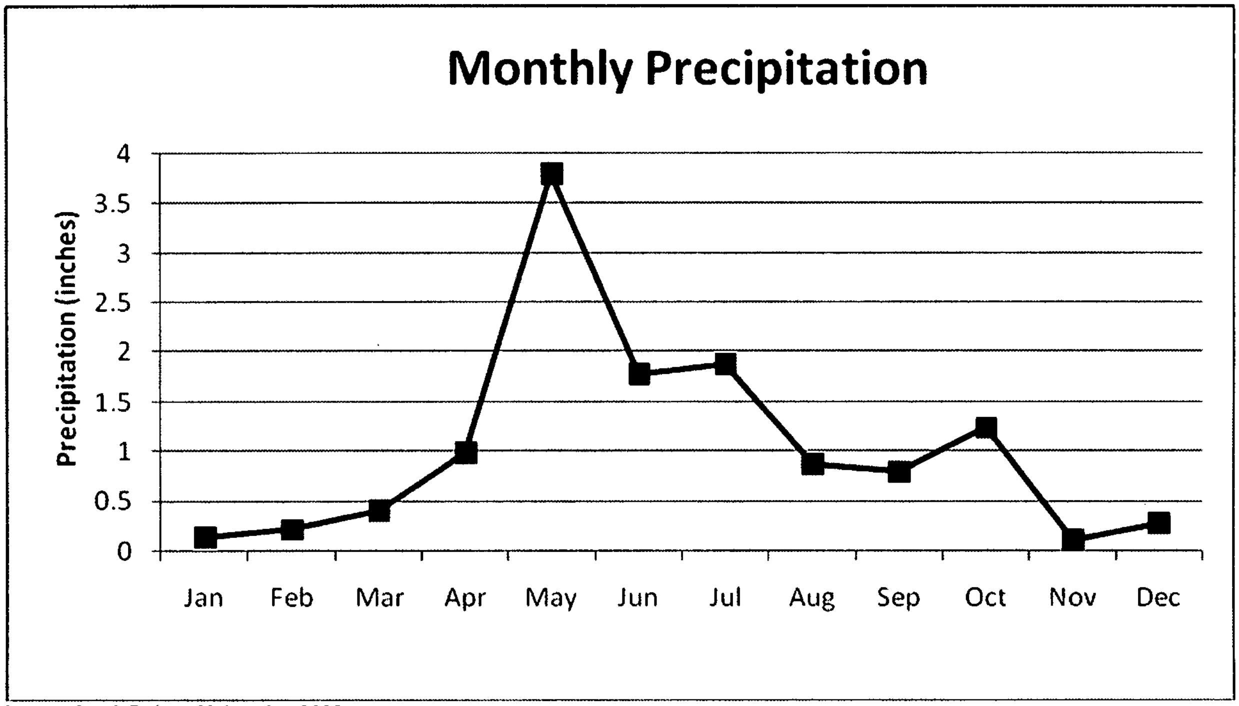


Source: South Dakota University, 2008

Figure 3.6-25: Diurnal Relative Humidity by Season from Project Meteorological Site

3.6.3.4 Precipitation

Data for this site were collected using a Vaisala VRG 101 all-weather precipitation gauge. The region received 12.42 inches of precipitation during the year of monitoring. Figure 3.6-26 displays the precipitation totals by month. The largest monthly precipitation total occurred in May (3.8 inches) and the least occurred in November (0.10 inch). The greatest daily precipitation total (1.29 inches) occurred on May 23, 2008. Also on May 23, 2008, the area received 0.71 inch of precipitation between the hours of 8 p.m. and 9 p.m., which was the most intense event of the sampled year.



Source: South Dakota University, 2008

Figure 3.6-26: Monthly Precipitation from the PAA Meteorological Site

3.6.3.5 Potential Evapotranspiration

The potential ET data were taken from July 18, 2007, to July 14, 2008. The ASCE Standardized Reference Evapotranspiration Equation for a tall reference crop was used to estimate daily ET. The weather parameters needed to estimate ET using this method are daily, maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. Most ET occurs during the months of July, August, and September with an average monthly accumulation of 10.3 inches (Figure 3.6-27) because of the high temperatures and unstable weather. During the winter low, ET occurs because of low temperatures and low solar radiation. The average ET during the winter months is 1.5 inches.

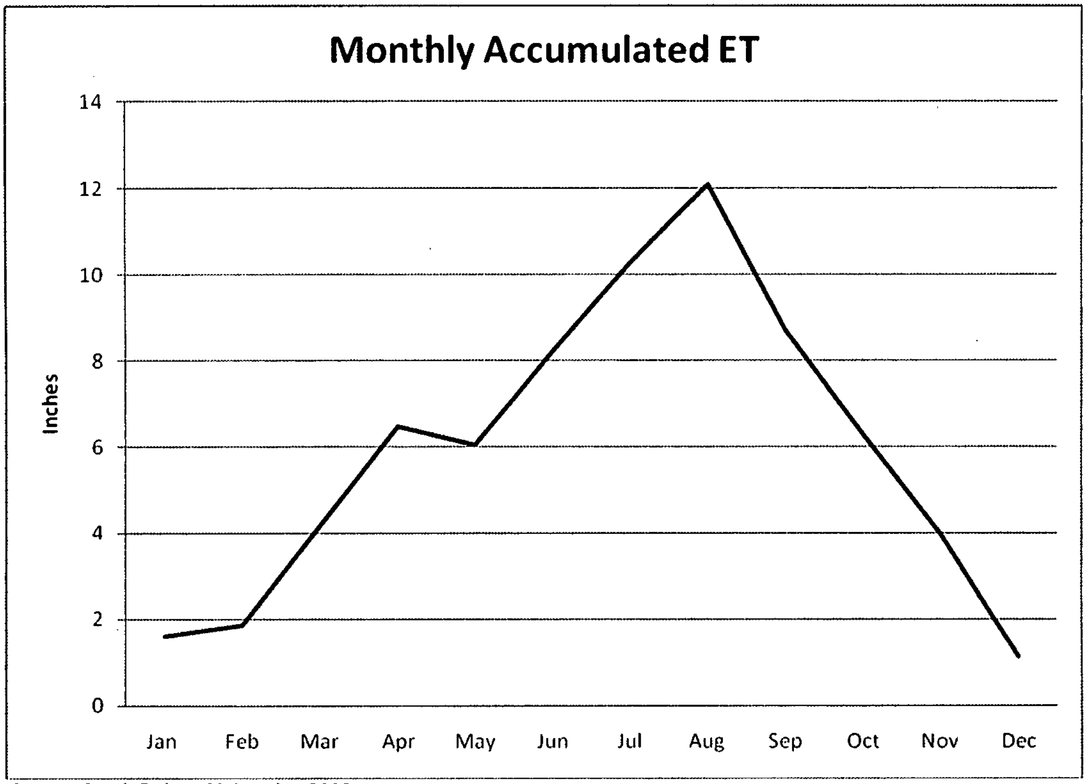


Figure 3.6-27: Estimated Evapotranspiration Calculated Using Weather Data Collected at the PAA Meteorological Site

3.6.4 Air Quality

ISL facilities do not significantly affect air quality. The impacts due to construction are classified as "small" if the gaseous emissions are within regulatory limits, the air quality in the region of influence is in compliance with the National Ambient Air Quality Standards (NAAQS), and the facility is not classified as a major source according to the New Source Review or operating permit programs. Because of the isolated location (13 miles northwest of Edgemont) and the atmospheric conditions of the PAA, the cumulative air quality impacts will be negligible. The generation of dust and gaseous effluents will be limited primarily to construction phases.

The construction phase of ISL projects generally produces non-radiological gaseous emissions including fugitive dust and combustion emissions. Diesel emissions from construction equipment comprise the majority of the combustion emissions and are considered to be small, short-term effects.

Potential air quality impacts during construction activities at the Proposed Action will include pollutants from heavy equipment, vehicle and drill rig exhaust, dust from traffic, and dust from disturbing soil during drilling and ground-clearing activities. Mobile sources of air pollutants will be diesel engines on the drill rigs and diesel water trucks. Most other mobile vehicles will be gasoline powered and equipped with pollution control systems. The greatest amount of dust will be generated from vehicular traffic on the unpaved roads.

3.7 Noise

The primary land use within and in the surrounding 2.0-kilometer radius of the PAA is devoted to rangeland. Other land uses include grazing, crop land, hunting, and wildlife habitat. Traffic from U.S. Highway 18 and State Highway 89 generate the majority of the existing ambient noise in the vicinity of the proposed project.

There are a few residences within the vicinity of the proposed project. As a result of the remote location and low population density of the area surrounding the proposed project site. It is expected that there will not be significant noise impacts (NUREG-1910, 2008).

3.8 Historic and Cultural Resources

3.8.1 Historic, Archeological and Cultural Resources

A Level III Cultural Resources Evaluation was conducted in the PAA. Personnel from the Archaeology Laboratory, Augustana College (Augustana), Sioux Falls, South Dakota, conducted on-the-ground field investigations between April 17 and August 3, 2007.

Augustana documented 161 previously unrecorded archaeological sites and revisited 29 previously recorded sites during the current investigation. Expansion of site boundaries during the 2007 survey resulted in a number of previously recorded sites being combined into a single, larger site. Twenty-eight previously recorded sites were not relocated during the current investigation. Excepting a small foundation, the non relocated sites were previously documented as either prehistoric isolated finds or diffuse prehistoric artifact scatters.

Prehistoric sites account for approximately 87 percent of the total number of sites recorded. Historic sites comprise approximately five percent of total sites recorded, while multi-component sites (prehistoric/historic) comprise the remaining eight percent. Ten of the sites documented have only prehistoric and historic components.

The small number of Euro American sites documented was not unanticipated given the peripheral nature of the PAA in relation to the Black Hills proper. The disparity existing between the number of historic and prehistoric sites observed in the PAA is also not unexpected; however, the sheer volume of sites documented in the area is noteworthy. The land evaluated as part of the Level III cultural resources evaluation has an average site density of approximately one site per 8.1 acres. Even greater site densities were reported in 2000 during the investigation of immediately adjacent land parcels for the Dacotah Cement/BLM land exchange (Winham et al., 2001). This indicates that the permit area is not unique, in regards to the number of documented sites, and is typical of the periphery of the Black Hills.

The high density of sites observed in the PAA, specifically those of prehistoric affiliation, is both consistent with previous findings in the immediate vicinity (Winham et al., 2001) and strongly indicative of the intense degree to which this landscape was being exploited during prehistoric times. Data indicate a slight rise in the number of sites observed from earlier periods into the Middle Plains Archaic, and then a major increase into the Late Plains Archaic/Plains Woodland period before an equally significant drop-off into Late Prehistoric times. In general, this trend is largely consistent with the majority of available paleodemographic data from the region (Rom et al., 1996). Despite the high density of sites within the permit area, there is a lack of evidence indicative of extended or long-term settlement localities in the region. Though the reason behind this phenomenon remains unclear, the bulk of preliminary data from the current investigation appear to mirror this trend.

The landscape comprising the PAA is erosional in nature, leading to many sites being heavily deflated. The extent of the erosion processes is evidenced by the large number of sites recommended by Augustana as not eligible for listing on the National Register of Historic Places because of their location on deflated landforms. This equates to approximately half of the total number of identified sites in the PAA. Notable exceptions to these deflated localities include the valleys and terraces along Beaver and Pass Creeks, as well as many places within and adjacent to, some of the more heavily wooded areas.

Nearly 200 hearths were identified within 24 separate site areas during Augustana's investigation. These features varied considerably from one another in both size and form (and likely function in many cases) and ranged from fully intact to completely eroded. Previous research in the nearby area has demonstrated a similar pervasiveness of such features in the archaeological record [Buechler, 1999; Lippincott, 1983; Reher, 1981; Sundstrom, 1999; Winham et al., 2001], and specifically in relation to Plains Archaic-period site assemblages [Rom et al., 1996].

Radiocarbon data obtained from a number of these hearths produced dates ranging from approximately 3,150–1,175 before present (B.P.) (UGa-4080 and UGa-4081), with the majority of these samples dating to Middle and Late Plains Archaic times (Reher, 1981).

Protection by way of avoidance of archaeological sites was maintained during the exploration phase of the Proposed Action, and site avoidance is the continued goal during development and production. Where required, sites in the area of activity will be flagged and/or fenced and personnel will be made aware of their presence. In the event that a new site is discovered, the site will be protected and the state archaeologist will be notified. These commitments are documented in an executed Memorandum of Agreement with the SD State Archaeologist.

3.9 Visual and Scenic Resources

Visual and scenic resources consist of the visible natural (e.g., landforms and vegetation) and cultural components (e.g., roads and buildings) of the environment. Important visual resources can be landscapes that have unusual or intrinsic value, or areas with human or cultural influences that are valued for their visual or scenic setting. The BLM Visual Resource Management (VRM) is an attempt to assess and classify landscapes in order to properly manage their visual and scenic resources (BLM, 1984).

3.9.1 Visual Resource Management Classes

In order to determine the VRM class of the landscape within the PAA and the surrounding 2.0-mile area were rated in accordance with the U.S. BLM Manual 8400 – Visual Resource Management. The visual resource inventory classes are used to develop visual resource management classes. The following VRM classes are objectives that quantify the acceptable levels of disturbance for each class.

- Class I Objectives – 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 Objectives – To retain the existing character of the landscape. This level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract 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 Objectives – 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.com

- Class IV Objectives – To provide management activities which 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's attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

According to the scenic quality inventory conducted in June 2008, which rated scenic quality, sensitivity level, and distance zones, the area was classified a VRM Class IV. The objective of this class is to provide management for activities that might require major modifications of the existing character of the landscape. The level of change permitted for this class can be high. Table 3.9-1, provided by the BLM, was used to determine the visual resource inventory class.

Table 3.9-1: BLM Visual Resource Inventory Classes

		Visual Sensitivity Levels						
		High			**Medium**			**Low**
Special Area		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III* / IV*	III	IV	IV	IV
	C		IV	IV	IV	IV	IV	IV
		f/m	b	s/s	f/m	b	s/s	s/s
		Distance Zones						

* If adjacent area is Class III or lower, assign Class III, if higher assign Class IV
f/m = foreground –middleground
b = background
ss – seldom seen

3.9.2 Project Visual Resource Management Rating

In order to determine the scenic quality rating of the PAA and the surrounding 2.0-mile area, a visual resource inventory was conducted in accordance with the BLM Handbook H-8410-1, Visual Resource Inventory (BLM, 1986). A visual resource inventory was conducted for each Scenic Quality Rating Units (SQRU) – areas that demonstrated similar physiographic characteristics – in the area.

Scenic Quality – Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are given an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. These key factors are rated according to form, line, color, texture, scale and space on a comparative scale from zero to five taking into consideration similar features within the same physiographic province. The results of the inventory and the associated rating for each key factor are summarized in Table 3.9-2 and Table 3.9-3.

Sensitivity Level – Sensitivity levels are a measure of the publics concern for scenic quality. Public lands are assigned high, medium, or low sensitivity levels by considering the following factors: type of users, amount of use, public interest, adjacent land use, and special areas.

Distance Zones – Distance zones categorize areas according to their visibility from travel routes or observation points. The three categories are foreground-middleground, background and seldom seen.

- Foreground-Middleground Zone – The area that can be seen from each travel route from a distance of 3 to 5 miles where management activities might be viewed in detail. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.
- Background – The area that can be seen from each travel route up to a distance of 15 miles and that extend beyond the foreground-middleground zone.
- Seldom Seen – The areas that are not visible within the foreground-middleground and background zones or areas beyond the background zones.

Table 3.9-2: Scenic Quality Inventory and Evaluation of the SQRU 001 for the PAA

Key Factor	Rating Criteria	Score
Landform	Flat to rolling plains with weathered plateaus in the background	3
Vegetation	Vegetation is dominated by several variety of grasses and shrubs with some wildflowers and cottonwood trees	3
Water	Water is present but not visible from the road and view points	0
Color	Soil is light brown to brown and vegetation is tan to light green and dark green	3
Adjacent Scenery	The area borders the forested Black Hills uplift	1
Scarcity	Landscape is common for the region	1
Cultural modifications	Existing modifications consist of a dirt road and railway and grazing activities	0
	Total Score	11

Table 3.9-3: Scenic Quality Inventory and Evaluation of the SQRU 002 for the PAA

Key Factor	Rating Criteria	Score
Landform	Flat to rolling plains with hills covered by evergreen forests	3
Vegetation	Vegetation is dominated by several variety of grasses and shrubs with some wildflowers and cottonwood trees and evergreen forest	3
Water	Water is present but not visible from the road and view points	0
Color	Soil is light brown to brown and vegetation is tan to light green and dark green	3
Adjacent Scenery	The area borders the forested Black Hills uplift	1
Scarcity	Landscape of the Black Hills Uplift is uncommon with the physiographic province of the Great Plains	3
Cultural modifications	Existing modifications consist of a dirt road and railway and grazing activities	0
	Total Score	13

According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no special management is required (NRC, 2003). Based on the visual resource inventory conducted in June

2008, the total score of the two Scenic Quality Rating Units within the Proposed License Area were 11 and 13; therefore, no further evaluation of the existing scenic resources or future changes to the scenic resources of the area due to the proposed project will be required.

3.10 Socioeconomics

The study area for the Proposed Action socioeconomic baseline study includes population centers within an 80-km radius of the Proposed Action's geographic center (latitude 43° 28' 50.071" N, longitude 103° 59' 34.559" W), considered to represent the likely maximum commuting distance for regular employees of the Proposed Action (taking into account that actual road miles traveled from communities within the defined radius to the Proposed Action may be in excess of the "direct line" distance).

A project's direct zone of social influence may be defined as the area within which the Proposed Action's socioeconomic impacts and benefits are reasonably anticipated to be concentrated, including the population areas most likely to contribute to the Proposed Action's local workforce and to provide ongoing sources of supplies and commodities during construction and operations. The direct social zone of influence adopted for the Proposed Action socioeconomic baseline report primarily includes the townships, towns, and unincorporated areas within the two South Dakota counties hosting the deposits, Custer and Fall River. Approximately 1.5 miles (2.4 km) of the Proposed Action's western border follows the Wyoming / South Dakota state line south of Dewey, South Dakota. Therefore, the Wyoming locations of Newcastle and Osage[1] in Weston County are also included in the Proposed Action's direct social zone of influence. These locations are within a 50-mile (80-km) radius of the PAA's approximate center, and are thus close enough to reasonably supply workers or supplies to the Proposed Action on a regular basis. No areas of appreciable population size were located within the same radius from the Proposed Action in other Wyoming counties or to the south in Nebraska.

Within the direct social zone of influence, this baseline study report focuses on the Custer and Fall River counties as being the host counties for the Proposed Action and thus the most likely to benefit directly from project implementation, including receipt of tax revenues. Towns within these two counties include:

- Custer County:

[1] Osage is not an incorporated town but is defined as a "CDP" or census-designated place by the USCB in partnership with State agencies. CDPs are areas of significant population outside of any incorporated municipality and that are locally identified by a name.

- Buffalo Gap, Custer City, Fairburn, Hermosa, and Pringle

- Fall River County:
  - Edgemont, Hot Springs, and Oelrichs

Rapid City, South Dakota, the closest urban area to the Proposed Action, is approximately 100 miles (161 km) via road northeast of the PAA, in Pennington County, and may serve as a regional logistics hub and source of workers and supplies for the Proposed Action as well. Because of its greater distance from the Proposed Action, Rapid City is considered to be part of the Proposed Action's indirect social zone of influence. Two other towns in Pennington County also fall within the Proposed Action's indirect social zone of influence, Hill City and Keystone.

3.10.1 Population

The majority of population and demographic information contained in this baseline report was obtained from Census 2000 data and from the 2006 ACS, the most recent Federal demographic survey. Other sources of demographic information include the U.S. Department of Commerce's Bureau of Economic Analysis (BEA), South Dakota Governor's Office of Economic Development (SD GOED), the University of South Dakota's Business Research Bureau, and county and city websites.

NUREG-1569 obliges consideration of population data within a 50-mile (80-km) radius from the Proposed Action's approximate center during preparation of the Technical Report for the Proposed Action, as shown in Figure 3.10-1.

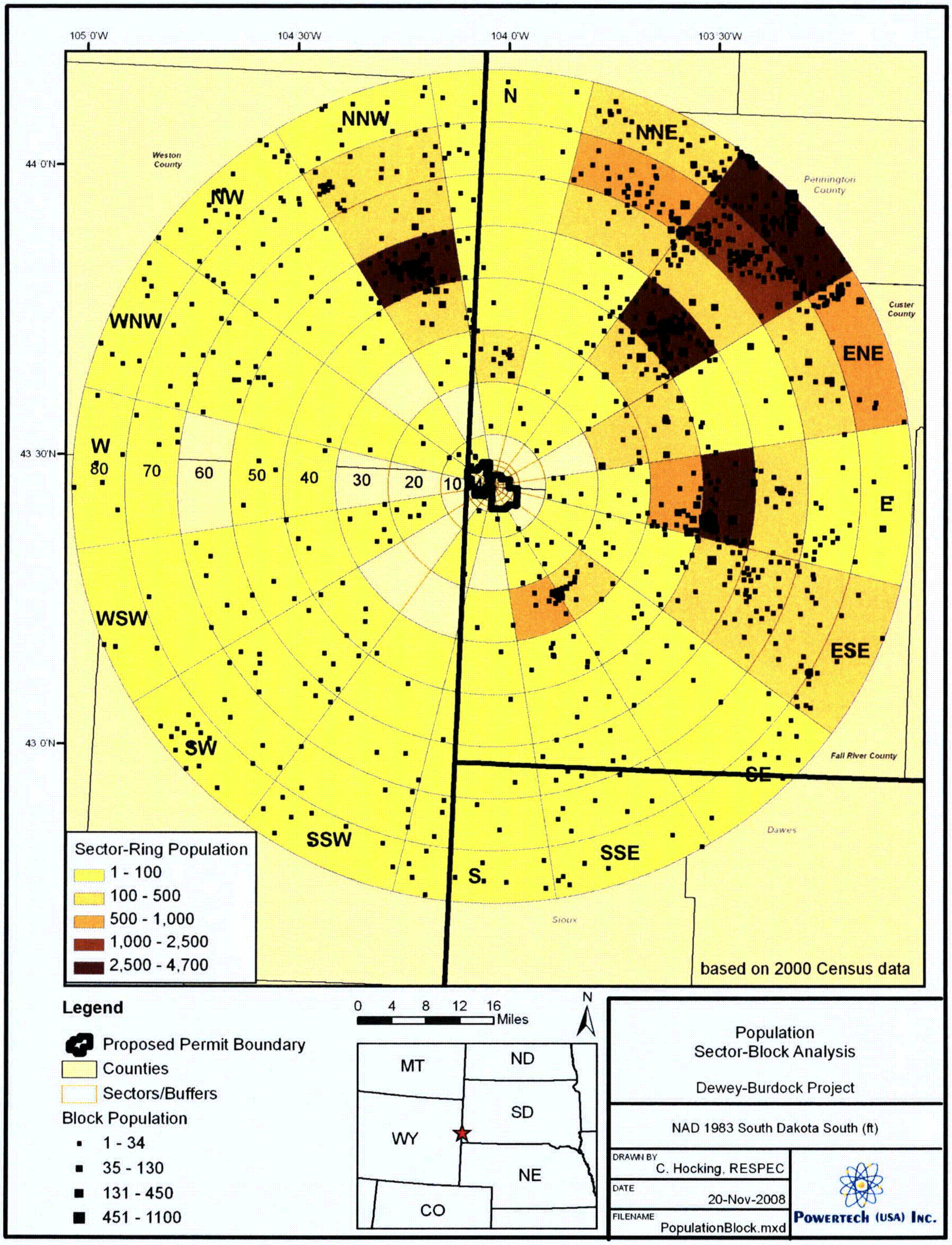


Figure 3.10-1: Population Sector Block Analysis

In general, detailed information on population distribution and demographics is only provided for the towns within the Proposed Action's direct social zone of influence, as defined in the preceding section, with emphasis on the two South Dakota counties in which the Proposed Action is located, Custer and Fall River. For some datasets (such as population), estimations based on data trends are cited to provide more updated information; these estimations are acknowledged as projections rather than defined data where used. Population by sector and cumulative population by sector based on Figure 3.10-1 are presented in Table 3.10-1.

Table 3.10-1: Population within a Given Distance from Project Center

	Distance from Project Center, km							
Sector	**0 - 10**	**10 - 20**	**20 - 30**	**30 - 40**	**40 - 50**	**50 - 60**	**60 - 70**	**70 - 80**
N	0	26	165	54	25	25	39	58
N, cumulative	*0*	*26*	*191*	*245*	*270*	*295*	*334*	*392*
NNE	0	12	8	59	64	229	780	386
NNE, cumulative	*0*	*12*	*20*	*79*	*143*	*372*	*1,152*	*1,538*
NE	0	10	15	494	3,852	391	1,825	3,427
NE, cumulative	*0*	*10*	*25*	*519*	*4,371*	*4,762*	*6,587*	*10,014*
ENE	0	0	154	282	21	73	268	539
ENE, cumulative	*0*	*0*	*154*	*436*	*457*	*530*	*798*	*1,337*
E	0	24	47	501	4,651	278	70	95
E, cumulative	*0*	*24*	*71*	*572*	*5,223*	*5,501*	*5,571*	*5,666*
ESE	0	21	26	76	329	183	143	136
ESE, cumulative	*0*	*21*	*47*	*123*	*452*	*635*	*778*	*914*
SE	0	12	342	18	32	12	13	34
SE, cumulative	*0*	*12*	*354*	*372*	*404*	*416*	*429*	*463*
SSE	2	18	649	52	7	30	20	30
SSE, cumulative	*2*	*20*	*669*	*721*	*728*	*758*	*778*	*808*
S	11	1	7	6	18	2	17	44
S, cumulative	*11*	*12*	*19*	*25*	*43*	*45*	*62*	*106*
SSW	3	7	0	2	2	25	21	48
SSW, cumulative	*3*	*10*	*10*	*12*	*14*	*39*	*60*	*108*
SW	0	0	0	29	18	21	23	61
SW, cumulative	*0*	*0*	*0*	*29*	*47*	*68*	*91*	*152*
WSW	6	19	14	15	4	28	8	9
WSW, cumulative	*6*	*25*	*39*	*54*	*58*	*86*	*94*	*103*
W	0	0	0	2	10	0	22	18
W, cumulative	*0*	*0*	*0*	*2*	*12*	*12*	*34*	*52*
WNW	8	6	2	2	18	57	58	33
WNW, cumulative	*8*	*14*	*16*	*18*	*36*	*93*	*151*	*184*
NW	6	2	0	10	22	30	50	72
NW, cumulative	*6*	*8*	*8*	*18*	*40*	*70*	*120*	*192*
NNW	2	0	35	234	4,129	121	316	77
NNW, cumulative	*2*	*2*	*37*	*271*	*4,400*	*4,521*	*4,837*	*4,914*
Ring Population, all Sectors	**38**	**158**	**1,464**	**1,836**	**13,202**	**1,505**	**3,673**	**5,067**

Data from: US Census Bureau, 2006 American Community Survey population estimates.

The distance to the nearest resident within each sector was calculated from querying the geographic data in Figure 3.10-1 and is presented in Table 3.10-2.

Table 3.10-2: Distance to Nearest Residents

Sector	Number of Residents	Distance from Project Center	
		Miles	Km
N	38	7.2	11.6
NNE	112	8.3	13.3
NE	423	6.7	10.8
ENE	154	13.1	21.1
E	24	6.8	11.0
ESE	110	10.7	17.3
SE	69	7.5	12.1
SSE	88	5.9	9.4
S	23	0.9	1.4
SSW	23	3.4	5.5
SW	39	21.0	33.7
WSW	27	1.7	2.7
W	14	20.3	32.6
WNW	39	6.2	10.0
NW	49	3.5	5.6
NNW	250	4.2	6.7

Data from US Census Bureau, 2000 Census.

3.10.2 Demography

Demographic data for Custer and Fall River county populations collected for this baseline study includes information regarding population breakdown by sex, age, race, and household size, and is summarized and compared to similar data for the State of South Dakota in Table 3.10-3. Demographic data was collected from the Census 2000 statistical pool at both the county and state levels to provide a descriptive picture of the populations within the immediate PAA in comparison to that of the State of South Dakota as a whole.

Review of the tabulated data indicates that the populations of Custer and Fall River counties are older than the state average, with older median ages, lower percentages of households with children, and higher percentages of households with persons 65 years of age or older. Additionally, family and household sizes for both counties were slightly smaller than the State averages.

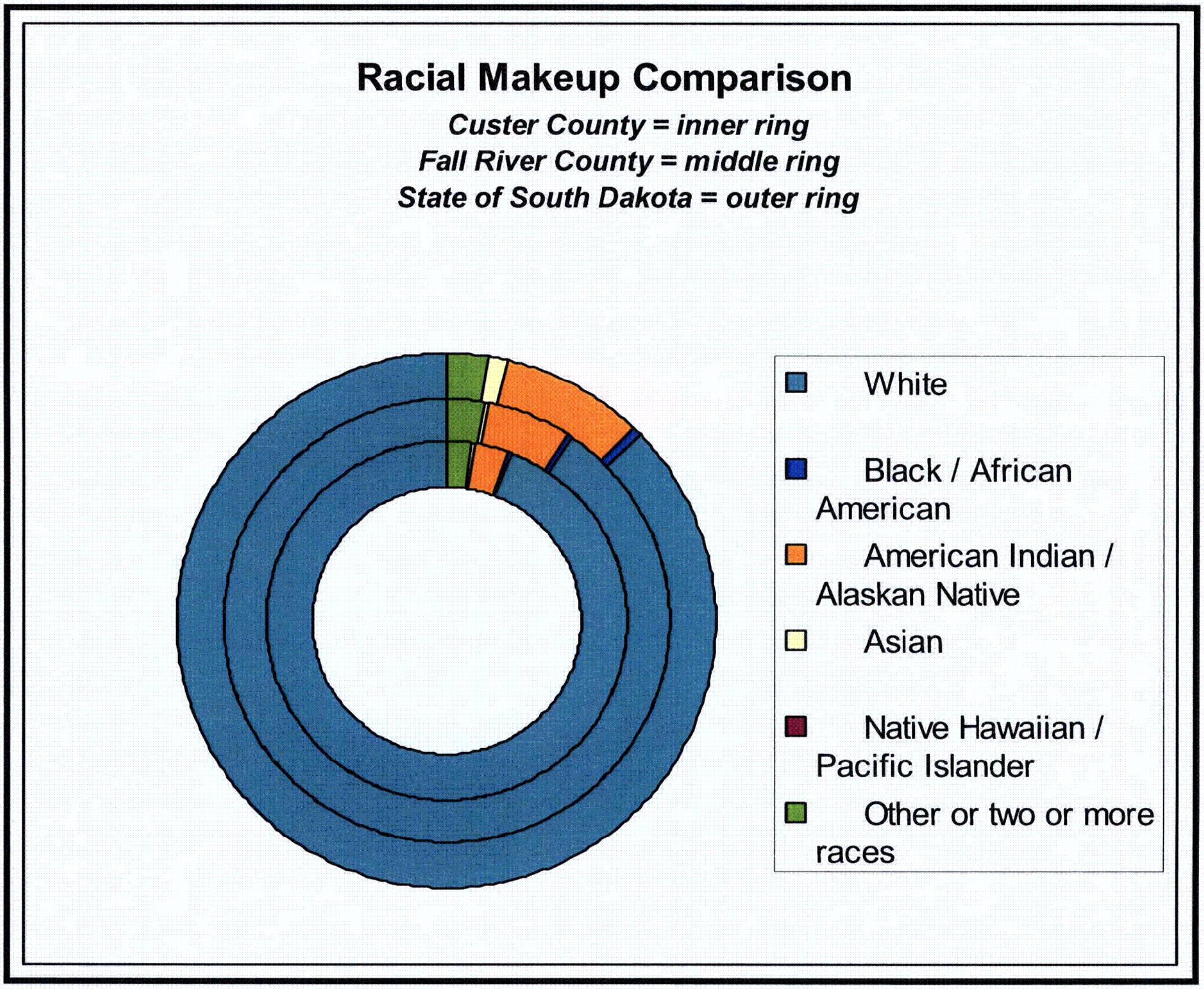
Table 3.10-3: PAA Demographic Data, South Dakota

Data Type	Custer County	Fall River County	South Dakota
Male / female ratio, %	51.1 / 48.9	52.3 / 47.7	49.6 / 50.4
Median age, years	43.2	45.5	35.6
Average household size, people	2.35	2.23	2.50
Average family size, people	2.80	2.82	3.07
Households with individuals under 18 years, %	29.1	25.9	34.8
Households with individuals 65 years and over, %	27.4	33.4	25.0
Female householder with no husband present, %	6.6	8.5	9.0
Above, with own children under 18 years, %	4.0	5.2	6.1
Race, %			
White	94.2	90.5	87.2
Black / African American	0.3	0.3	0.7
American Indian / Alaskan Native	3.1	6.1	8.6
Asian	0.2	0.2	0.9
Native Hawaiian / Pacific Islander	0.0	0.1	0.0
Other or two or more races	2.2	2.8	2.6
Hispanic / Latino (of any race)	1.5	1.7	2.0

Data from Census 2000, US Census Bureau

Female-headed households with no husband present accounted for 6.6 percent and 8.5 percent of the total households during the 2000 Census for Custer and Fall River counties, respectively, somewhat lower than the State average of 9 percent. In both counties, 61 percent of these households included children under the age of 18 years, lower than the State average of 68 percent of female-headed households.

Racial data for the two counties show that the local population is predominantly white, with American Indian / Alaskan Native the predominant minority group. At 6.1 percent, the percentage of American Indians in Fall River County is roughly twice that of Custer County, but still below the State average of 8.6 percent. A graphic depiction of the area's racial makeup is shown on Figure 3.10-2, again compared to the State average.



Data from US Census Bureau, Census 2000.

Figure 3.10-2: Racial Makeup Comparison

For comparative purposes, similar data was tabulated for the two Wyoming counties bordering the Proposed Action, Niobrara and Weston, as shown below (Table 3.10-4), again compared against the State-wide data, this time for Wyoming. As with the South Dakota counties hosting the Proposed Action, the populations of Niobrara and Weston counties are older than the State average, with smaller household and family sizes, lower proportions of children in the home, and higher percentage of senior citizens. The percentage of female-headed households was also similar to the PAA counties, and lower than the State-wide average. Both Wyoming counties also have lower percentages of Native American populations than the State average, and substantially lower than either Custer or Fall River counties.

Table 3.10-4: PAA Demographic Data, Wyoming

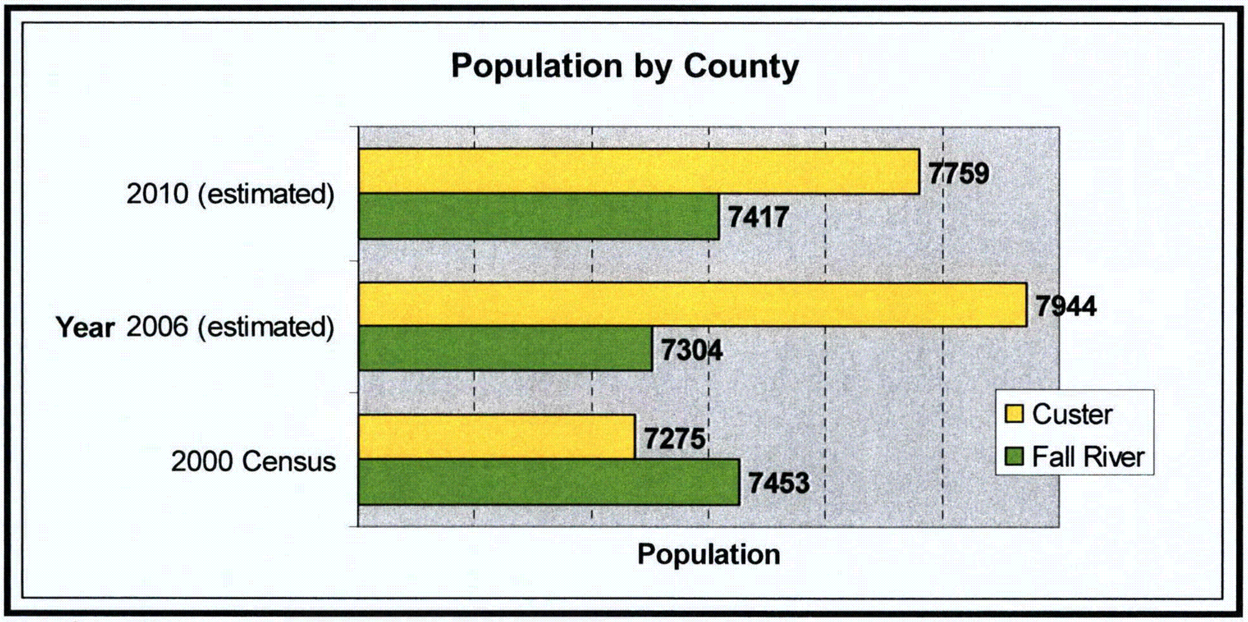
Data Type	Niobrara County	Weston County	Wyoming
Male / female ratio, %	48.8 / 49.1	50.8 / 49.2	50.3 / 49.7
Median age, years	42.8	40.7	36.2
Average household size, people	2.28	2.42	2.48
Average family size, people	2.81	2.88	3.00
Households with individuals under 18 years, %	28.7	33.0	35.0
Households with individuals 65 years and over, %	33.1	26.9	20.8
Female householder with no husband present, %	6.0	7.3	8.7
Above, with own children under 18 years, %	4.2	4.6	6.0
Race, %			
White	98.0	95.9	92.1
Black / African American	0.1	0.1	0.8
American Indian / Alaskan Native	0.5	1.3	2.3
Asian	0.1	0.2	0.6
Native Hawaiian / Pacific Islander	0.0	0.0	0.1
Other or two or more races	1.2	2.4	4.3
Hispanic / Latino (of any race)	1.5	2.1	6.4

Data from US Census Bureau, Census 2000.

3.10.2.1 Population Projections

The most recent verifiable population data for Fall River and Custer counties comes from the last Federal census, in 2000. Estimations of population changes for South Dakota counties were calculated by the United States Census Bureau (USCB) for 2006 and by the SD GOED (based on the USCB's projections) for 2010. As Figure 3.10-3 shows, Fall River is projected to have lost almost 2 percent of its population between 2000 and 2006, in comparison to a 9 percent gain in population in Custer County over the same time period.

Projections for the 2010 county populations show a 1.5 percent gain for Fall River County and a slight decrease of 2.3 percent for Custer County, both over the 2006 estimates.



Data from US Census Bureau.

Figure 3.10-3: Population by County

A breakdown of population per town within each county is shown in Table 3.10-5, based again on Census 2000 data and 2006 USCB population projections. Custer City and Hot Springs, the county seats of Custer and Fall River counties, respectively, are also the largest towns in each county.

Table 3.10-5: Population Change, Custer and Fall River Counties, 2000 – 2006

County / Town	Population	
	2000 Census	2006 (estimate)
Custer		
Buffalo Gap	164	161
Custer City	1860	1984
Fairburn	80	78
Hermosa	315	354
Pringle	125	118
Fall River		
Edgemont	867	810
Hot Springs	4129	4102
Oelrichs	145	143

Data provided by US Census Bureau, 2000 and 2006

General population trends within both counties are shown in Figure 3.10-4 and indicate that while Custer County overall is projected to gain in population, the three smallest towns in the county (Fairburn, Pringle, and Buffalo Gap) were estimated to lose between -1.8 percent (at Buffalo Gap) to -5.6 percent (at Pringle) of their populations between 2000 and 2006.

The two larger towns, Hermosa and Custer City, both were projected to gain in population over the same time period, with Hermosa's rate of increase nearly twice as high as that of Custer City. In keeping with the general county population trend, all three towns in Fall River County show estimated population decreases from 2000 to 2006, with the highest percent decrease in Edgemont (the closest town to PAA), at -6.6 percent.

Rapid City, the largest urban area nearest to the Proposed Action, had a 2000 population of 59,607, projected to increase by 5.2 percent to 62,715 by 2006.

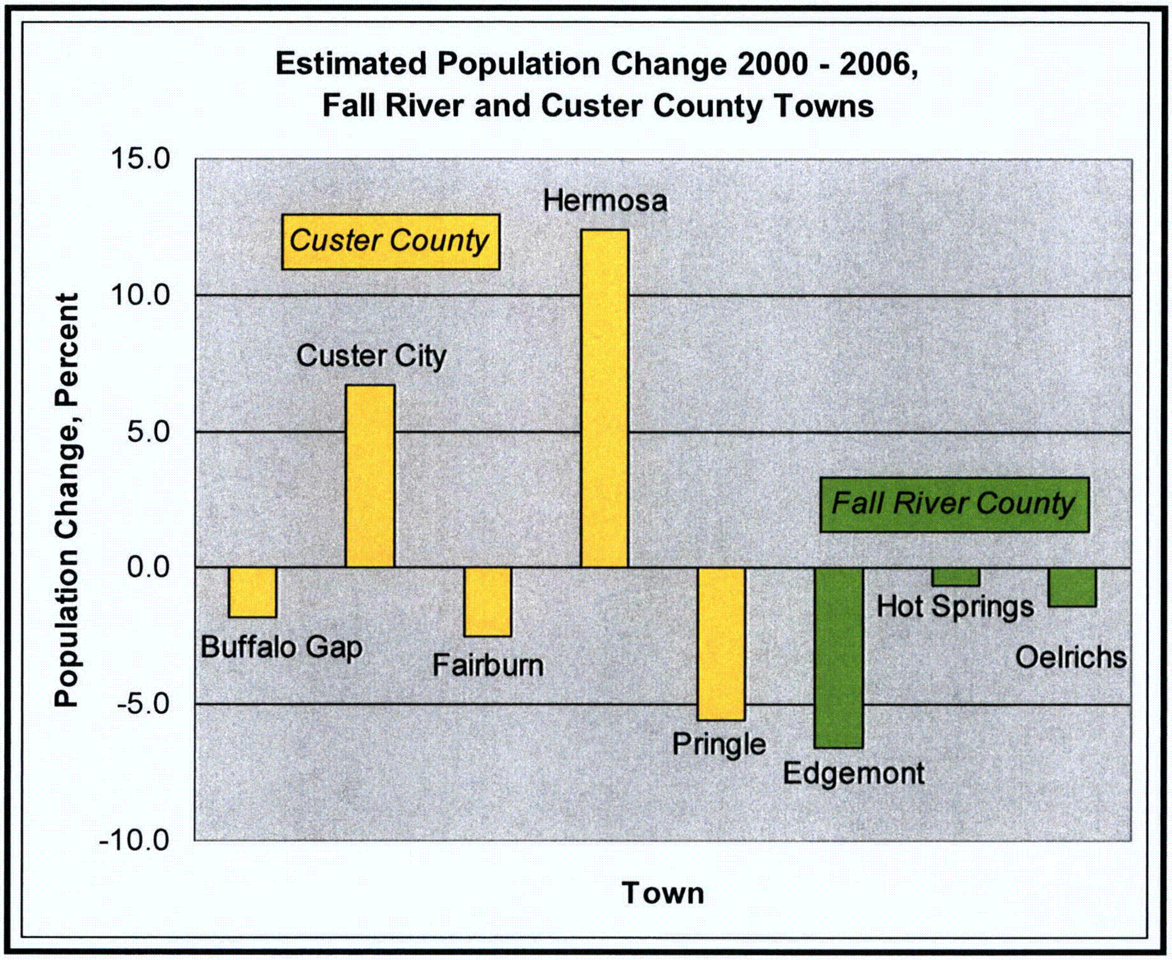


Figure 3.10-4: Estimated Population Change 2000 – 2006, Fall River and Custer Counties

Estimated 2006 population densities for both Custer and Fall River counties were quite low, at approximately four to five people per square mile (two people/ km^2). In comparison, the state average population density estimate for 2006 was approximately 10 people per square mile (four people/km^2).

Population data for some other areas of interest to the Proposed Action are shown in Table 3.10-6, and include population statistics for two towns in Pennington County (which includes Rapid City) – Hill City and Keystone, and two locations in Weston County, Wyoming – Newcastle and Osage, all considered close enough to the Proposed Action to be within in its direct social zone of influence.

Table 3.10-6: Population Data for Other Areas of Interest, 2000-2006

County, State / Town	Population		
	2000 Census	**2006 (estimate)**	***% Change***
Pennington Co, SD			
Hill City	**780**	**871**	+ ***11.7***
Keystone	**311**	**315**	+ ***1.3***
Weston Co, WY			
Newcastle	**3065**	**3272**	+ ***6.8***
Osage	**215**	**n/a**	***n/a***

Data provided by US Census Bureau, 2000 and 2006; "n/a" = inter-census data not available.

3.10.2.2 Schools

Public schools (kindergarten through 12th grade) in South Dakota are generally organized at the county or sub-county level by school district. The five public school districts in the PAA and their attendant schools and age levels are:

- **Custer School District:**
  - Custer Elementary, Pre-Kindergarten (PK) - 5th
  - Custer Middle, 6th – 8th
  - Custer High, 9th – 12th
  - Hermosa Elementary, PK – 8th
  - Fairburn Elementary, Kindergarten (K) – 8th
  - Spring Creek Elementary, K – 8th
- **Elk Mountain School District:**
  - Elk Mountain Elementary, K – 6th
- **Hot Springs School District:**
  - Hot Springs Elementary, PK - 5th
  - Hot Springs Middle, 6th - 8th
  - Hot Springs High, 9th – 12th

- **Edgemont School District:**
  - Edgemont Elementary, K – 6th
  - Edgemont Junior High, 7th – 8th
  - Edgemont High, 9th – 12th
- **Oelrichs School District:**
  - Oelrichs Elementary, K – 6th
  - Oelrichs Junior High, 7th – 8th
  - Oelrichs High, 9th – 12th

There are no private or charter primary or secondary schools in Custer County. Bethesda Lutheran School in Hot Springs is the only private school in Fall River County, and serves grades PK – 5th.

Primary and secondary school attendance rates in Custer and Fall River counties were higher than the State-wide rates from kindergarten onward and typically higher in Fall River than in Custer County. However, the percentage of the population of either county attending college or graduate school in 2000 was less than half the State attendance rate (Table 3.10-7).

Table 3.10-7: Primary and Secondary School Attendance Rates, 2000 & 2006

School Category	Percent of Population ≥ 3 Years Old Attending School		
	Custer County (1)	Fall River County (1)	South Dakota (1), (2)
Nursery, pre-kindergarten, and pre-school	4.0	5.92	6.1, 6.7
Kindergarten	4.8	6.1	5.4, 4.9
Elementary (grades 1st – 8th)	42.7	51.8	44.6, 41.9
High (grades 9th – 12th)	37.7	27.4	23.4, 21.5
College or graduate school	10.7	8.8	20.6, 25.0

Data from US Census Bureau: (1) Census 2000; (2) 2006 American Community Survey estimates.

The closest post-secondary schools to the Proposed Action are in Rapid City, approximately 100 miles via northeast via road, and include the Western Dakota Technical Institute (WDTI), South Dakota School of Mines and Technology (SDSMT), and the Rapid City Campus of the National American University (NAU).

The WDTI is one of four State-run technical institutes in South Dakota, and offers 25 career programs leading to the Associate of Applied Science degree, as well as many non-credit classes, workshops, short-term training programs, and online courses. Approximately 850 full-time students are currently enrolled at WDTI, with over 4,000 students participating in full-, part-time, or non-credit courses annually.

The SDSMT is one of the six state public universities governed by the South Dakota Board of Regents, and offers undergraduate (Associate of Arts, Bachelor of Science) and graduate degrees (Master and Doctor of Science) in various science and engineering fields. Current enrollment is 1,572 full-time and 498 part-time students.

The Rapid City campus is one of NAU's 20 campuses in six states, including an on-line campus also based in Rapid City. NAU is a private institute of higher learning, offering regionally accredited and degree programs in a variety of fields, both at its campuses and on-line. Current enrollment at NAU's Rapid City campus is 1,005, including 646 full-time and 359 part-time students.

3.10.3 Local Socioeconomic Baseline Conditions

3.10.3.1 Major Economic Sectors

The South Dakota Department of Labor (SD DOL) defines "labor force" as all civilians not in institutions, 16 years of age and older, and who are employed or unemployed and actively seeking employment. SD DOL develops its labor force estimates in cooperation with the US Bureau of Labor Statistics. "Labor supply" is defined by the SD DOL as the number of persons who would be available to staff a new or expanding business in the area of interest, and includes people who are currently employed but are seeking to change jobs and people who are unemployed but actively seeking jobs, and also considers workers who would commute into the area to work. Labor supply statistics are developed solely by SD DOL.

The percentage of the total county populations represented by their labor forces is roughly the same for Custer and Fall River counties, but lower than the State-wide rate, potentially due to the older populations in the area, as noted in Section 3.10.2. Annual unemployment rates in both counties were higher than the State-wide rate of 3.1 percent, with unemployment higher in Fall River County (Table 3.10-8).

Table 3.10-8: PAA Labor Statistics, December 2007

	Custer County	Fall River County	South Dakota*
Labor force, persons	3,955	3,680	440,085
Labor force, % of total population	49.8	50.4	56.3
Employed, persons	3,810	3,520	426,815
Unemployed, persons	145	160	13,270
Unemployment rate, annual %	3.2%	3.6%	3.1%
Labor supply, persons	470	535	67,570
Labor supply, % of labor force	11.9	14.5	15.4

Data from Labor Market Information Center, South Dakota Department of Labor
*State-wide data is seasonally adjusted

The majority of workers between the ages of 25 to 64 in both counties have only 12 years of formal education (high-school level), as shown in Table 3.10-9.

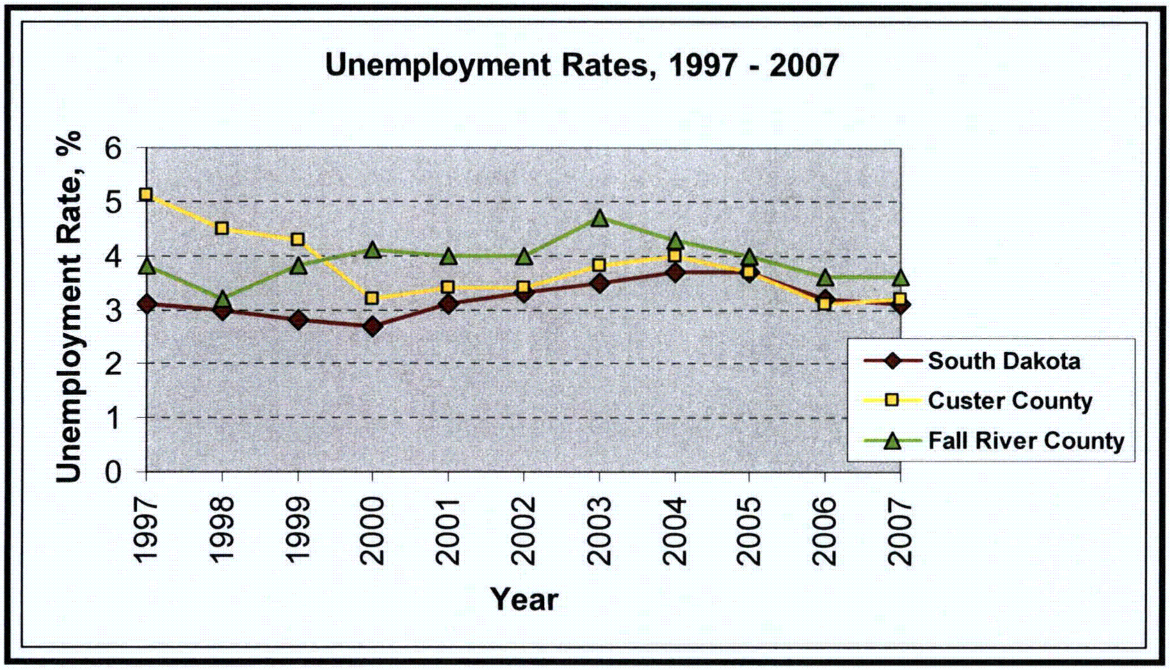
Table 3.10-9: Labor Force Educational Attainment (25 to 64 Years of Age), 2000

	Custer County, %	Fall River County, %	South Dakota
Less than 12 years of school	6.3	12.1	15.5
High school (12 years of school)	31.1	35.0	32.9
Some college (no degree)	27.1	28.6	23.0
Associate degree	7.5	3.8	7.1
Bachelor's degree	20.3	13.1	15.5
Graduate degree	7.7	7.4	6.0

Data from South Dakota Governor's Office of Economic Development and the US Census Bureau, 2000

3.10.3.2 Unemployment Trends

Unemployment trends for Custer and Fall River counties and South Dakota's state-wide rate over the last decade are shown in Figure 3.10-5, which plots the average unemployment rate for each year determined from monthly county and state data from the SD DOL's Labor Market Information Center.



Note: Data from South Dakota Department of Labor, Labor Market Information Center

Figure 3.10-5: Unemployment Rates, 1997 - 2007

As the chart shows, the disparity between county and State unemployment rates has been decreasing, so that since 2005 Custer and Fall River county unemployment rates are closely matched to that of the State. This trend adjustment has been most pronounced for Custer County, which had an unemployment rate of nearly twice the State average in 1997, but which now is within 4 percent of the State average. Fall River County's 2007 average unemployment rate was approximately 16 percent higher than the State-wide rate of 3.1 percent.

3.10.3.3 Employment

Employment data from 2006 for major sectors of employment including private sector enterprises and local, state, and federal government for Custer and Fall River counties are shown in Table 3.10-10 and illustrated in Figure 3.10-6. "Covered workers" are defined by the SD DOL as workers at firms for whom unemployment insurance is provided. Workers excluded from the "covered" category include the self-employed, unpaid family workers, elected government officials, railroad employees, election officials, work-study students, some religious and non-profit organization employees, smaller business employees, and part-time or seasonal workers. According to correspondence (email, 7 March 2008) with Ron Meier, Senior Economic Analyst with the SD DOL's Labor Market Information Center, covered worker data will be updated to reflect the 2007 annual statistics in late June / early July 2008.

Table 3.10-10: PAA Covered Worker Employment by Sector, 2006

Employment Sector	Custer County, % employed (1)	Fall River County, % employed (1)	South Dakota, % employed (2)
Construction	6.59	4.62	5.69
Education / Health Services	9.62	10.36	13.6
Financial Activities / Insurance	3.31	2.75	7.61
Information	NR	1.43	1.81
Leisure / Hospitality	25.15	16.26	11.06
Manufacturing	1.52	0.96	10.78
Natural Resources / Mining	2.44	1.79	1.07
Other Services	1.12	1.71	2.69
Professional / Scientific / Technical Services	1.64	4.07	6.66
Trade / Transportation / Utilities	14.89	14.55	20.66
% Total, Private Ownership (3)	***66.28***	***58.50***	***82.00***
Local government	11.30	15.34	11.47
State government	11.26	5.74	3.63
Federal government	8.22	20.49	2.90
% Total, Government (3)	***30.78***	***41.57***	***18.00***
Total Covered Workers:	**2505**	**2509**	**383,856**

Data from South Dakota Governor's Office of Economic Development and South Dakota Department of Labor, Labor Market Information Center, 2006.
Notes: (1) County data are from 2007; (2) State data are from 2006; (3) Totals exceed 100 percent due to rounding; NR = not reported

Government (local, state, or federal) was the largest employment sector for both Custer and Fall River counties. In 2006, slightly under half of all covered workers in Fall River County were employed by some form of government, in comparison to 31 percent of the covered workforce in Custer County and 18 percent of the workforce State-wide. Major private enterprise sectors of employment for both counties were leisure/hospitality (including arts, entertainment, recreation, food service, and accommodations) and trade/transportation/utilities (including retail, wholesale, transportation, warehousing, and utilities).

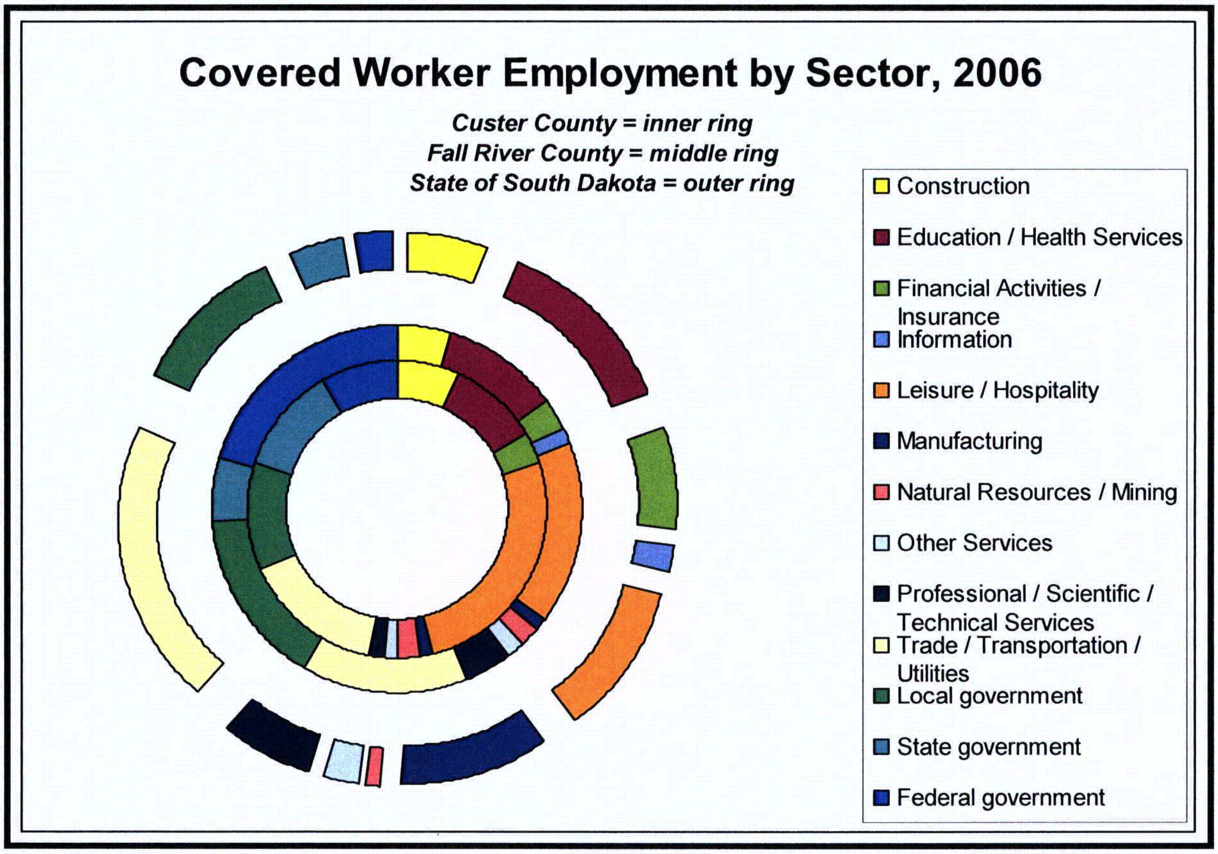


Figure 3.10-6: Covered Worker Employment by Sector, 2006

A more detailed breakdown of private and public sector employers for both counties is provided in Table 3.10-11, based on 2006 data collected by the SD GOED from local development corporations. Major employers in Custer County include the US Department of Agriculture Forest Service (whose Black Hills National Forest headquarters are in Custer City), local school districts, and various health care providers. Major employers in Fall River County include the US Department of Veteran's Affairs (which operates a VA Medical Center in Hot Springs) and the National Park Service, in addition to local school districts and health care providers.

Table 3.10-11: Major Employers, Custer and Fall River Counties, 2006

Employment Sector	Total Employed	Major Employers	Custer County	Fall River County
	Custer / Fall River		# Employed – Town	# Employed – Town
Construction	34 / 11	Jorgenson Log Homes	34 – Custer City	
		Barker Concrete Construction		11 - Edgemont
Education / Health Services	283 / 321	Custer Regional Senior Center	100 - Custer City	
		Custer School District	183 – Custer City	
		Cactus Hills Retirement Community		9 - Edgemont
		Edgemont School District		47 - Edgemont
		Castle Manor Nursing Home		140 – Hot Springs
		Hot Springs School District		125 – Hot Springs
Financial Activities	4 / -	Battle Creek Agency	4 - Hermosa	
Leisure / Hospitality	79 / 20	Cuny Table Café	4 - Buffalo Gap	
		Crazy Horse Memorial	60 – Custer City	
		Trails West	5 - Hermosa	
		Waterhole Restaurant & Bar	10 - Hermosa	
		Super 8 Motel		15 – Hot Springs
		State Line Club		3 - Oelrichs
		Horsehead		2 – Oelrichs
Natural Resources / Mining	33 / -	Pacer Corporation	33 – Custer City	
Other Services	- / 36	Black Hills Special Services		36 – Hot Springs
Trade / Transportation / Utilities	84 / 115	Black Hills Electric Cooperative	30 – Custer City	
		Buffalo Gap Repair	2 - Buffalo Gap	
		Rancher Feed & Seed	2 - Buffalo Gap	
		Lynn's Dakotamart	35 – Custer City	43 – Hot Springs
		Fresh Start	15 - Hermosa	
		Nelson's Oil & Gas		4 - Edgemont
		Maverick Junction		33 – Hot Springs
		Pamida		35 – Hot Springs
Local Government	74 / 7	Custer County	74 – Custer City	
		City of Edgemont		7 - Edgemont
State Government	30 / 106	Custer State Park	30 – Custer City	
		State Veterans' Home		106 – Hot Springs
Federal Government	583 / 504	Black Hills National Forest	583 - Custer City	
		VA Medical Center		402 – Hot Springs
		Wind Cave National Park		100 – Hot Springs
		U.S. Post Office		2 – Oelrichs

Data from South Dakota Department of Labor and Governor's Office of Economic Development

3.10.3.4 Income Levels

Information regarding median and per capita incomes and poverty statistics for Custer and Fall River counties is only available from the decennial federal census, state-level information is updated during the USCB's annual American Community Survey. Therefore, the county- and town-level information in Table 3.10-12 is presented in 1999 dollars, and has not been adjusted for inflation; State-wide data are for 2006 (2005 dollars).

Table 3.10-12: PAA Income Levels

Location	Covered Workers, Annual Average Pay (1)	Median Household Income (2)	Median Family Income (2)	Per Capita Income (2)
Custer County	*$25,141*	*$36,303*	*$43,628*	*$17,945*
Custer County - Adjusted for inflation		*$41,917*	*$50,376*	*$20,721*
Buffalo Gap		$25,000	$28,750	$14,680
Custer City		$31,739	$41,313	$17,216
Hermosa		$23,750	$33,125	$20,832
Fall River County	*$26,727*	*$29,631*	*$37,827*	*$17,048*
Fall River County – Adjusted for inflation		*$34,214*	*$43,678*	*$19,685*
Edgemont		$24,919	$36,667	$17,273
Hot Springs		$27,079	$35,786	$16,618
Oelrichs		$27,222	$28,906	$13,454
South Dakota (3)	***$30,282***	***$42,791***	***$53,806***	***$22,066***

Data provided by South Dakota Department of Labor, Labor Market Information Center and US Census Bureau.
Note: (1) 2006 data; (2) Census 2000 data (1999 dollars) except State data; (3) State data = 2006 American Community Survey.

Median incomes at the household and family level were higher for both Custer and Fall River counties than for the individual towns within each county, indicating that unincorporated county residents contribute substantially to the area's gross income. Income values for both counties were lower than the comparable State-wide values, due in part to the time disparity of the available data. To facilitate comparison, the county-level data was adjusted for inflation to 2005 dollars (2006 data) using a web-based gross domestic product (GDP) deflator calculator (http://www.measuringworth.com/calculators/uscompare/result.php) based on the ration of nominal GDP to real GDP, a broad measure of inflation representing the price of all goods and services in the economy. The county adjusted median values are still lower than the comparable State-wide incomes in each category, but Custer County median income values range from 2 percent (household income) to less than 7 percent (family income) below their State analogs, while Fall River County median values are diverge by almost 11 percent (per capita income) to 20 percent (household income) from comparable State-wide values.

3.10.3.5 Tax Base

South Dakota does not impose a state income tax on its citizens or businesses, and abolished its estate tax in 2001. The majority of State revenue is generated from the 4 percent State-wide sales and use (services) tax, with other sales and use taxes levied by many municipalities, typically an additional 1 – 2 percent. The South Dakota Department of Revenue and Registration (SD DRR) is the entity responsible for collection and regulation of various taxes at the State level, including:

- Non-income business taxes – including sales and use, contractor's excise, and municipal (city) and special jurisdiction (tribal) taxes;
- Special taxes – including tobacco excise, bank franchise, ore and energy mineral severance, gaming excise, coin-operated laundromat licensing, and various alcohol taxes; and
- Motor vehicles taxes – including titles, licensing, motor fuel, and dealer licensing.

Towns with a municipal sales and use tax may also impose a gross receipts tax on various sales, including lodging, restaurants, alcoholic beverage sales, and admissions to places of amusement and cultural and sports events. SD DRR is responsible for collection of municipal taxes. Only towns imposing a municipal sales and use tax in the PAA are listed in Table 3.10-13.

Table 3.10-13: PAA Municipal Tax Rates - 2007

Location	Municipal Tax Rate	Gross Receipts Tax Rate
Custer County		
Custer City	2 %	1%
Hermosa	2%	No
Pringle	2%	No
Fall River County		
Edgemont	2%	1%
Hot Springs	2%	1%

Data from South Dakota Department of Revenue and Registration, 2008.

Local governments are solely responsible for collection of property taxes, which are the primary source of funding for school systems, counties, municipalities, and other local government units.

Table 3.10-14 presents the total taxable amounts for calendar year 2007 on sales and services for the larger towns in Custer and Fall River counties, and shows the amounts as a percent of South Dakota's total taxable sales over the same time period. The county total rates are approximate as they do not take into account any sales taking place in the unincorporated areas of the county.

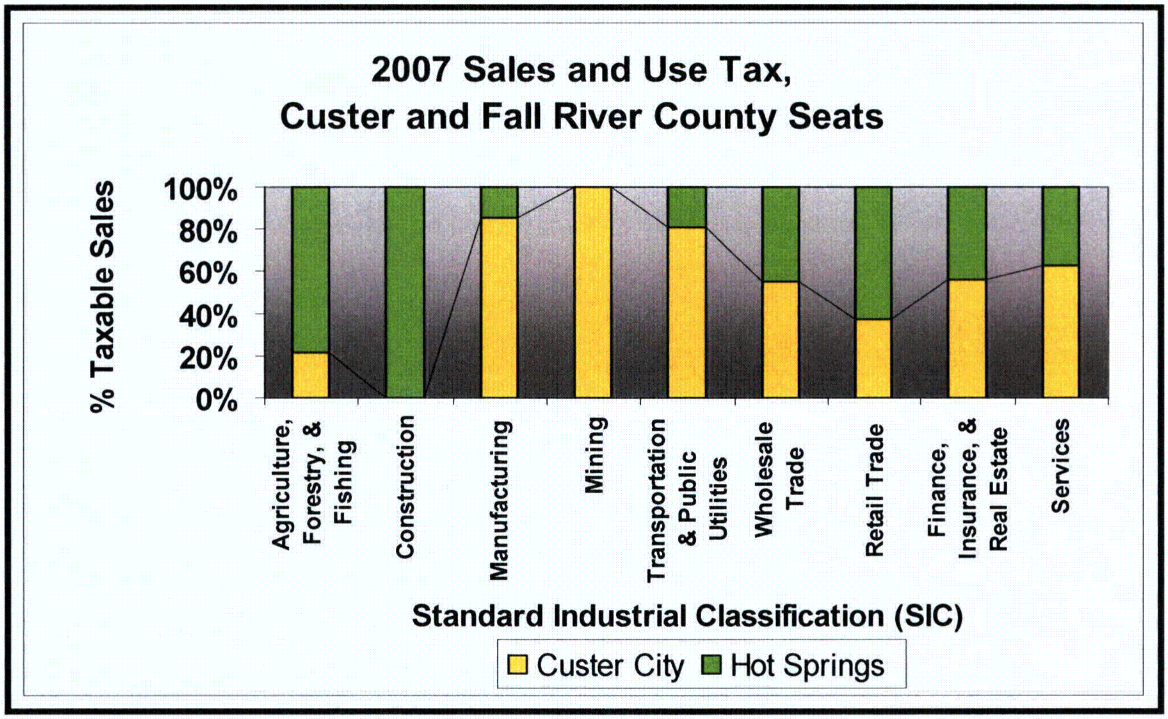
Table 3.10-14: Total Taxable Sales for Project-Area Towns - 2007

Location	Total Taxable Sales	% of State Taxable Sales
Custer County		*~ 5.52*
Buffalo Gap	$404,188	0.03
Custer City	$79,332,055	5.08
Fairburn	$106,078	0.01
Hermosa	$5,768,664	0.37
Pringle	$552,539	0.04
Other cities	$351,520	0.02
Fall River County		*~ 4.2*
Edgemont	$6,863,927	0.44
Hot Springs	$57,148,891	3.66
Oelrichs	$714,584	0.05
Other cities	$704,086	0.05

Data from South Dakota Department of Revenue and Regulation, South Dakota Sales and Use Tax Report, Calendar Year 2007.

Figure 3.10-7 shows the percentage various business sectors contributed to the total taxable sales and use revenue for Custer City and Hot Springs, the respective county seats for Custer and Fall River counties, and the largest cities in each county. Businesses are grouped by standard industrial classification (SIC) as defined by SD DRR, and data reflect 2007 calendar year totals from SD DRR's annual report. The chart shows that the manufacturing, mining, transportation and public utilities, and services sectors were more important to Custer County than to Fall River, while agriculture, foresty, and fishing; construction; and retail trade were more important to Fall River County than to Custer. Wholesale trade and finance, insurance, and real estate sectors were approximately equal in terms of revenue generated for each county.

Figure 3.10-7: 2007 Sales and Use Tax, Custer and Fall River County Seats



SIC categories generating the most taxable sales for Custer City in 2007 were services ($30,987,910), retail trade ($30,916,880), and transportation and public utilities ($12,340,925), accounting for 94.3 percent of the city's total sales and use tax revenue. SIC categories generating the most taxable sales for Hot Springs in 2007 were retail trade ($37,494,437), services ($12,989,107), and transportation and public utilities ($2,056,135), generating 94 percent of the city's total sales and use tax revenue.

Property tax categories include agricultural land, owner-occupied property, and other valuations (such as residential property not occupied by the owner, commercial property, and utility property). Each county is responsible for administering and collecting its own property tax system and monies, which are the primary source of funding for school systems and local government entities. Table 3.10-15 lists the property tax base for Custer and Fall River counties in 2007, and compares them to the State-wide totals. In 2007, agricultural land accounted for only 14 percent of the property tax base in Custer County, in comparison to 24.6 percent of the property tax base in Fall River County and 24.9 percent State-wide. Owner-occupied housing accounted for 47.9 percent of Custer County's tax base, compared to 38.7 percent in Fall River County and 39.0 percent State-wide. Other valuation percentages for both counties were similar to the State-wide rate of 36.1 percent of total property taxes collected in 2007.

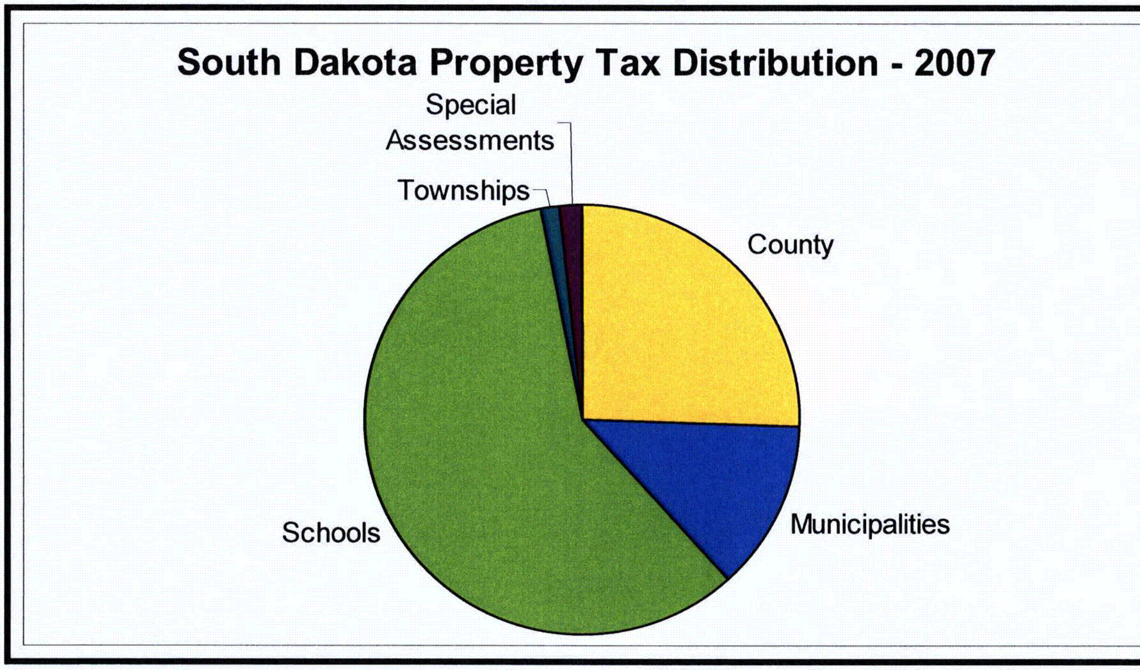
Table 3.10-15: Project-Area Property Tax Base - 2007

Property Tax Category	Custer County	Fall River County	South Dakota
Agricultural Real Valuation	$84,160,015	$96,691,027	$211,381,559
Owner-Occupied Real Valuation	$285,740,111	$152,274,225	$330,332,434
Other Valuation	$227,203,660	$144,165,093	$306,178,271
Total Valuation	**$597,103,786**	**$393,130,345**	**$847,892,264**

Data from South Dakota Department of Revenue and Regulation, 2007 Annual Report.

Figure 3.10-8 shows that the majority (58.5 percent) of property taxes collected in South Dakota are used to fund local school districts. Another 38.4 percent of property tax revenue is used to fund county (25.4 percent) and municipality (13.0 percent) governments, with the remaining 3.1 percent used for funding townships and for special assessment purposes, generally for use by improvement districts for infrastructure (road, bridge, water, sewer, etc.) improvements (Goldman et al., 2001).

Figure 3.10-8: South Dakota Property Tax Distrubution



Data from South Dakota Department of Revenue and Regulation, 2007 Annual Report.

South Dakota provides property tax relief for agricultural and owner-occupied property owners by using a portion of its General Fund ($120 M in 2007) to pay school taxes for these taxpayers.

3.10.3.6 Housing

Housing data was obtained from the USCB, which compiles various housing statistics from the most recent census on a state-wide or county-wide basis. Data used for this baseline study included information about the number and type of housing units, homeownership rates, and median home values. USCB also updates certain municipal data on an annual basis via the American Community Survey (ACS), including building permits issued and number of housing units present, so that this data reflects more current trends and can be used in economic forecasting. Housing data for Newcastle and Osage in Weston County, Wyoming are also provided as these locations could also serve as potential host communities for project employees.

3.10.3.7 Dwelling Types

Census 2000 data was collected for various types of housing units, including single-family detached and attached homes, multi-unit dwellings (apartments), mobile homes, and rooms or groups of rooms designed as separate living quarters with direct occupant access. Census 2000 data is subdivided by single unit (detached and attached), specific housing unit type, the USCB does provide the information on housing units in multi-unit structures as a percentage of total housing units. Table 3.10-16 summarizes the Census 2000 housing data for the PAA, including owner-occupied (generally equivalent to for sale) and rental unit vacancy rates and seasonal/recreational/occasional use unit vacancy rates. Custer County has the highest seasonal unit vacancy rate (more than double Fall River and the two adjacent Wyoming counties), indicative of its proximity to the many recreational and scenic areas in the Black Hills.

Table 3.10-16: PAA Housing Unit Statistics - 2000

Housing Unit Type	Custer County, SD		Fall River County, SD		Niobrara County, WY		Weston County, WY	
	Units	% of Total	Units	% of Total	Units	% of Total	Units	% of Total
Total housing units	3624	100%	3812	100%	1338	100%	3231	100%
Single family homes	2358	65.0%	2429	63.7%	1096	81.9%	2186	67.6%
Multi-unit housing	261	7.2%	568	14.9%	104	7.8%	203	6.3%
Mobile homes	990	27.3%	807	21.2%	133	9.9%	823	25.5%
Other (boat, RV, van, etc.)	15	0.4%	8	0.2%	5	0.4	19	0.6%
Rental units	615	17.0%	901	23.6%	222	16.7%	549	17.0
Owner-occupied vacancy	-	2.3%	-	4.8%	-	7.5%	-	4.8%
Rental vacancy	-	9.1%	-	9.6%	-	18.2%	-	12.0%
Seasonal / recreational / occasional use vacancy	-	10.1%	-	7.5%	-	4.7%	-	4.4%
Units lacking complete plumbing	26	0.9%	47	1.5%	17	1.7%	11	0.4%
Units lacking complete kitchen facilities	51	1.7%	49	1.6%	4	0.4%	13	0.5%
No telephone service	77	2.6%	123	3.9%	44	4.4%	113	4.3%

Data from US Census Bureau, Census 2000 Summary File 3 Dataset

At the time of the last census, the majority of residencies in all four counties were single-family owner-occupied homes on less than 10 acres of land.

Periodic estimations are made by the USCB to update the total number of housing units available within a given geography, based on building permits issued, mobile home shipments, and estimates of housing unit loss since the last census. The most recent housing unit estimation at the county level in South Dakota was in 2006; however data is not divided into housing unit types. Fall River County had an estimated 4,007 housing units in 2006 (USCB), an increase of 5.1 percent over Census 2000 data, although the county suffered an approximate 2 percent population decline over the same period (Section 2.2.1). In comparison, Custer County posted a 16.5 percent increase in housing units since 2000, with a total of 4,223 units in 2006. These data support economic forecasting that lists Custer County as one of South Dakota's 10 fastest-growing counties (Business Research Bureau, 2007).

The 2006 estimation data for the bordering Wyoming counties showed a much more modest increase in housing units since the last census, with an increase of 1.1 percent (15 additional units) in Niobrara County and an increase of 2.5 percent (81 additional units) in Weston County.

3.11 Public and Occupational Health

3.11.1 Background Exposure to Ionizing Radiation

Background exposure to ionizing radiation is caused by natural sources such as radiation from outer space (cosmic radiation) and from naturally occurring radioactive substances in the ground (terrestrial radiation). Other sources of background exposure include man made sources from medical diagnostic tests such as x-rays and other consumer products and naturally occurring radiation in the body. The average total effective dose equivalent, for a U.S. resident, from natural background radiation sources is approximately 300 mrem/yr, and varies by location and elevation; in addition, man-made sources of radiation contribute to another 60 mrem/yr received by U.S. residents, for a total average dose of 360 mrem/yr (National Council of Radiation Protection and Measurements, 1987, as stated in NUREG-1910, 2008).

The background dose varies due to changes in elevation. With increasing elevation, comes increasing exposure to cosmic radiation. Terrestrial radiation fluctuates depending on the porosity and moisture content of the soils/bedrock in the area. Radon is a radioactive gas produced from the decay of U-238, which is naturally found in soil. Soils/bedrock types such as granite generally have higher radon levels. "Everything on the planet, including every living thing, is [and always has been] bathed in a sea of radiation" [NRC, 1994] (EPA, 2006, as stated in NUREG-1910, 2008).

3.11.2 Occupational Health and Safety

3.11.2.1.1 Total Effective Dose Equivalent to Individual Receptors

As stated in Section 4.14.2.3.12 of the ER, the maximum radiological effect of the the Proposed Action would be to increase the total effective dose equivalent (TEDE) of continental population by 7.5E-6 percent. Powertech (USA) has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the proposed uranium ISL operation is less than 100 mrem/yr. Additionally, the annual effective dose equivalent (EDE) limit found in 40 CFR part 190 of 25 mrem y^{-1} was not exceeded at any receptors. A more indepth discussion is located in Section 7 of the TR.

An evaluation of the TEDE calculations follows:

1) The maximum 40 CFR part 190 EDE of 10.8 mrem y^{-1}, located at the property boundary north-northwest of the SF, is 43.2 percent of the public dose limit of 25 mrem y^{-1}. The 40 CFR 109 TEDE public dose limit is not exceeded at any boundary receptor.

2) The maximum total TEDE of 12.5 mrem per year, located at the property boundary north-northwest of the SF, is 12.5 percent of the 10 CFR 20 public dose limit of 100 mrem y^{-1}. The 10 CFR 20 public dose limit is not exceeded at any property boundary.

3) The maximum 40 CFR part 190 EDE at a resident is 2.32 mrem y^{-1}, located at Spencer Ranch. This is 9.28 percent of the public dose limit of 25 mrem y^{-1}. None of the resident receptors have 40 CFR part 190 EDEs exceeding the 25 mrem y^{-1} public dose limit. None of these estimated EDEs exceed the 10 CFR 20 constraint rule for airborne effluents of 10 mrem y^{-1}.

4) The maximum TEDE at a resident is 4.48 mrem y^{-1}, located at Spencer Ranch. It is 4.48 percent of the 10 CFR 20 public dose limit of 100 mrem y^{-1}. None of the residents have TEDEs exceeding the 100 mrem y^{-1}public dose limit.

3.11.2.1.2 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Dewey Burdock site is also predicted by the MILDOS-AREA code. The results are contained in Table 3.11-1 where TEDE is expressed in terms of person-rems. For comparison, the dose to the population within 80 km of the facility due to background radiation has been included in the table. Background radiation doses are based on a North American population of 346 million and an average TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 3.11-1. These calculations are also combined with the dose to the region within 80 km (50 mi) of the facility to arrive at the total radiological effects of one year of operation at the Dewey Burdock site. The maximum radiological effect of the Dewey Burdock operation would be to increase the TEDE of continental population by 7.5E-6 percent.

Table 3.11-1 Total effective dose equivalent to the population from one year's operation at the Dewey Burdock site.

Criteria	TEDE (person rem/yr)
Dose received by population within 80 km of the facility	0.879
Dose received by population beyond 80 km of the facility	8.13
Total continental dose	9.01
Background North American dose	1.2E8
Fractional increase to background dose	7.5E-8

3.12 Waste Management

Currently there are no waste generation activities since this is the Proposed Action for a new facility. Waste management impacts related to the proposed project are discussed in Section 4.15.