Section 3.0
Affected Environment

3.1 LAND USE

3.1.1 Site Location

The Site is located in Paradox Valley of western Montrose County, approximately 7 miles east of the unincorporated community of Bedrock and 12 miles west of the Town of Naturita. The Site's legal description is the Southwest ¼ of the Southeast ¼ of Section 5, all of Section 8, the North ¼ of Section 17, and the Southeast ¼ of the Northwest ¼ of Section 17, Township 46 North, Range 17 West, of the New Mexico Principal Base and Meridian.

3.1.1.1 Regional Land Use Patterns

NRC Guidance for Environmental Reports for Uranium Mills requires that a proposed project's potential impacts on the surrounding population be evaluated for all areas within 50 miles (80 kilometers - km) of the Site (NRC, 1982a). To provide for consistency with this analysis, which is addressed in Section 3.10 of this ER, the current section evaluates existing land-use conditions within 50 miles (80 km) of the Site. The analysis emphasizes land-use patterns in Montrose County because this is where the Site is located and where potential impacts to land-use patterns associated with the Proposed Action would occur.

The majority of land in the vicinity of the Site is public land that is administered by the Bureau of Land Management (BLM) and the U.S. Forest Service (see Figure 3.1-1). BLM lands include DOE uranium lease tracts in the Gateway area of Mesa County, Uravan and Paradox Valley areas of Montrose County, and the Slick Rock Area of San Miguel County (DOE, 2007). Private lands comprise 30 percent of the land within 50 miles (80 km) of the Site. Portions of the San Juan National Forest, Uncompahgre National Forest, Manti-LaSal National Forest, Lizard Head Wilderness Area, Black Canyon of the Gunnison Wilderness Area, Gunnison Gorge National Conservation Area, Arches National Park, and Canyonlands National Park are located within 50 miles (80 km) of the Site as is the U.S. Bureau of Reclamation's (BOR's) Paradox Valley Unit (PVU) desalinization plant. The Ute Mountain Indian Reservation covers a portion of Montezuma County, Colorado, and the Navajo Indian Reservation covers a portion of San Juan County, Utah. These tribal lands are located over 50 miles (80 km) away from the Site.

3.1.1.2 Local Land Use Patterns

NRC Guidance for Environmental Reports requires the evaluation of land use within a 5 mile (8 km) radius of the Site (NRC, 1982a). Based on information provided by the Montrose County GIS Department, 88 percent of the land within 5 miles (8 km) of the Site is undeveloped land that is administered by the BLM and 12 percent is privately owned (Montrose County, 2009b). As shown in Figure 3.1-2, some lands within the vicinity of the Site, including the site itself, are currently used to graze livestock. Grazing lands in the vicinity of the Site are zoned as general agricultural districts, which allow for the placement of on-site-built or manufactured single family home on the property. Therefore, some grazing lands near the Site include residences and some are vacant (Waller, 2009). A small portion of land in the immediate vicinity of the Site is used for residential and other agricultural purposes. All land uses are subject to valid existing rights, which may be conveyed by title, deed, right-of-way, permit, withdrawal, or any other legally recognized instrument (Visus, 2009).

Bureau of Land Management
Bureau of Reclamation
Forest Service
National Park Service
Private Lands
Department of Energy Uranium Lease Tracts
US Census Populated Places (areas)

Figure 3.1-1

Land Management within 50 miles (80 km) of the Site

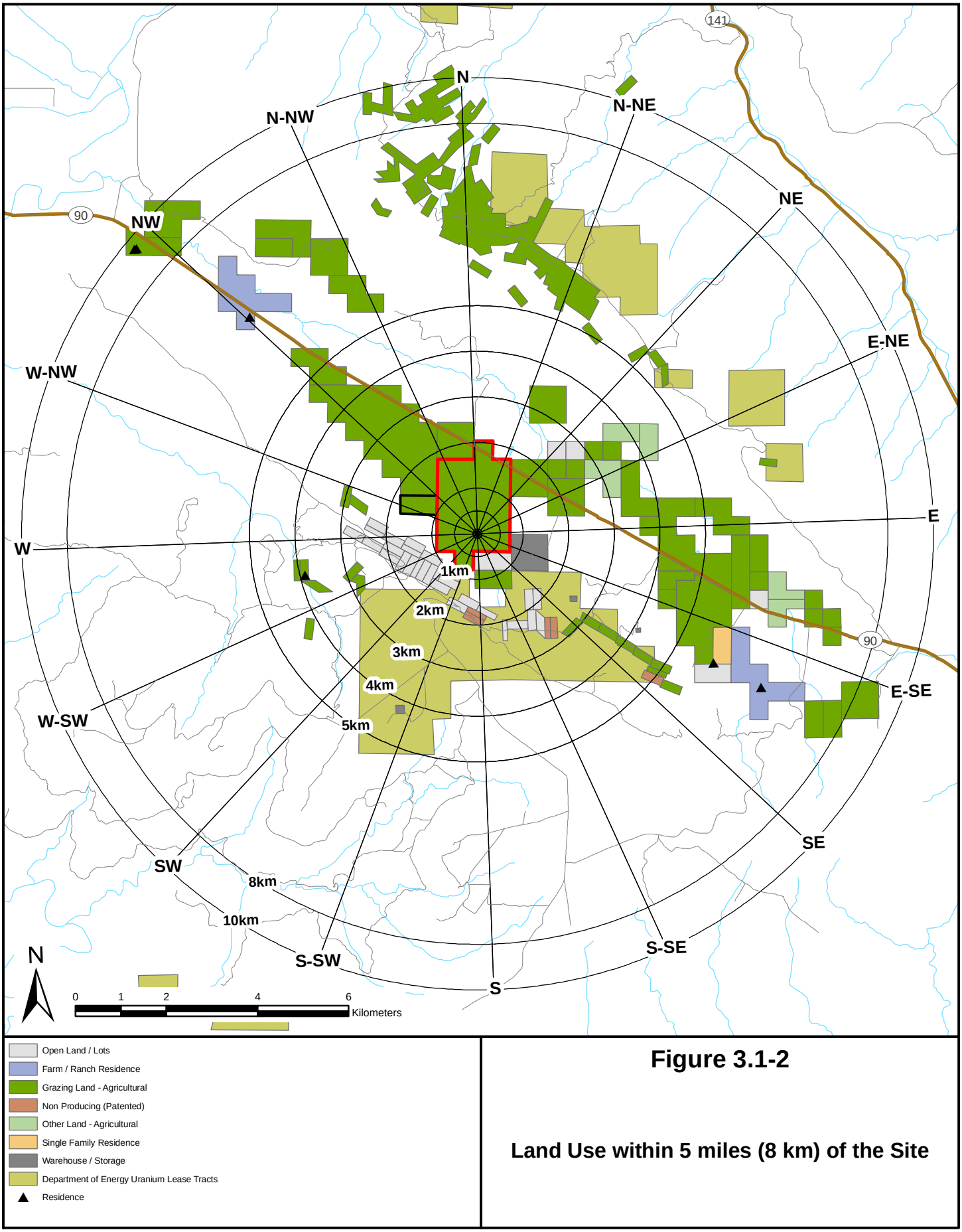


Figure 3.1-2

Land Use within 5 miles (8 km) of the Site

3.1.2 Surrounding Land Uses

Montrose County, which includes the Site, covers approximately 2,200 square miles of southwest Colorado. Most of the land in the county is publicly owned. The BLM is the dominant federal land management agency in Montrose County, overseeing 44 percent of the county's surface area. DOE uranium lease tracts overlap with approximately 2 percent of BLM-administered lands in the county. The DOE has jurisdiction over activities related to uranium and vanadium mining on lease tracts, and the BLM has jurisdiction and authority over all other surface and subsurface uses (DOE, 2007). National Forest System (NFS) lands cover 23 percent of Montrose County, National Park lands cover 1 percent, and State lands cover another 1 percent. Private lands cover 31 percent of the county.

The BOR's Paradox Valley Unit is located approximately 7.5 miles (12 km) west of the Site. As part of the Colorado River Basin Salinity Control Project, the Paradox Valley Unit is designed to prevent natural salt loads from entering the Dolores River and degrading the quality of water flowing into the Colorado River. The Paradox Valley Unit intercepts brine groundwater before it enters the Dolores River and disposes of the brine by deep well injection. Major project facilities include a brine production well field, brine surface treatment facility, injection facility, a 15,932 foot deep injection well, and associated roads, pipelines, and electrical facilities (BOR, 2009).

Major land uses in Montrose County include agriculture, mining, and recreation. Public lands provide the public with multiple use opportunities. Areas of urban concentration are limited to the City of Montrose and Town of Olathe, both of which are located on the eastern side of the county. The only other incorporated jurisdictions are the towns of Naturita and Nucla, both of which are located on the western side of the county.

3.1.2.1 Agriculture

Farming. According to the U.S. Department of Agriculture's 2007 Census of Agriculture, farmland covers approximately 23 percent of Montrose County. Between 1997 and 2007, the county lost approximately 50,000 acres of farmland (see Table 3.1-1). Most farmland losses are due to encroaching residential development. Farms in Montrose County are decreasing in size. Although the average farm size was 307 acres in 2007 (down from 429 acres in 1997), most farm holdings are much smaller. In 2007 the median farm size in Montrose County was 46 acres (down from 83 acres in 1997) (U.S. Department of Agriculture, 1999 and 2009).

Table 3.1-1
Agricultural Statistics for Montrose County, 1997, 2002 and 2007[1]

Agricultural Indicator	1997	2002	2007
Number of farms	866	915	1,045
Acreage			
Land in farms	371,881	334,747	322,105
Average farm size	429	366	307
Median farm size	83	73	46
Total cropland	89,191	106,613	93,262
Harvested cropland	65,276	60,890	60,094
Irrigated land	85,040	75,459	85,656
Land in orchards	NA	295	318
Organic production	NA	NA	154
Vegetable crops	NA	3,870	2,878
Dry edible beans	NA	7,063	4,208
Grain crops	12,344	8,688	11,089
Hay	37,437	35,748	38,467

Agricultural Indicator	1997	2002	2007
Livestock inventory (number)			
Cattle and calves	60,599	48,435	47,388
Hogs and pigs	1,180	1,618	675
Sheep and lambs	35,427	18,366	19,792
Goat inventory	86	96	1,486
Farmland as percent of county area	25.9%	23.3%	22.5%
Harvested cropland as percent of total cropland	73.2%	57.1%	64.4%
Irrigated land as percent of total farmland	26.6%	22.5%	22.9%
Percent of farms with cattle/calving operations	57.6%	43.0%	45.2%
Percent of farms with sheep/lambs	11.8%	8.3%	6.0%
[1] Source: U.S. Department of Agriculture, 1999, 2004, and 2009.			

Approximately 25 percent of Montrose County farmland is irrigated. Over 60 percent of the county's harvested cropland is used to produce hay, which is the county's primary crop. Other commercial crops produced in the county include grain crops (barley, corn, oats, and wheat), which cover 19 percent of harvested cropland; dry edible beans, which cover 7 percent of harvested cropland; and vegetables, which cover approximately 5 percent of harvested cropland.

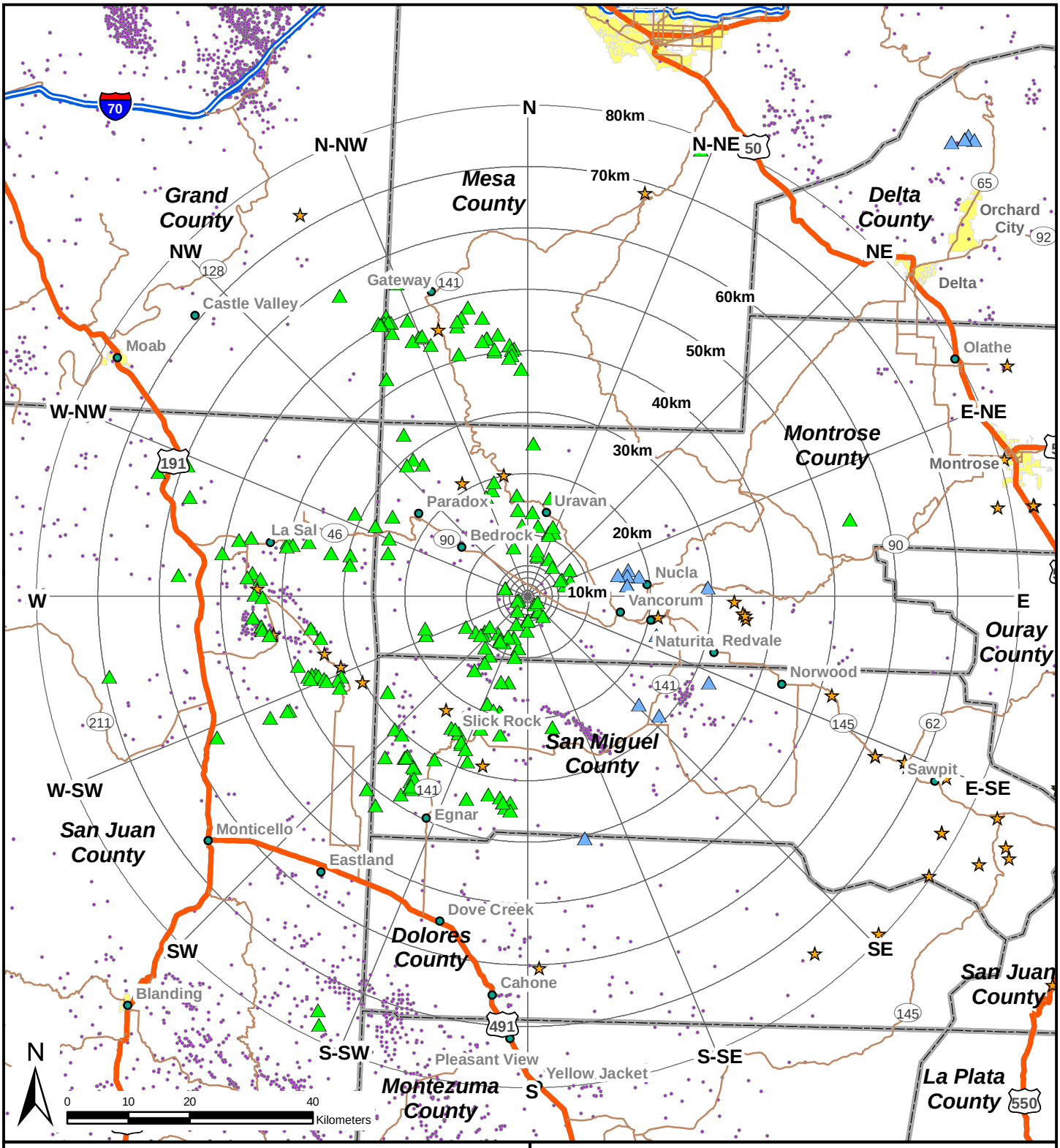
Grazing. Cattle and calves are the predominant livestock in Montrose County. In 2007, 45 percent of the county's farms had cattle/calving operations (down from 58 percent in 1997). Although the Census of Agriculture does not provide data on farm lands not used for cropland, it is likely that most agricultural land not in croplands is used to graze livestock.

The Site contains 880 acres that have historically been used to graze cattle during the winter. The BLM's East Paradox Common Allotment, which is adjacent to the Site, contains 15,003 acres that are permitted for 2,107 animal unit months (AUMs) between December 18 and February 28 (Stindt, 2009). The BLM allotment has a seasonal carrying capacity of 7.12 acres per AUM. The carrying capacity of public lands near the site has been improved through seeding and vegetation treatment (*e.g.* sagebrush removal, grass replacement) over the past several years (Stindt, 2009). BLM grazing allotments encompass public and private lands, but only public lands are included in determining active AUMs.

Forestry. Trees conducive to commercial forestry (*e.g.* ponderosa pine, Douglas fir, Engelmann spruce) are extremely limited in western Montrose County due to minimal rainfall, steep topography, and relatively low elevations; however, there is limited harvesting of pinyon pine and juniper trees for firewood and fenceposts on public lands in western Montrose County in the vicinity of the Site (Berger, 2009 and DOE, 2007).

3.1.2.2 Mineral Resources and Mining

Mineral resources in southwest Colorado and southeast Utah include oil, natural gas, coal, gold, copper, silver, uranium, vanadium, and zinc. Based on information provided by the Colorado Division of Reclamation, Mining and Safety (DRMS); the Utah Division of Oil, Gas and Mining (DOGM); and the Colorado Oil & Gas Conservation Commission (COGCC), Figure 3.1-3 shows permitted mines and oil and gas wells that are within 50 miles (80 km) of the Site (Colorado Department of Natural Resources - CDNR, 2009a; Smith, 2009a; and COGCC, 2009a). Areas with intense uranium and vanadium mining are largely within 30 miles (50 km) of the Site. Areas with intense oil and natural gas drilling tend to be along the periphery and outside the Site's 50 mile (80 km) radius.



Coal

Copper; Gold; Silver

Uranium; Vanadium; Zinc

Oil & Gas Wells

Figure 3.1-3

Permitted Mines and Oil & Gas Wells within 50 miles (80 km) of the Site

Uranium. The Site is located in the Uravan Mineral Belt - a zone of uranium and vanadium deposits in San Miguel, Montrose, and Mesa counties in Colorado and Grand County in Utah that contains a substantial portion of the nation's known uranium ore reserves (DOE, 2007). This mineralized zone is the oldest uranium mining region in the United States. Historically, almost 1,200 mines were located within the Uravan Mineral Belt, which produced over 63 million pounds of uranium and 330 million pounds of vanadium between 1948 and 1978 (CDNR, 2009b). Due to falling uranium prices, uranium production in Montrose County halted in the mid-1980s. Improving market conditions in the early 2000s resulted in the resumption of limited mining operations.

According to the CDNR, as of September 2009, there were 35 actively permitted uranium mining projects, including four producing mines, in Colorado. As shown in Table 3.1-2, all four producing mines (Sunday, West Sunday, St. Jude, and Topaz mines) are in San Miguel County, and all but two of the permitted projects are in Montrose, San Miguel, and Mesa counties (CDNR, 2009b).

Table 3.1-2
Active Uranium Mining Permits in Colorado, September 2009[1]

Site Name	Operator	County	Status
October Ore Pile Reclamation	Nuvemco, LLC	Mesa	Active
Whirlwind Mine	Energy Fuels Resources	Mesa	Active– standby Nov 2008
C-JD-5	Gold Eagle Mining, Inc.	Montrose	Active
C-JD-7	Cotter Corp.	Montrose	Active
C-JD-8	Cotter Corp.	Montrose	Active- standby Nov 2005
C-LP-21 Mine	Cotter Corp.	Montrose	Reclaimed
CM-25 Mine	Cotter Corp.	Montrose	Reclaimed
Club Mines	Umetco Minerals Corp.	Montrose	Reclaimed
J Birds	Rimrock Exp. & Dev.	Montrose	Active
JD-6 Mine	Cotter Corp.	Montrose	Active- standby Nov 2005
JD-7 Pit	Cotter Corp.	Montrose	Active
JD-9 Mine	Cotter Corp.	Montrose	Active- standby Nov 2005
Last Chance #3 & #4	Nuvemco, LLC	Montrose	Permit review
Mineral Joe Claims	Cotter Corp.	Montrose	Active
Monogram Mines	Nuvemco, LLC	Montrose	Conversion approved
Monogram-JoDandy	Nuvemco, LLC	Montrose	Active
SM-18 Mine	Cotter Corp.	Montrose	Active- standby Nov 2005
Tramp Mine	Bluerock Energy Corp.	Montrose	Active
Van 4 Shaft	Denison Mines (USA)	Montrose	Active
Wright Group	Cotter Corp.	Montrose	Active
Burros Mine	Gold Eagle Mining, Inc.	San Miguel	Active
Carnation Mine	Denison Mines (USA)	San Miguel	Active
Centennial	B-Mining Co.	San Miguel	Active
Deremo-Snyder	Umetco Minerals Corp	San Miguel	In reclamation
Ellison Mine	Gold Eagle Mining, Inc.	San Miguel	Active
Hawkeye Mine	Gold Eagle Mining, Inc.	San Miguel	Active
Ike No. 1 Mine	Cotter Corp.	San Miguel	Reclaimed
Sego Mine	Sutherland Drilling	San Miguel	Active
SR-13A Mine	Cotter Corp.	San Miguel	Active
St. Jude Mine	Denison Mines (USA)	San Miguel	In ore production
Sunday Mine	Denison Mines (USA)	San Miguel	In ore production
Topaz Mine	Denison Mines (USA)	San Miguel	In ore production
West Sunday	Denison Mines (USA)	San Miguel	In ore production
Schwartzwalder	Cotter Corp.	Jefferson	In reclamation
Pitch Project	Homestake Mining Co.	Saguache	In reclamation

[1] Source: CDNR, 2009b.

As shown in Figure 3.1-3, there are several uranium/vanadium mines in Utah that are within 50 miles (80 km) of the Site. The Beaver, Energy Queen, Pandora, and Rim mines are all located in the La Sal region of San Juan County. With the exception of the Energy Queen Mine which is operated by Energy Fuels, all of these mines are operated by Denison. As of March 2009, the Beaver and Pandora mines were producing ore, and the Rim Mine was on temporary standby (PayDirt Magazine, 2009). Energy Fuels' Energy Queen Mine is currently being rehabilitated.

In May 2009, the BLM Monticello Field Office approved White Canyon Uranium Ltd's plans to develop an underground uranium mine approximately 35 miles east of Blanding, in San Juan County, Utah (BLM, 2009a). The Utah DOGM approved the project, known as the Daneros Mine, in July 2009 (Baker, 2009). The Daneros Mine which is expected to produce 100,000 tons of uranium over seven years is located more than 50 miles (80 km) away from the Site. The nearest uranium and vanadium processing plant, the White Mesa Mill, is located in Blanding, Utah, which is more than 50 miles (80 km) from the Piñon Ridge Site.

Coal. The New Horizon Mine is the only coal mine within 50 miles (80 km) of the Site. The New Horizon is a surface coal mine that supplies coal to the Nucla Station, a 100 megawatt power plant located near the Town of Nucla. Table 3.1-3 shows annual production from the New Horizon Mine between 2001 and 2008. Colorado's top producing coal mine, Bowie #2, is located more than 50 miles (80 km) from the Site in eastern Delta County. Production from the New Horizon Mine is approximately 10 percent that of Bowie #2 (CDNR, 2009c).

Table 3.1-3
New Horizon Mine Coal Production, 2001 – 2008[1]

Year	Tons	Year	Tons
2001	370,725	**2005**	420,730
2002	386,366	**2006**	405,611
2003	352,859	**2007**	406,279
2004	413,332	**2008**	403,230

[1] Source: CDNR, 2009c.

Oil and Gas. Oil and gas production in southwest Colorado is concentrated in the Paradox Basin areas of Montezuma and San Miguel counties along the Colorado-Utah border. Natural gas is also produced in northern Mesa County, and proven oil and gas reserves are located south and east of the Slick Rock area in San Miguel County. According to the COGCC, there are currently no producing oil or natural gas wells in Montrose County (COGCC, 2009b). Most of the region's oil production is in San Juan County, Utah, and most natural gas production is in Montezuma County, Colorado. As shown in Figure 3.1-3, most oil and gas drilling within the region occurs outside the 50 mile (80 km) range of the Site.

3.1.2.3 Recreation

Rafting. The Dolores River flows from its headwaters in the San Juan Mountains through Dolores, San Miguel, Montrose, and Mesa counties into Grand County, Utah, where it converges with the Colorado River. Although the Dolores River does not have federal designation as a Wild and Scenic River, the BLM manages it as such (DOE, 2007). The segment of the Dolores River between McPhee Reservoir, in Dolores County, and Bedrock is a BLM-designated Special Recreation Management Area (SRMA) that is managed for destination recreation-tourism targeting visitors from the southwestern United States and local residents who participate in rafting along the Dolores River, fishing, mountain-biking and jeeping (San Juan Public Lands, 2007). The section of the Dolores River between Slick Rock and Bedrock is a popular rafting destination. Motorized watercraft are prohibited on this section of the river.

Because no water from McPhee Reservoir is allocated for recreational purposes, adequate flows for boating depend on spillwater releases which limit the length of the river season. The peak period for river activity is from April 30 to June 15 during spring runoff. Between Slick Rock and Bedrock, the Dolores River is seldom navigable between July and April due to insufficient water and cold temperatures (Ryan, 2009).

According to the BLM Durango Field Office, people typically launch at Slick Rock and float to Gypsum Valley or Bedrock. Because of the river's proximity to SH 141 north of Bedrock and the lack of established take-out points between Bedrock and Gateway, Bedrock is more popular as a take-out point rather than a launch point (Fonze, 2009). The BLM Durango Field Office maintains registration records for launches in San Miguel County. Because registering is voluntary, the records reflect approximately 60 to 70 percent of river usage (Ryan, 2009). Although the BLM Uncompahgre Field Office does not have comparable data for launches in Montrose County, launch data from San Miguel County are reflective of river usage within the vicinity of the Site.

Table 3.1-4 shows Dolores River launch data between 2005 and 2008. At the time this report was written, 2009 launch data were not available. A single launch typically includes multiple people. Due to inadequate releases from McPhee Reservoir, there were no boating seasons in 2006 and 2007. Of the 630 launches that were recorded in 2008, there were 121 launches in April, 451 launches in May, and 58 launches in June (Ryan, 2009).

Table 3.1-4
Dolores River Launch Summary[1]

Launch Site	County	River Mile	2005	2008
Bradford Bridge	San Miguel	0	288	303
Dove Creek Pump Station	San Miguel	20	69	74
Slick Rock	San Miguel	47	71	139
Gypsum Valley	Montrose	61	95	114
Coyote Wash	Montrose	85	NA	NA
Bedrock	Montrose	97	NA	NA
Gateway	Mesa	141	NA	NA

[1] Source: Ryan, 2009.

Floating is also popular on the San Miguel River, which flows from the San Juan Mountains above Telluride into the Dolores River west of Uravan. According to the BLM Uncompahgre Field Office, the section of the river below Placerville to Norwood is the most popular section of the San Miguel River to float. The section of the river between Norwood and the river's confluence with the Dolores River is not a popular rafting destination because the scenery is not as spectacular as farther upstream (Fonze, 2009).

Hunting. Big-game hunting is popular on public lands in Montrose County. Hunting is also allowed on private land with permission from the landowner. Hunting areas within the region of the Site include the Colorado Division of Wildlife's (CDOW's) Game Management Units (GMU) 61, 62 and 70. Table 3.1-5 shows the number of hunters and the harvested deer and elk in these areas in the 2008 hunting season. Most of the deer and elk in GMU 70, where the Site is located, are found in wooded, mountainous areas that provide suitable habitat.

Table 3.1-5
Regional Deer and Elk Harvest Statistics in the Vicinity of the Site, 2008[1]

GMU	Area	Game	Harvest	Hunters	Success Rate
61	Uncompahgre Plateau	Deer	364	603	60.4%
62	Delta and Montrose counties, east of Uncompahgre Plateau	Deer	928	1,635	56.8%
70	San Miguel County, southwest Montrose County	Deer	1,372	2,015	68.1%
61	Uncompahgre Plateau	Elk	610	1,275	47.8%
62	Delta and Montrose counties, east of Uncompahgre Plateau	Elk	1,203	6,233	19.3%
70	San Miguel County, southwest Montrose County	Elk	1,184	4,356	27.2%

[1] Source: CDOW, 2009a.

Other. In addition to hunting, most of the BLM and NFS lands in Montrose County are accessible to the public for off-highway vehicle use, mountain biking, hiking, and other recreational uses (DOE, 2007). Fishing is popular on the Dolores and San Miguel rivers, and road cycling is popular on State Highways 141 and 145 along the Dolores River. The Gateway area and surrounding Unaweep Canyon in Mesa County, 80 miles north of the Site, has been targeted for recreation-related development. The John Hendricks family began developing the Gateway Canyons Resort in 2005 as a center for outdoor recreation and adventure. The development currently includes 56 guest rooms, a spa, automobile museum, restaurant, grocery store, gas station, and an outdoor recreation-gear store. An events center is under construction and there are plans to build three additional luxury lodges in the next few years (Gateway Canyons Resort, 2009).

In December of 2007 the BLM Grand Junction Field Office (GJFO) initiated a process to amend the 1987 Grand Junction Resource Area Resource Management Plan (RMP) by designating a Gateway SRMA. The amendment intended to incorporate recreation needs, travel routes, and recreation management objectives on public lands in the Gateway area into the 1987 RMP. According to the BLM GJFO, in early 2009 the BLM halted its efforts to amend the 1987 RMP and designate a Gateway SRMA. Instead, BLM decided to incorporate recreational uses in the Gateway area into a revised RMP, which is scheduled to be completedi in 2011 or later (Ham, 2009).

3.1.3 Land Use Planning Issues

Montrose County is currently updating its Master Plan. This process, which began in October 2008, is expected to be completed by December 2009. The county master plan update identifies targeted urban growth areas and sites for commercial and industrial development. Naturita and Nucla are targeted urban growth areas in western Montrose County. On September 30, 2009, the Montrose County commissioners approved a Special Use Permit for the Piñon Ridge Site (Montrose County, 2009a).

3.2 TRANSPORTATION

3.2.1 Transportation Routes

Figure 3.2-1 shows the major regional transportation routes in western Colorado and eastern Utah that are within the vicinity of a 50 mile (80 km) radius around the Site. U.S. Highway 50 is the primary roadway traversing eastern Montrose County. To the north, U.S. Highway 50 connects Montrose County with Delta and Mesa counties, and intersects Interstate-70 near Grand Junction. From the City of Montrose, U.S. Highway 50 heads east into Gunnison County. South of the City of Montrose, U.S. Route 550 parallels the Uncompahgre River through Ridgway in Ouray County and Durango in La Plata County to connect with U.S. Highway 160 near Durango. U.S. Route 550 is a National Scenic Byway (the San Juan Skyway) between Ridgway and Durango.

SH 141 is the primary north-south highway in western Montrose County. From the north, the highway enters Montrose County paralleling the Dolores River. The Dolores and San Miguel rivers merge near Uravan, and SH 141 follows the San Miguel River through Vancorum and Naturita. SH 141 continues south into San Miguel County, connecting the area surrounding the Site with the Slick Rock and Egnar areas of western San Miguel County. Approximately 4 miles east of Naturita, SH 141 intersects SH 145. SH 145 travels through the Redvale community into Norwood and Telluride in San Miguel County. SH 141/145 is a Colorado Scenic Byway (the Unaweep/Tabeguache Scenic and Historic Byway) between Whitewater in Mesa County and the junction of SH 145 and SH 62 near Placerville in San Miguel County.

SH 90 is the primary east-west highway through Montrose County. It enters the county as Utah SH 46 and passes through the community of Bedrock before intersecting with SH 141 near Vancorum. East of Nucla, SH 90 crosses the Uncompahgre Plateau to connect with U.S. Highway 550 and the City of Montrose. Approximately 35 miles of SH 90 is unpaved across the Plateau, and adverse weather conditions frequently close this portion of the roadway, known as the Tabeguache Trail, during the winter. Consequently, residents of western Montrose County typically travel to the Town of Montrose via SH 145 and SH 62 over the Dallas Divide to Ridgway and up U.S. Highway 550 during winter and spring months. In March 2009, the Montrose County Commissioners applied for federal funding to pave the remainder of SH 90 across the Uncompahgre Plateau. The project is not included on CDOT's list of American Recovery and Reinvestment Act Projects dated July 17, 2009 (CDOT, 2009a). Region 5 of the CDOT maintains all U.S. and state highways in Montrose County.

Utah SH 46 crosses approximately 21 miles of northeastern San Juan County, Utah to intersect with U.S. Highway 191 at La Sal Junction. U.S. Highway 191 runs north to south, from its intersection with Interstate-70 at Crescent Junction, through the towns of Moab, Monticello, and Blanding into Arizona. Region 4 of the UDOT maintains both of these highways.

3.2.2 Roadway System in Vicinity of the Site

Figure 3.2-2 shows the roadway systems in the vicinity of the Site. Access to the Site would be located near milepost 23 on SH 90. The existing intersection of the site access point and SH 90 is a four-leg layout. The access opposite the Site is a dirt road with little to no observed traffic volume. There are no physical features (*e.g.* signs, walls, berms, plants, etc.) within the sight zones of the intersection of SH 90 and the site access point (TurnKey Consulting, LLC - TurnKey, 2008).

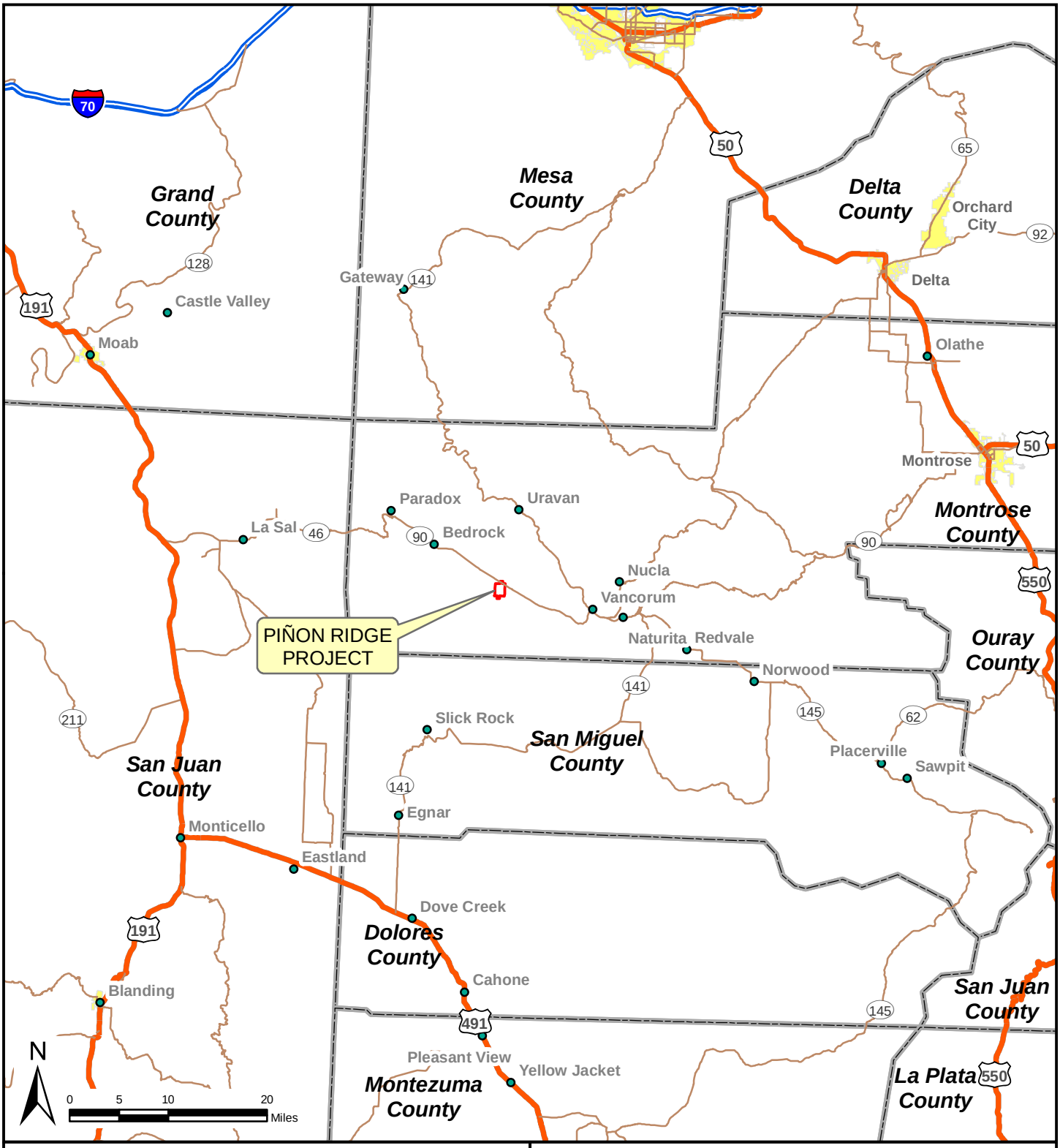


Figure 3.2-1

Major Regional Transportation Routes

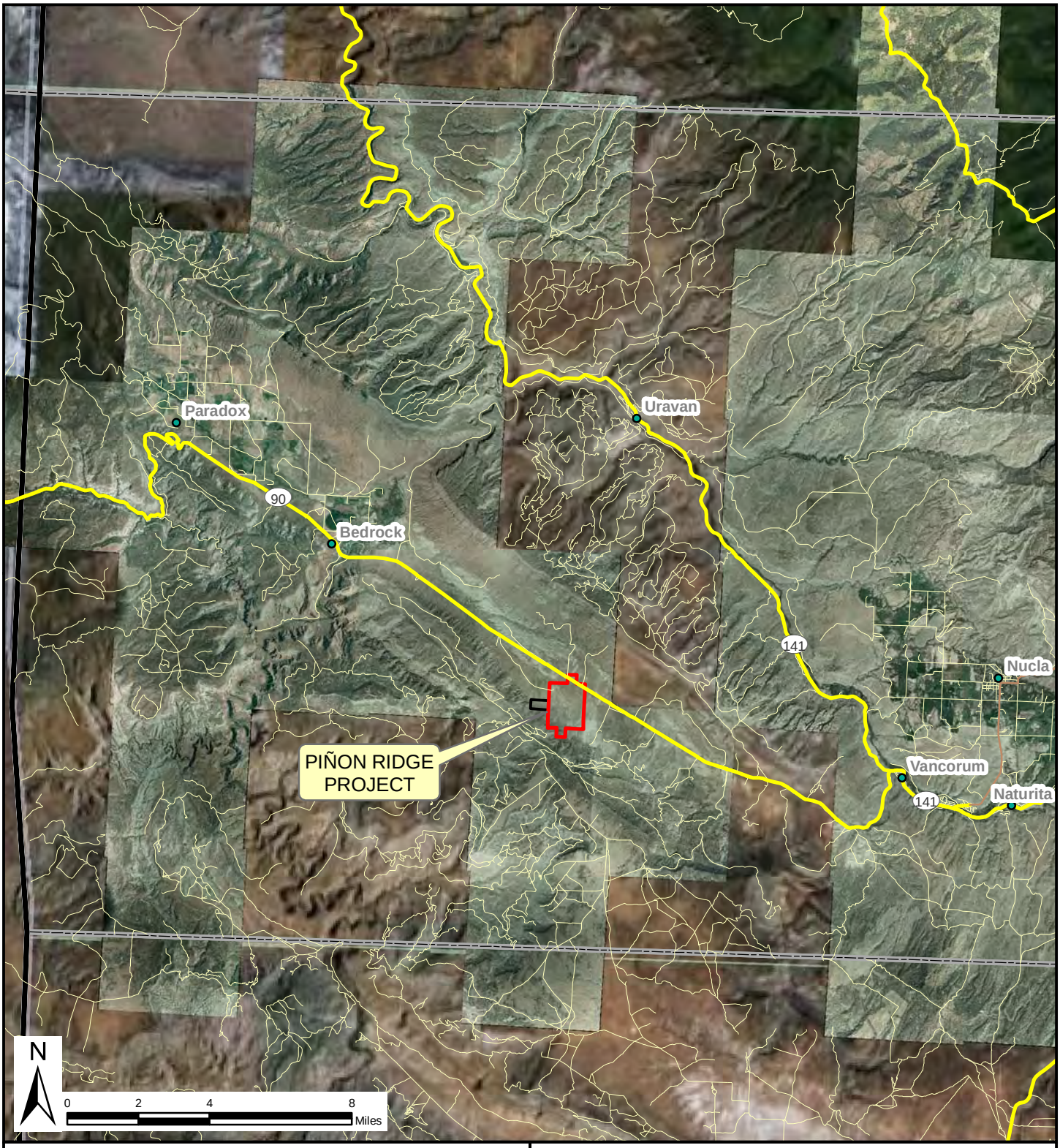


Figure 3.2-2

Minor Roads Near the Site

There are several unimproved roads in the vicinity of the Site. Many of these roads were built on public lands by ranchers and miners before the BLM developed road construction and usage regulations, and are currently maintained by county agencies or the BLM (TurnKey, 2008). Private roads in the area lead to residences and ranching operations.

3.2.3 Traffic Patterns

Table 3.2-1 shows 2008 annual average daily traffic volumes on roadways within the vicinity of the Site.

Table 3.2.1
Annual Average Daily Traffic on Roads within the Vicinity of the Site, 2008

Segment Description	Mileposts		All Vehicles	Trucks
	Start	End		
Colorado State Highway 90[1]				
County RD 5.75 to Paradox	0.000	9.493	200	40
Paradox to Bedrock	9.493	14.797	NA	NA
Bedrock to Vancorum	14.797	33.874	530	82
Colorado State Highway 97[1]				
SH97 (Nucla Road) to County Road EE28 in Naturita	0.000	0.320	2,000	146
Naturita to Nucla	0.320	3.932	1,600	85
Colorado State Highway 141[1]				
US491/SH141 junction to Egnar	0.000	9.381	730	127
Egnar to K8 Road	9.381	11.271	730	173
K8 Road to southeast of SH141/145 junction	11.271	44.124	480	129
Southeast of SH141/145 junction to northwest of SH145	44.124	55.505	590	176
NW of SH145 to Naturita	55.505	60.213	1,500	222
East of SH97 (Nucla Road) to west of SH97 in Naturita	60.213	60.452	1,700	173
West of SH97 to Main Street in Naturita	60.452	60.701	2,400	228
Main Street to West 2nd Ave in Naturita	60.701	60.801	1,200	132
Naturita to junction of SH141 and SH90 at Vancorum	60.801	62.436	660	121
2 miles north of SH141/SH90 junction	62.436	64.395	340	46
2 miles north of SH90 junction to Gateway	64.395	110.525	460	91
Foy Road intersection to Gateway	110.525	153.767	680	121
Gateway to Whitewater	153.767	154.109	1,400	336
U.S. Highway 491[1]				
Junction of US491 and SH141 to County Road	63.272	67.947	2,400	562
County Road 6 to Utah border	67.947	69.602	2,100	573
Colorado State Highway 145[1]				
West of Lone Cone Road to Market Street in Norwood	99.494	101.066	2,800	274
Market Street to Spruce Street in Norwood	101.066	101.561	2,600	200
Spruce Street to Summet Street in Norwood	101.561	102.596	2,000	194
Norwood to Redvale	102.596	110.107	1,300	126
Redvale to SH145/SH141 intersection	110.107	116.879	1,200	110
Utah State Highway 46[2]				
Junction of SH 46 & SH 191 to La Sal Junction Post Office	0.000	9.052	600	210
La Sal Junction Post Office to Colorado state line	9.052	21.595	335	118
U.S. Highway 191[2]				
SR95 junction to Blanding	47.255	50.412	2,760	735
800 South to 200 North in Blanding	50.412	51.656	6,915	2,187
Blanding to Verdure	51.656	65.162	2,120	744
Verdure to 400 South in Monticello	65.162	71.460	2,455	946
400 South to US491 in Monticello	71.460	71.857	2,610	1,039
US491/US191 junction to 600 North in Monticello	71.857	72.395	3,160	1,341
600 North in Monticello to SR211	72.395	86.136	3,415	1,538
SR211 to La Sal Junction (SH46)	86.136	103.446	3,735	1,703
La Sal Junction to Old Airport Road	103.446	117.890	3,705	1,709
Old Airport Road to La Sal Loop	117.890	123.194	5,030	2,096

Segment Description	Mileposts		All Vehicles	Trucks
	Start	End		
La Sal Loop to 400 East Moab	123.194	124.484	9,635	3,586
400 East to Center Street in Moab	124.484	125.702	14,510	4,753
Center Street to 500 West in Moab	125.702	126.981	9,185	2,599
500 West, Moab to SR128	126.981	128.180	9,240	2,202
SR128 to Colorado River	128.180	129.798	8,225	1,593
Colorado River to SR279	129.798	130.262	6545	2043
SR279 to SR313 (Arches National Monument Road)	130.262	136.733	4835	1958
SR313 to I-70 Crescent Junction	136.733	157.193	5140	2623
Interstate 70[2]				
SR24 Hanksville Buckmaster Draw	149.198	157.939	4,085	1,601
SR6 West SR191 North	157.939	160.410	8,090	3,573
SR19 West Green River	160.410	164.547	8,870	4,359
SR19 East Green River	164.547	175.585	8,765	4,744
Ranch exit (Floy)	175.585	182.170	8,465	5,003
SR191 Crescent Junction, Moab	182.170	187.420	6,800	3,882

[1] Source: CDOT, 2009b.
[2] Source: Butterfield, 2009.

The junction of SH 90 and SH 141 is the nearest highway intersection to the Site. This junction is a three-leg configuration. Table 3.2-2 shows the results of a traffic count conducted at this intersection by TurnKey on October 19, 2007. The table includes an adjusted count to consider peak time of year traffic (July).

Table 3.2-2
Peak Hour Traffic Volume at Junction of SH 141 and SH 90, 2007[1]

	Eastbound			Northbound			Southbound		
Hourly traffic count	Lft	Thru	Rt	Lft	Thru	Rt	Lft	Thru	Rt
Raw count	1	NA[2]	13	18	12	NA	NA	17	1
Peak season adjustment	1	NA	15	21	14	NA	NA	20	1

[1] Source: TurnKey, 2008.
[2] NA=not available.

CDOT estimates that, over the next 20 years, traffic on SH 141 will increase 3.85 percent annually, and traffic on SH 90 will increase 3.4 percent annually (TurnKey, 2008).

3.2.4 Traffic Crashes

Table 3.2-3 shows the number of traffic crashes involving fatal and non-fatal injuries in counties near the Site for the years 2000 through 2008. Crash data for Colorado counties were obtained from the Colorado State Patrol (CSP), which reports crash data for CSP enforcement activity only. Statewide, the CSP investigates approximately 30 percent of traffic crashes, including 70 percent of all crashes involving fatalities. The CSP investigates most of the traffic crashes that occur in western Colorado (Allbee, 2009). Crash data for Utah counties reported by the Utah Department of Public Safety (UDPS) include crash reports completed by all law enforcement officers throughout the state.

Table 3.2-3
Traffic Crash Injuries and Fatalities in Surrounding Counties[1]

Year	Injury Type	County				
		Mesa CO	Montrose CO	San Miguel, CO	Grand UT	San Juan, UT
2000	Injury	401	131	58	NA	NA
	Fatal	14	2	3	NA	NA
2001	Injury	418	116	40	NA	NA
	Fatal	21	6	3	NA	NA
2002	Injury	423	108	37	119	115
	Fatal	18	3	2	8	6
2003	Injury	391	104	41	195	158
	Fatal	6	2	1	7	4
2004	Injury	400	87	48	185	169
	Fatal	14	6	7	11	7
2005	Injury	370	95	32	135	126
	Fatal	11	5	1	8	8
2006	Injury	377	80	41	153	106
	Fatal	16	5	2	8	0
2007	Injury	206	41	30	134	141
	Fatal	20	4	1	5	16
2008	Injury	212	44	15	NA	NA
	Fatal	8	9	4	NA	NA

[1] Sources: CSP, 2009; Allbee, 2009; and UDPS, 2009.
[2] NA=not available.

Fatality rate data provide additional information on fatal traffic crashes. Table 3.2-4 shows highway fatality rates in counties near the Site. According to CDOT, the 2008 highway fatality rate, expressed as fatalities per million vehicle miles traveled (MVMT), was 0.0114 across the State of Colorado, 0.0452 in Montrose County, 0.0173 in Mesa County, and 0.0521 in San Miguel County (CDOT, 2009c). Comparable highway fatality rates are not available for Utah counties. In 2007, the highway fatality rate in Utah was 0.0111 per MVMT on all highways and 0.0234 on rural roads in the state (National Highway Traffic Safety Administration - NHTSA, 2009).

Table 3.2-4
Fatality Rates per Million Vehicle Miles Traveled

Area	2007	2008
Colorado – all roads[1]	0.0114	0.0114
Colorado - rural roads[1]	0.0202	NA[3]
Mesa County[1]	0.0359	0.0173
Montrose County[1]	0.0226	0.0452
San Miguel County[1]	0.0130	0.0521
Utah – all roads[2]	0.0111	NA
Utah – rural roads[2]	0.0234	NA

[1] CDOT, 2009c.
[2] NHTSA, 2009.
[3] NA=not available.

3.3 GEOLOGY AND SOILS

3.3.1 Geology

Paradox Valley has been studied as part of the Paradox Basin by geologists since the nineteenth century from the perspectives of uranium/vanadium deposits, later exploration of oil and gas reservoirs and the more academic interest in the salt anticlines per se. A 1981 guidebook put out by the Rocky Mountain Association of Geologists (RMAG, 1982) stated in the Preface that the lack of petroleum exploration at that time was probably due to the complexity of the Paradox Salt. Since then, the literature of oil and gas, uranium, and pure geology of the region has proliferated.

Evaluation of the Site's conformance with mill and tailings siting criteria outlined in Appendix A, Part 18 of 6 CCR 1007-1 (CDPHE, 2001) requires a detailed knowledge of the local and regional geology. NRC Guidance for Environmental Reports for Uranium Mills also requires that there is a geologic characterization of the Site (NRC, 1982a and 2003a). Kleinfelder conducted extensive on-site field investigations to characterize baseline geology of the Site, as desribed below.

Geologic characterization began with a literature review in USGS, Colorado Geological Survey, and New Mexico Bureau of Mines and Mineral Resources sources. Aerial photographs of the area were obtained and reviewed to assist in the identification of larger scale geologic features. Geologic mapping was conducted in August 2007 on a topographic base map using a scale of 1 inch = 200 feet and a contour interval of 2 feet. Soils were classified according to the Unified Soil Classification System (USCS). The geologic mapping was conducted in accordance with the *Amendment No. 2, Geological Investigations Work Plan* (Kleinfelder, 2008a).

Supplemental geologic reconnaissance and mapping was conducted in December 2008 in the northern half of the Site and on the adjacent property to investigate any sinkholes or other karst features. The investigation included field reconnaissance of an observed sinkhole north of the Property Boundary, field observations of multiple circular-shaped clearings observable in aerial photographs, and reconnaissance of the contact between the alluvial valley fill deposits to the south and the weathered surface of the Paradox member of the Hermosa Formation to the north. The work was conducted in accordance with *Amendment No. 2, Geological Investigations Work Plan* (Kleinfelder, 2008a).

A refraction and reflection geophysical survey was conducted in 2007, to determine if faults could be detected in the Quaternary deposits, and if any evidence could be obtained regarding groundwater in the area. The seismic survey methodology and results are summarized in the *Geologic Report* Kleinfelder (2009e). In addition, two pilot tests using electromagnetic methods were conducted in February and March 2008 to further investigate an anomalous soil feature later identified in a trench. This work was performed in accordance with the Work Plan for Additional Geophysical Investigations (Sunbelt Geophysics, 2008). The results of the two pilot tests were provided in the *Geologic Report* by Kleinfelder (2009e).

Three trenches were excavated and mapped in December 2007 over possible subsurface faults inferred from the seismic refraction and reflection surveys. The purpose of the trench excavations was to assess if fault rupture or displacement has occurred in Quaternary alluvium overlying the inferred faults (to see if faults have been recently active). The trench mapping was completed in accordance with *Amendment No. 2 Geological Investigations Work Plan* (Kleinfelder, 2008a). During the trench mapping activities, organic samples were collected for

radiocarbon analysis to help establish the ages of the alluvium. The radiocarbon analysis methodology and results prepared by the Paleo Research Institute, Inc. were reported in the *Geologic Report* (Kleinfelder, 2009e). In total, the trenches totaled approximately 3,150 feet of linear excavation.

Several drilling programs were conducted at the Site for purposes of geotechnical characterization, general site geology, groundwater characterization and monitoring, and water resources development. These include:

- Phase 1 geotechnical investigation consisting of 20 borings in support of geotechnical soil testing (Kleinfelder, 2009e);
- Phase 2 geotechnical investigation consisting of 73 borings to support additional geotechnical characterization and design of facilities (Golder, 2008b);
- Nine groundwater monitoring wells drilled to provide sampling points for the baseline characterization of groundwater quality (Golder, 2009d);
- Eighteen borings drilled for geological characterization and as a preliminary phase of the water resources investigation (Kleinfelder, 2009e);
- Three production wells and six observation wells installed to investigate available water resources (Golder, 2009c); and
- Four additional borings to assess the soil discontinuity identified in Trench 2 (Kleinfelder, 2009d).

Geotechnical and stratigraphic discontinuity drilling consisted of continuous core or hollow stem auger drilling to identify soil types, depth to bedrock, and evidence of recent fault movement or voids. These borings were generally advanced to depths of less than 100 feet. Coring in the bedrock was typically performed using wet coring methods. Samples of unconsolidated sediments were collected by split spoon sampling methods. Core samples were collected from borehole intervals selected by the rig geologist to be representative of lithologic units and stratigraphic/formational boundaries. Groundwater monitoring wells, production wells, observation borings, and EX borings were drilled to depths of up to 1,020 feet using air rotary or down-the-hole hammer methods. Cuttings were collected from discrete intervals and logged by the rig geologist.

3.3.1.1 Regional Geology

The Site is located in Paradox Valley, within the Canyonlands Section of the Colorado Plateau Physiographic Province (Cater, 1954, 1955a 1955b, 1970, and Cater et al., 1955). This province consists of desert to arid parts of Utah, Colorado, New Mexico, and Arizona, a geomorphically young terrain of largely flat-lying continental strata with mesas, pediments, and deeply incised canyons (most famously, the Grand Canyon). The physiographic province was defined and described by Hunt (1967).

Paradox Valley lies in the eastern part of the depositional Paradox Basin, a vast basin approximately 200 miles long by 80 miles wide, with a northwest axis, and flanking the Uncompahgre anticlinal uplift (Figure 3.3-1). A schematic stratigraphic section is shown in Figure 3.3-2. In Mississippian time, marine limestone was deposited on the crystalline

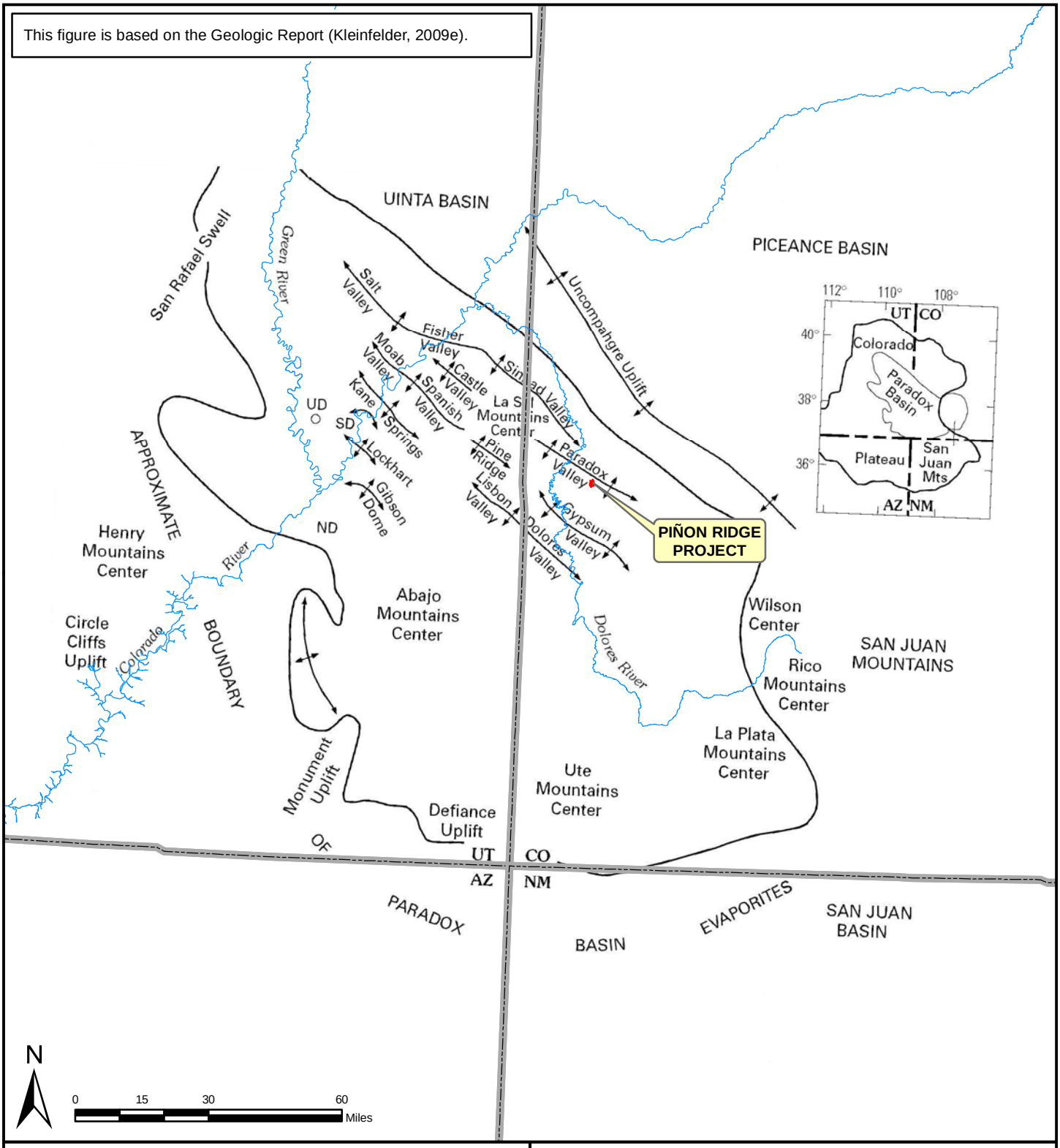


Figure 3.3-1

Regional Setting of the Paradox Basin

This figure is based on the Geologic Report (Kleinfelder, 2009e).

Era	Period	Formation and Map Unit Symbol	
Mesozoic	Cretaceous	Mancos Shale Km	
		Dakota Sandstone Kd	
		Burro Canyon Formation Kbc	
	Jurassic	Morrison Formation Jms	
		Summerville Formation Js	
		Entrada Sandstone Jec	
		Carmel Formation Jc	
		Navajo Sandstone Jn	
		Kayenta Sandstone Jk	
		Wingate Sandstone Jw	
	Triassic	Chinle Formation Trc	
		Moenkopi Formation Trm	Paradox Member Salt
Paleozoic	Permian	Cutler Formation Pc	
	Pennsylvannian	Hermosa Formation Phi	
	Mississippian	Leadville Limestone ML	

Figure 3.3-2

Schematic Stratigraphic Section Paradox Valley

basement, in Colorado called the Leadville Limestone, and at the Grand Canyon the Redwall Limestone. This limestone is overlain by upper Paleozoic sedimentary deposits including the shales and evaporites of the Paradox Member of the Hermosa Formation, regionally capped by the Honaker Trail Formation, and fluvial sandstone and conglomerate of the Permian Cutler Formation. The Paradox Member contains limestone, black shales, and gypsum, anhydrite, halite, and potash salt accumulations. Even as the Cutler Formation was deposited, the Paradox salt strata began to deform under burial load and between basin faults, to rise and flow into a series of northwesterly trending salt diapirs (intrusion of plastic, buoyant material through more competent rocks) (Chenoweth, 1987). This broad region of Paradox salt diapirs was termed the “Paradox fold and fault belt” by Kelley (1955). Up to the 1981 RMAG Guidebook (RMAG, 1982), early authors accorded formation status to the Paradox Salt.

The salt core anticlines continued to rise through the Jurassic Period, influencing the deposition of younger strata up to the Morrison Formation. The Honaker Trail and Cutler formations were tilted and thinned along the flanks of the rising salt diapirs. This continued through the Triassic period and into the Jurassic period, but diminished as the salt was lost from intervening synclines, and the diapirs stabilized. The area continued to accumulate up to 5,000 feet of younger Late Jurassic and Cretaceous formations across the upturned and truncated edges of the older formations (Chenoweth, 1987). Regional compression during the Laramide orogeny (Late Cretaceous to lower Tertiary time) accentuated these structures.

Broad uplift of the Colorado Plateau during the middle to late Tertiary, roughly 38 million to 2 million years ago, and extensive erosion in last few million years, exposed the salt diapirs to groundwater circulation via anticlinal jointing (Chenoweth, 1987), and the resulting dissolution of the salt caused collapse and removal of the anticlinal crests. Today, the anticlines have prominent sandstone bluff flanks, and broad, dry valleys exhuming the top of the Paradox Member. Paradox Valley obtains its name from the Dolores River crossing the valley perpendicular to its axis, while there is no watercourse along it (Cater, 1954, 1955a, 1955b, 1970 and Cater et al., 1955). According to Chenoweth (1987), Paradox Valley probably formed by the antecedent Dolores River cutting across the anticlinal crest and exposing the salt to rapid dissolution. Cater (1970) has estimated that the upper surface of the salt core of the anticline in Paradox Valley was at least 3,000 feet higher than the present day valley floor.

The salt core in Paradox Valley is exceptionally thick. An oil well drilled 1.5 miles north of the Town of Bedrock penetrated the base of the salt at 14,670 feet depth (Chenoweth, 1987). Cater (1954) reports that more than half the formation is composed of rock salt (halite), although this has not been encountered at the Site.

Triassic strata overlying the Cutler Formation include the red bed Moenkopi and Chinle formations. Above them lie the Jurassic Wingate Sandstone, Kayenta Formation and Navajo Sandstone (together, grouped as the Glen Canyon Series), and the Morrison Formation, famous for dinosaur fossils and uranium/vanadium deposits. To the east and west of the area, Dakota Sandstone overlies the Morrison Formation, and in turn is overlain by the Mancos Shale, deposited in the Cretaceous seaway.

Most erosion of the Colorado Plateau is thought to have occurred in upper Tertiary and Quaternary time (Pelletier, 2009), leaving the characteristic bluff-bordered valleys with relict mesas and buttes, and steeply incised river canyons. The landscape of the entire Colorado Plateau including Paradox Valley was reduced on average from 1,640 feet to 3,280 feet (500 to 1,000 meters) by erosion in that period, according to Pelletier, even as it was uplifted. Recent

deposits of sheet wash and aeolian sand sheets are widely distributed on the valley floors and on top of the mesas (Cater, 1954).

Volcanic rocks do not occur within the immediate vicinity of the Site. The nearest volcanic rocks occur at the western margin of the Oligocene (~ 20 to 30 million years old) San Juan volcanic field, approximately 60 miles east of the Site. Volcanism near Flagstaff, Arizona, some 250 miles to the southwest, began about 6 million years ago, and ended only 1,000 years ago. Other recent volcanic fields occur in and around the Grand Canyon, and near Grants, New Mexico. The La Sal Mountains at the northern head of Paradox Valley, and the Henry Mountains to the west, are igneous intrusions of Oligocene age (25 to 28 million years old), exhumed by the late Tertiary – Quaternary erosion referred to above. A small intrusive body of similar age occurs in the synclinal Disappointment Valley, some 20 miles south.

3.3.1.2 Site Geology

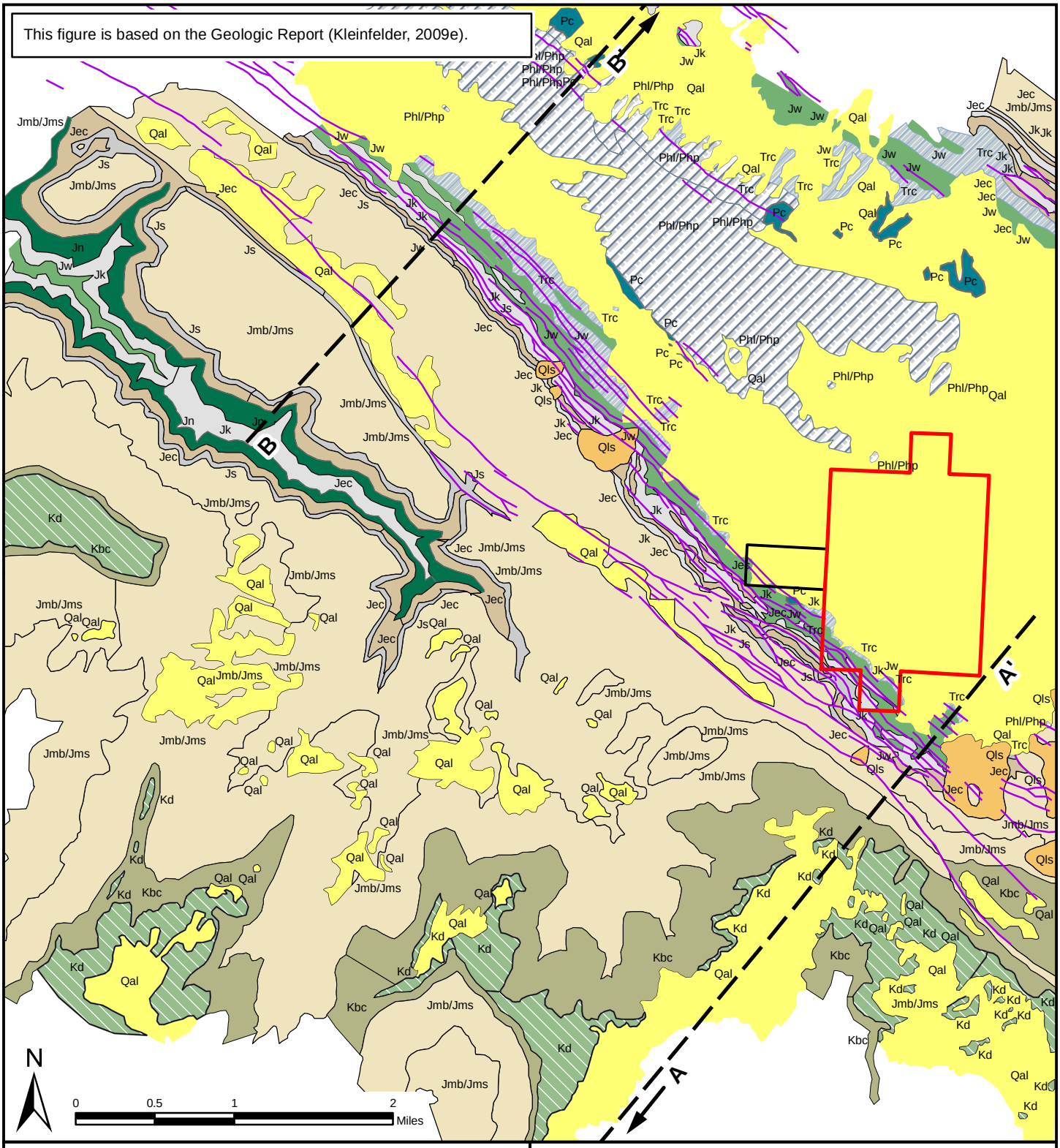
The Site is located on the south side of the southeastern end of Paradox Valley. The regional geology is shown in Figure 3.3-3. Cross sections at locations indicated in Figure 3.3-3, and taken from USGS quadrangle geology maps, are shown in Figure 3.3-4. Most of the Site is on the valley floor, but the southwest part of the Site extends onto the valley side below Davis Mesa, which consists of Triassic to Jurassic strata including Chinle, Wingate, Kayenta, Entrada, and Morrison formations. Most of the Site (the valley bottom) is covered by late Quaternary deposits of fine-grained alluvium and eolian (wind-blown) deposits with some gravelly alluvial stream channel deposits. Underlying the unconsolidated sediment cover in the valley are Chinle and Wingate sandstones and Paradox Member shales and evaporites.

Southeast of the Site is a slumped block of Morrison Formation, which is detached from the valley sides, and in which Cotter has mined uranium/vanadium ore. This block is thoroughly broken by curved faults, and shale beds are contorted (Strauss, 1982).

Paleozoic and Mesozoic strata outcropping in the flanks of Paradox Valley have been mapped and described extensively, as described in the regional geology section. The geology of the bedrock beneath the Site alluvium was explored with geophysical surveys, borings, and trenching. This work is reported in the *Geologic Report* (Kleinfelder, 2009e). The location of seismic survey lines, trenches, and borings of this program are shown in Figure 3.3-5.

Surficial Geology – Quaternary Sediments. Most of the Site is located on the floor of Paradox Valley and is underlain by deposits of unconsolidated late Quaternary eolian (wind blown) and alluvial sediments derived from the Triassic-Jurassic strata now exposed in the valley sides. The alluvial sediments pinch out against the bedrock to the south, thicken up to 140 feet thick near the center of the Site, and thin to the north near the center of the valley where the Hermosa Formation surfaces.

The Site alluvial surface consists principally of eolian, light brown to brown fine-grained sand with silt and clay. Thin alluvial fans skirt the base of the southwest valley side, and minor alluvial channel deposits of loose sand with some boulders occur along ephemeral channels which merge into valley bottom alluvial sheet wash deposits of fine-grained sand with intermixed gravel, silt, and clay. A patch of residual soils developed over the Paradox Member was mapped on the northeast portion of the Site.



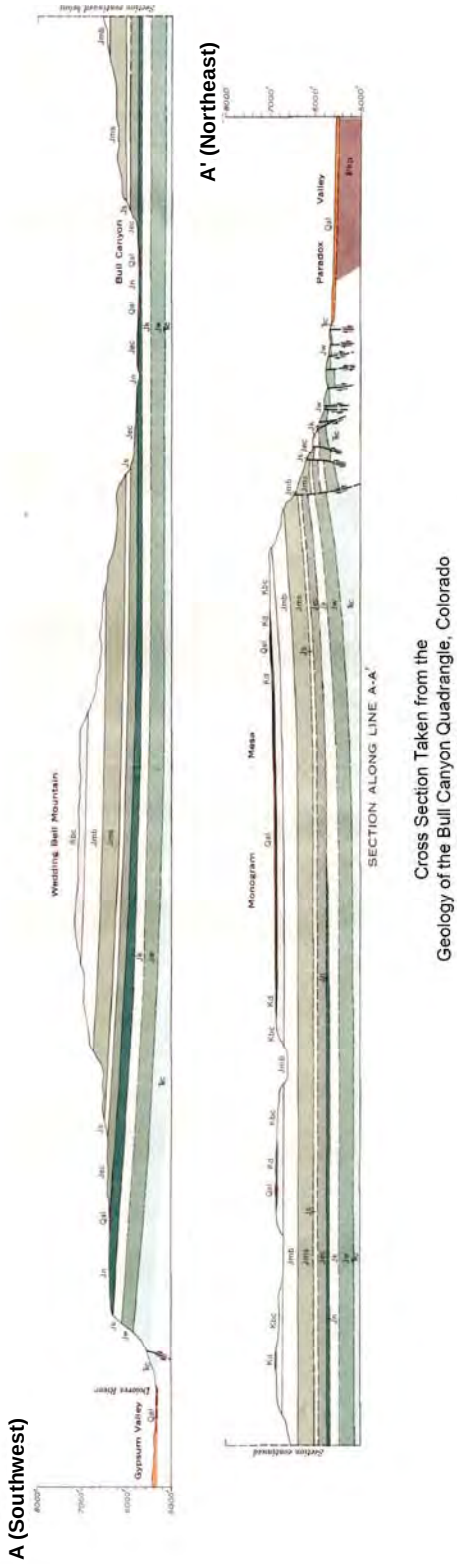
Property Boundary
Well Field Boundary
Geology Cross-Sections
Fault Trace

Geology
- Jec, Entrada Sandstone and Carmel Formation undivided
- Jk, Wingate Sandstone
- Jmb/Jms, Morrison Formation
- Jn, Navajo Sandstone
- Js, Summerville Formation
- Jw, Wingate Sandstone
- Kbc, Burro Canyon Formation
- Kd, Dakota Sandstone
- Pc, Cutler Formation
- Phl/Php, Hermosa Formation
- Qal, Alluvium
- Qls, Landslide deposits
- Trc, Chinle Formation

Figure 3.3-3

Regional Geology

This figure is based on the Geologic Report (Kleinfelder, 2009e).



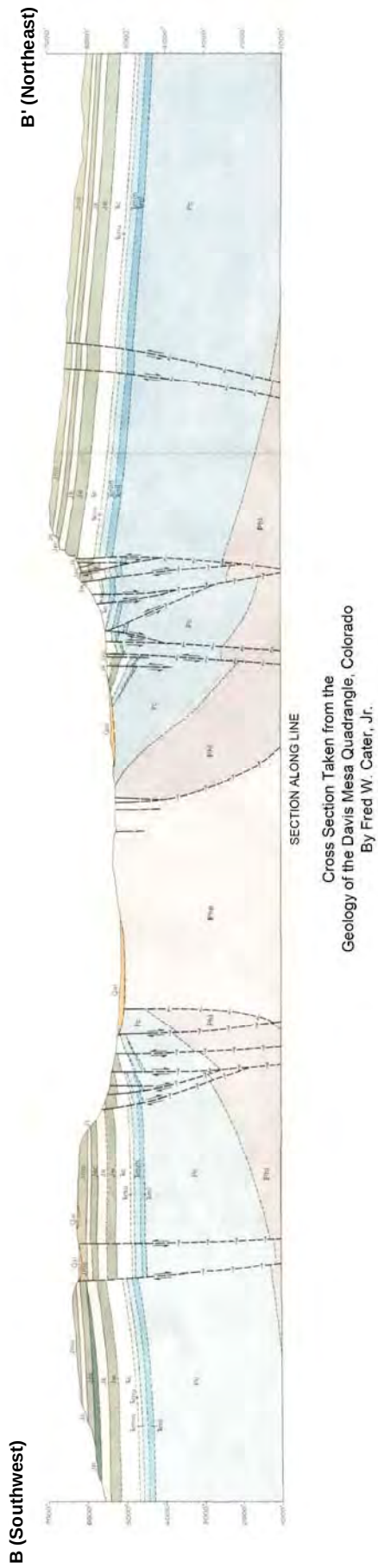
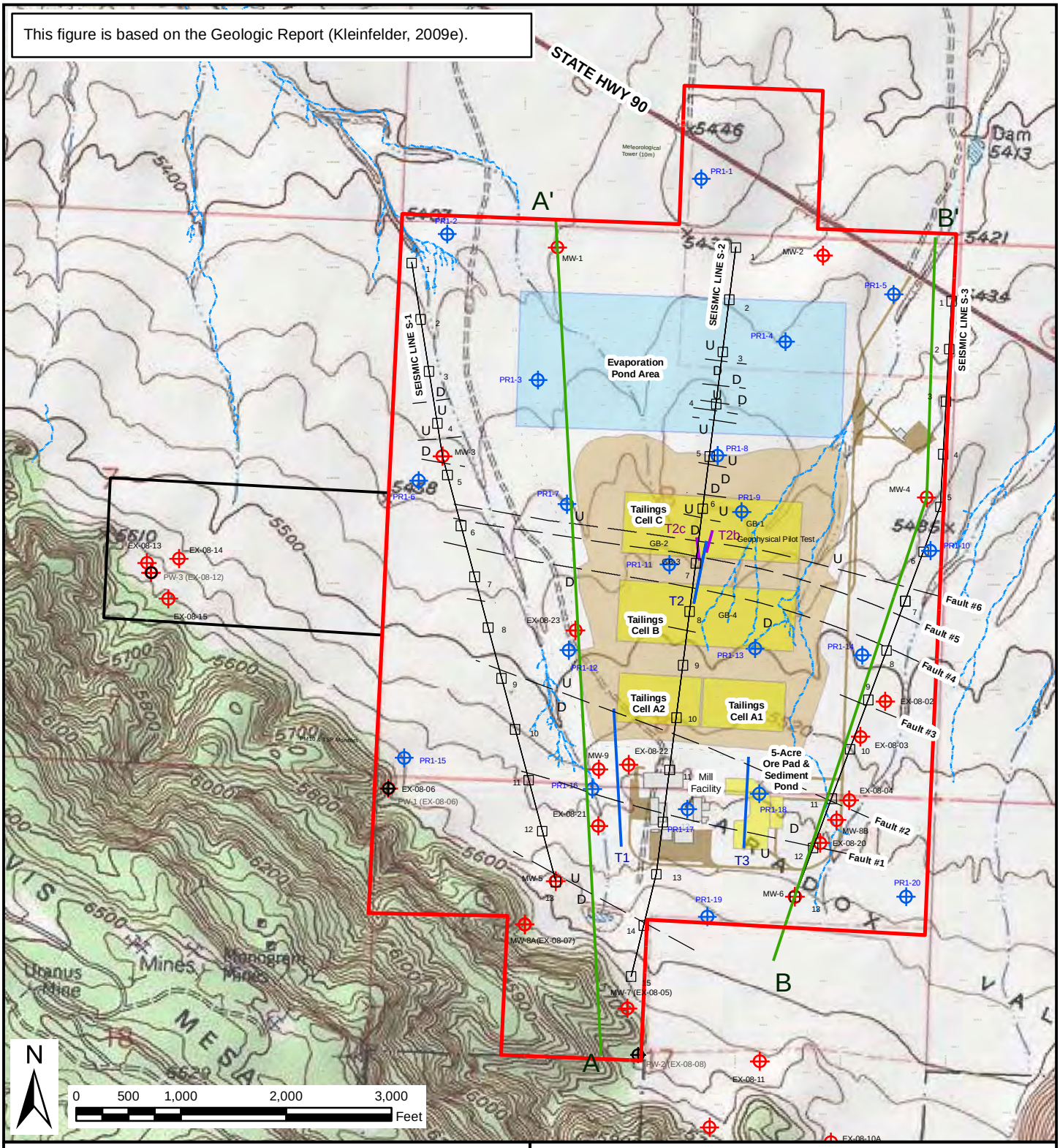


Figure 3.3-4

Regional Geologic Cross-Sections

See Figure 3.3-3 for Cross-Section Locations and Formation Explanantions



Property Boundary
Well Field Boundary
Monitor Wells
Production Wells
Exploratory Wells
Phase I Geotech PR Boring
Fault (Dashed where inferred)
Seismic Lines
Cross Section Lines
Trenches (Excavated & Mapped 12/07)
Trenches (Excavated & Mapped 05/08)
Ditches

Figure 3.3-5

Seismic Lines, Trenches, and Boring Locations

Unconsolidated materials identified in the geotechnical boreholes consisted primarily of light brown to brown interbedded silty sand (SM in the USCS classification - USCS, 1966) and sandy silt (ML), with occasional interbeds of sandy and silty clay and lean clay (CL). Fine to coarse gravel and cobble-sized materials occur in lenses or as float in the fine sediments. The coarser alluvial material represents alluvial detritus deposited as sheet wash or in small channels similar to those on the surface today. Some of the beds were weakly cemented by caliche (calcium carbonate). Three trenches excavated and mapped in December, 2007, at locations shown in Figures 3.3-5 and 3.3-6 showed no displacement of any soil layers by faulting.

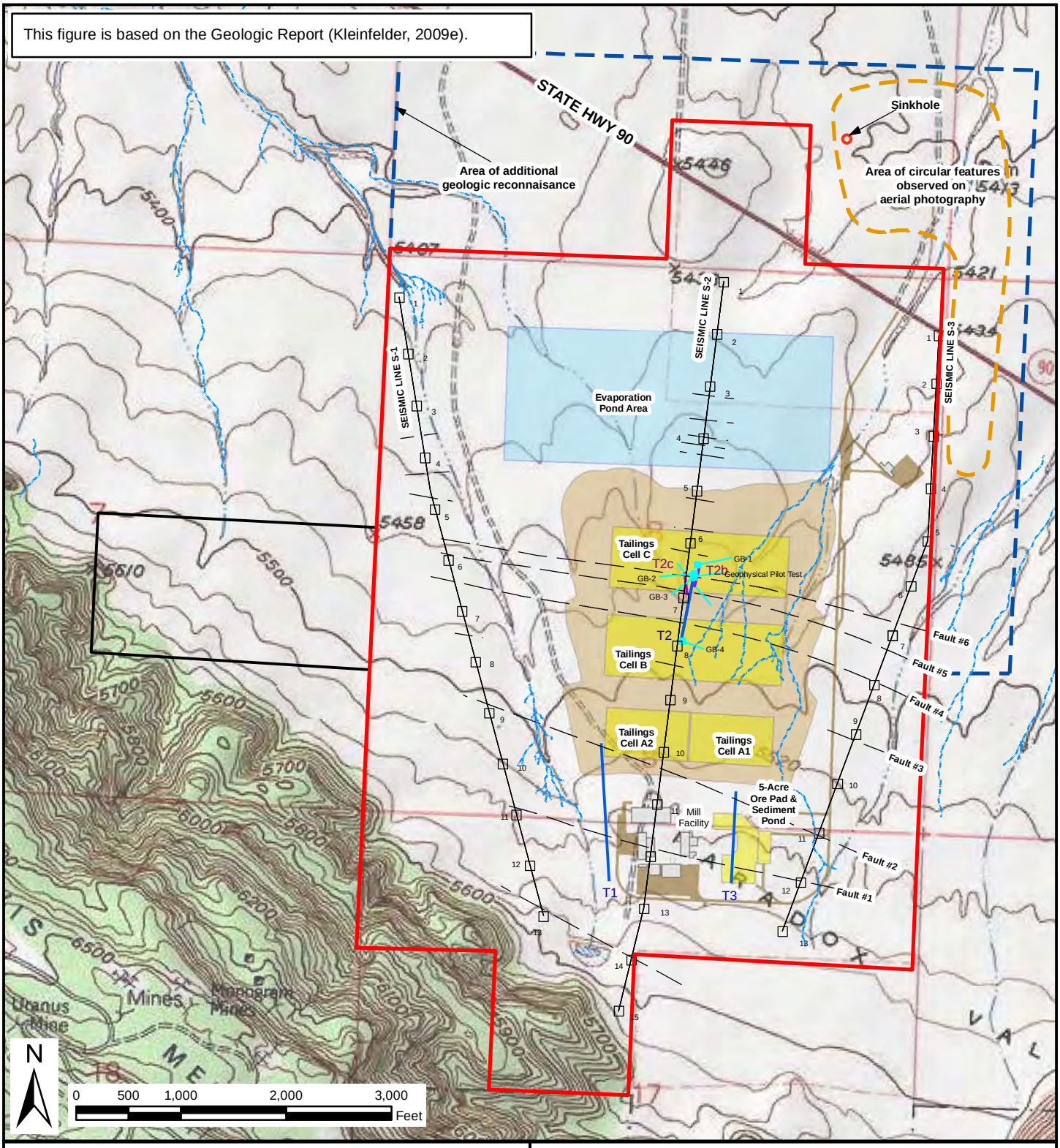
Additional investigations were conducted to more fully assess the lateral extent and the origin of a soil discontinuity feature identified in Trench 2, and the possibility it might be associated with a bedrock sinkhole. The investigations included electromagnetic survey (February/March 2008), excavation of two additional trenches (May 2008) and drilling of four boreholes (October 2008). The locations of the additional trenches and the four borings are provided in Figure 3.3-6. The conclusion of these investigations was that there is no bedrock discontinuity associated with the soil feature, and the latter is likely a channel cut-and-fill.

Bedrock Geology. Triassic and Jurassic strata outcrop in the valley side at the southwest of the Site below Davis Mesa. Rocks exposed there include siltstone, sandstone, shale, and conglomerate of the Chinle and Wingate formations. Rocks encountered in drill holes below the unconsolidated Quaternary sediments in the valley floor include Moenkopi, Chinle, and Wingate formations underlain by the Paradox Member. The Cutler Formation was not penetrated in any of the boreholes and appears to be absent at the Site, consistent with deposition of this formation being interrupted by the diapiric rise of the Paradox salt. The weathered surface of the Hermosa Formation is exposed in the valley floor north of the Site. Figures 3.3-7 and 3.3-8 show fence diagrams of lithology encountered in site borings.

Where the Paradox Member is intercepted in site borings, it consists of interbedded dark brown-dark gray-black shale, white to dark gray anhydrite, white to gray gypsum and minor carbonaceous limestone, siltstone, and sandstone. Occasionally, the cuttings have a sulfide odor. All known surface occurrences of the Paradox are remnants of the salt diapir and the beds are typically highly contorted.

Hermosa Formation evaporites are prone to dissolution and possible karst development, and additional investigations and mapping were conducted to look for solution features along the north and east margins of the Site where the Hermosa Formation is near the surface or is exposed. The area covered in these additional investigations is shown in Figure 3.3-6. A single sinkhole was identified in the weathered surface of the Hermosa Formation just north of the Site boundary (Figure 3.3-6). This sinkhole was approximately 5 feet in diameter and 4 feet deep with halite (sodium chloride salt) intermixed with soil in the walls. An aerial photography assessment of the northern part of the Site identified numerous circular features, 35 of which were located and inspected in the field. These features were concluded to be caused by “cryptogamic” soil development associated with radial propagation of algae-lichens. These are soil crusts rimmed by remnants of the lichens that formed them (Belnap and Lange, 2001). They are not indicative of any subsurface dissolution or other structure.

All of the Triassic strata and the Cutler Formation thin onto the southwest anticline flank, and in the valley the Moenkopi overlies the Hermosa. Only the uppermost Moenkopi has been identified in site boreholes. This section consists of interbedded sandstone, siltstone, and mudstone, varying from light gray to buff to brown and reddish-brown. In general, the sandstone



Property Boundary
Well Field Boundary
Fault (Dashed where inferred)
Seismic Lines
Trenches (Excavated & Mapped 12/07)
Trenches (Excavated & Mapped 05/08)
Geologic Investigation Borings 10/08

Figure 3.3-6

Additional Geologic Investigations

This figure is based on the Geologic Report (Kleinfelder, 2009e).

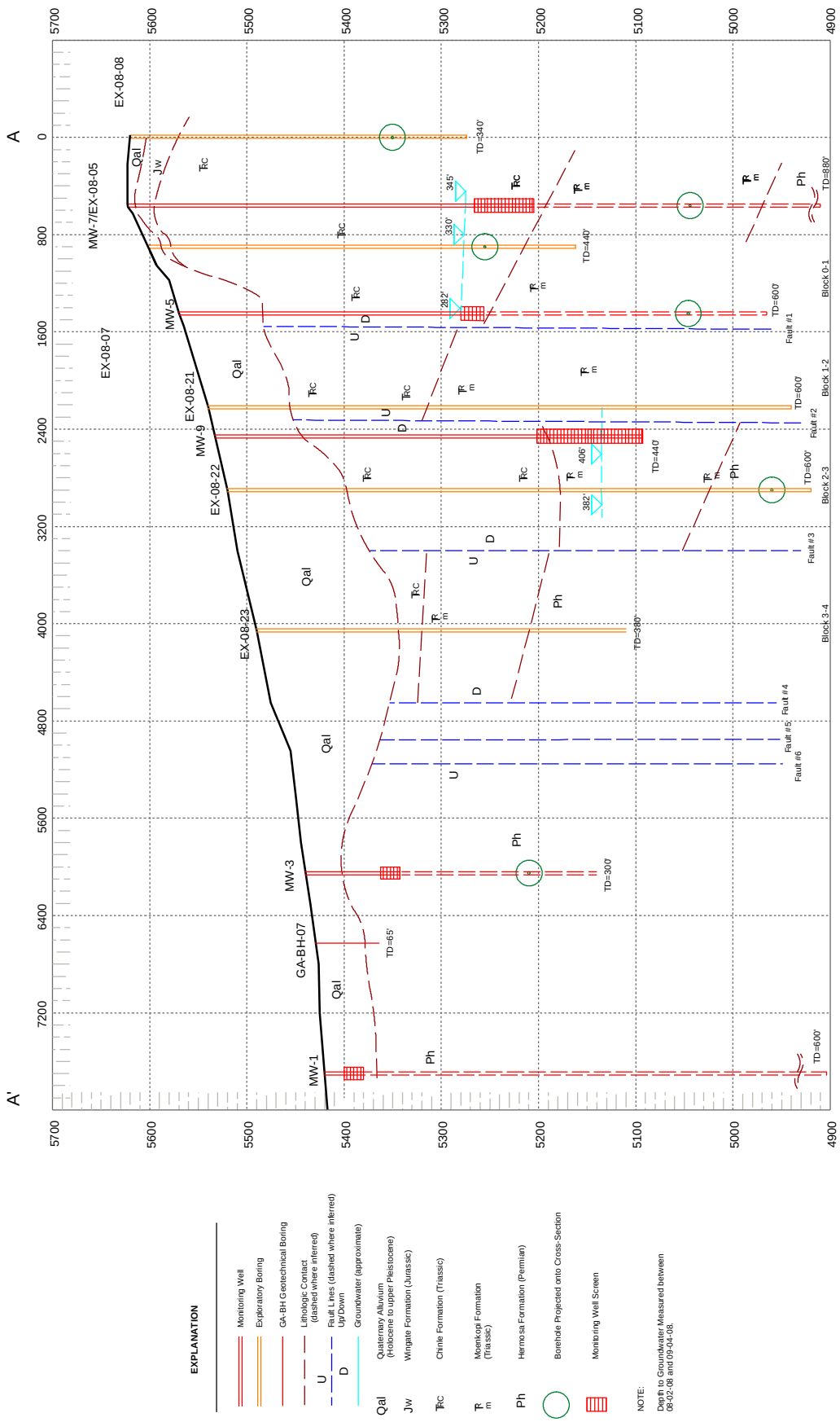
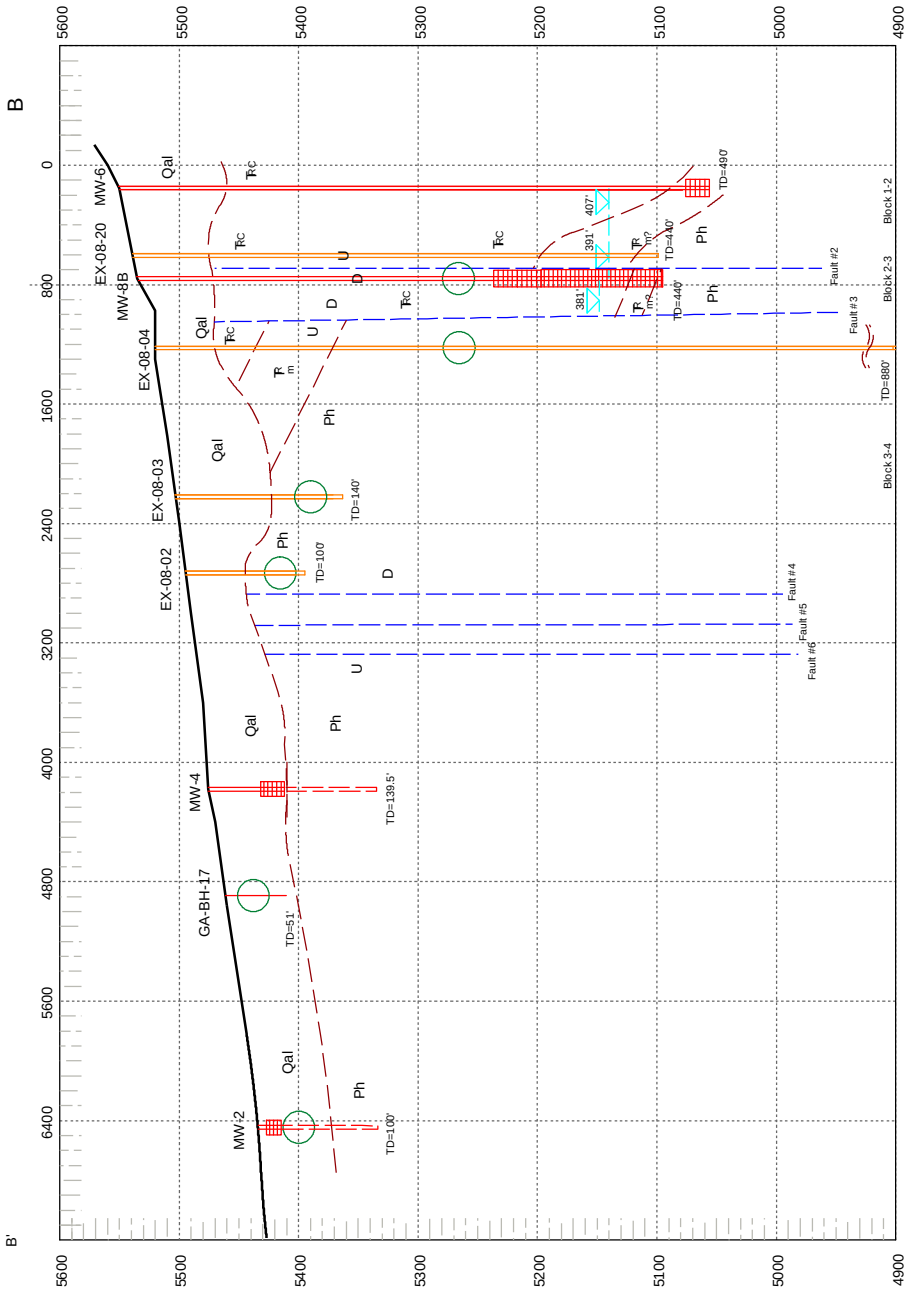


Figure 3.3-7

Geologic Cross-Section A-A'

This figure is based on the Geologic Report (Kleinfelder, 2009e).



EXPLANATION

- Monitoring Well
- Exploratory Boring
- GA-BH Geotechnical Boring
- Lithologic Contact (dashed where inferred)
- U / D Fault Lines (dashed where inferred) Up/Down
- Groundwater (approximate)
- Qal — Quaternary Alluvium (Holocene to upper Pleistocene)
- Jw — Wingate Formation (Jurassic)
- TRc — Chinle Formation (Triassic)
- TRm — Moenkopi Formation (Triassic)
- Ph — Hermosa Formation (Permian)
- Borehole Projected onto Cross-Section
- Monitoring Well Screen

NOTE:
Depth to Groundwater Measured between 08-02-08 and 09-04-08.

Figure 3.3-8

Geologic Cross-Section B-B'

is fine-grained. The top of the Moenkopi is occasionally recognizable by a clayey paleosol. Based on boreholes, the Moenkopi Formation is up to 200 feet thick beneath the southwestern corner of the Site. The Upper Triassic Chinle Formation overlies the Moenkopi Formation beneath the southern portion of the Site and consists of interbedded red to orange-red siltstone and fine-grained sandstone with interbeds of reddish-brown shale and pebbly conglomerate. The Chinle appears to be up to 400 feet thick in boreholes.

The cliff-forming Jurassic Wingate Sandstone overlies the Chinle Formation in the valley sides. The Wingate is an aeolian fine-grained, massive, light brown to buff colored sandstone composed of well-sorted quartz sand, typically brown-red in cliff faces with prominent dune cross bedding. The Wingate Formation attains a maximum thickness of 325 feet in the Davis Mesa Quadrangle (Cater, 1955b).

A slump block of Jurassic Morrison Formation sandstone and shale lies directly southeast of the Site, in which Cotter Corp has mined uranium/vanadium ore, and which the USGS mapped as a Quaternary slide (Tweto, 1979). Strauss (1982) mapped structure in this slump block.

Geological Structure. The Site is located within the salt diapiric anticlinal Paradox Valley. The crest of the anticline has collapsed and been eroded, so that the valley floor is the root of the diapir while the valley sides are the anticlinal flanks. The doming of the anticline was originally partly controlled by northwesterly striking faults, and the collapse caused extensive faulting on the limbs.

As shown in the cross section in Figure 3.3-4, major faults in the flanks of the valley parallel the anticline axis and bound the Paradox core, and stepped faults now observed in the valley sides are mostly (but not all) normal, consistent with the collapse of the arch over the upthrusting salt core. The down-slumped block of the Morrison Formation to the southeast of the Site is known from Cotter's surface and underground mine to be highly broken by faulting limited to the slide mass (Strauss, 1982).

Seismic reflection and refraction surveys show the same fault trend parallel to the anticline axis on the southeast flank of the valley beneath the Site, as shown in Figure 3.3-5. As indicated in Figure 3.3-7 and Figure 3.3-8, successive fault blocks are not necessarily regularly stair-stepped to the northeast.

A contour map of the top of bedrock based on boring logs is presented in Figure 3.3-9. The bedrock surface continues the slope of the valley sides off Davis Mesa toward the northeast, and off the Morrison Formation slump block toward the northwest, with a paleo-gully between. The bedrock surface flattens at a depth of about 80 feet. The bedrock surface does not appear to show any influence from the faults.

Seismic surveys were conducted by Geological Associates of Albuquerque in 2007 (Kleinfelder, 2009e), and exploration drilling was conducted by Kleinfelder in 2008 (Kleinfelder, 2009e). Six primary buried faults were identified as shown in Figure 3.3-5 and illustrated on the geologic cross-sections in Figure 3.3-7 and Figure 3.3-8. Several other small, closely spaced faults in the Hermosa Formation in the north of the Site were inferred from the seismic survey profiles. Interpretation in the cross section of Figures 3.3-7 and 3.3-8 of relative displacement on faults was based on borings, for which geophysical data were not useful due to similar seismic velocities in the uppermost strata. The depths of boring contacts were projected on to the cross-sections, which obscures the continuity of the displacement on these sections. Displacements

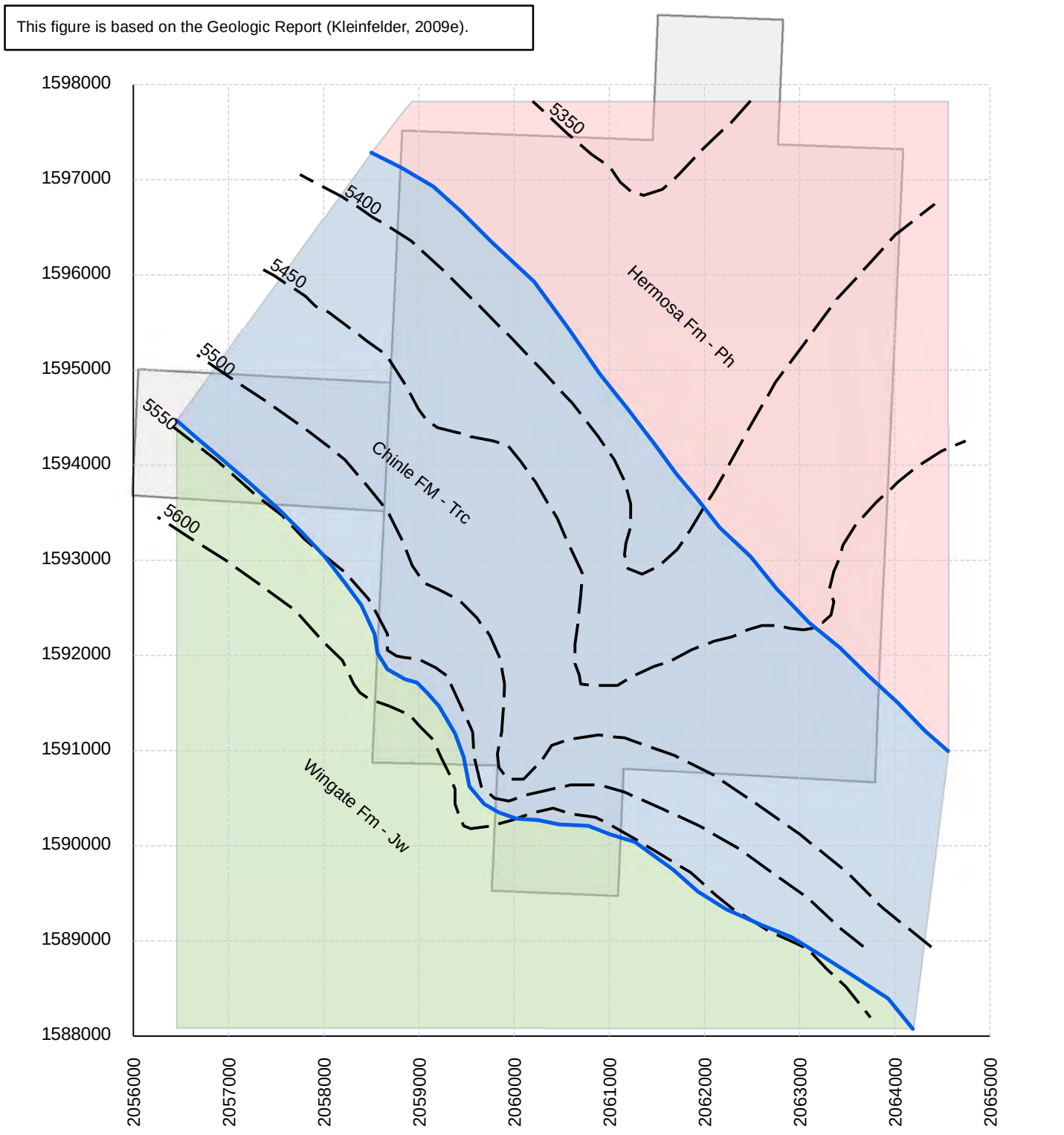


Figure 3.3-9

Top of Bedrock Contours

also vary along the faults with some rotation (scissors displacement), which is also consistent with the anticlinal limb collapsing along the axial trend, but segmented on local, curved slump faults.

From south to north, the six major inferred faults have been labeled as follows:

- Fault #1 – lying near the foot of Davis Mesa and trending WNW-ESE, normal and upthrown to the north.
- Fault #2 – lying under the footprint of the proposed Mill Facility and trending WNW-ESE, upthrown to the south.
- Fault #3 – lying under the southwest part of proposed Tailing Cell 1A and trending WNW-ESE with the north side upthrown.
- Faults #4, #5, and #6 – closely spaced and lying under proposed tailing Cells B and C, likely en echelon with displacement up to the north and probably dipping steeply to the south. This shear surface is the boundary between the salt diapir and the intruded Permian-Triassic strata.

Extensive trench mapping was conducted in December 2007 (Trenches 1, 2, and 3) and May 2008 (Trenches 2b and 2c) by Kleinfelder (2009e). The late Quaternary soil deposits overlying the buried faults showed no evidence of displacement of the soil layers, indicating an absence of post-depositional or late Quaternary surface faulting. The detailed geologic logs of the trench excavations are presented in Appendix A of the *Geologic Report* (Kleinfelder, 2009e). One apparent discontinuity in soil bedding observed in a trench was further investigated by electromagnetic survey by Sunbelt Geophysics in 2008 (in Kleinfelder, 2009e) to assess if there were any possible relationship to bedrock dissolution. Sunbelt Geophysics also evaluated a slight seismic anomaly. The soil discontinuity appeared to be less than 7 feet deep and have no traceable structure. The seismic signature appeared to correlate with a velocity contrast in Paradox Member rocks, probably related to a gypsum or anhydrite layer. Neither seems related to faulting or dissolution.

The pattern of faulting in the buried bedrock formations is consistent with the structural development of the Paradox anticline and the subsequent dissolution and collapse of the salt core. No bedrock topographic features, lineaments sought in aerial photography, or soil trenching indicate any deformation of Recent age.

3.3.1.3 Seismicity

According to the Colorado Geological Survey, more than 500 earthquake tremors have occurred in the State Colorado since 1867 (Colorado Geological Survey - CGS, 2002). The largest known earthquake in Colorado was the November 8, 1882 earthquake, of which the size and location remain uncertain (Sheehan et al., 2003). This earthquake had an estimated moment magnitude of 6.6 ± 0.6 and was located somewhere in north-central Colorado (Spence et al., 1996). It damaged the power plant in Denver and cracked buildings in Boulder. However, most of the earthquakes in Colorado have been due to induced seismicity caused by human activities. The best known examples are those induced by the disposal of waste fluids at the Rocky Mountain Arsenal near Denver and secondary oil recovery in western Colorado at the Rangely oil field (Sheehan et al., 2003). The injection of salty water in deep formations below the Paradox Valley Unit, approximately 9 miles west of the Site, by the BOR has also generated more than 3,000 minor earthquakes since the beginning of the injection process in 1995 with magnitude up to 4.3 in May 2000 (CGS, 2002). The two largest events recorded in northwest Colorado were also

man-made, being subsurface detonations of nuclear devices by the federal government to assess potential for development of tight natural gas fields (Rio Blanco and Rulison tests) (DOE, 2000).

Local and Regional Faulting. Geological studies in Colorado have discovered about 100 faults that moved during the Quaternary Period (past 2 million years). Most of these were identified by their displacement of Quaternary deposits. A few faults displace late Quaternary deposits (from approximately the last 130,000 years), including the Sangre do Cristo fault, on the west edge of the Sangre de Cristo Mountains, and the Sawatch fault, on the eastern margin of the Sawatch Range, two of the most prominent potentially active tectonic faults in Colorado. These faults are approximately 150 miles east of the Site.

The Uncompaghre Uplift east of the Paradox Valley is a large and broad tectonic anticline with a faulted margin against the Paradox Basin. These faults were active during the deposition of the Hermosa Formation, and in pulses through mid Triassic (Elston et al., 1964). Little or no seismicity is now associated with the Uncompaghre anticline or faults.

Faults in the vicinity of the Site are not tectonic faults associated with deep crustal movement. The most prominent faults in the area are the shear boundary between diapiric salt and intruded Permian-Mesozoic rocks, faults in the flanks of the anticlines raised by the diapirs, anticline collapse faults associated with salt core erosion, and valley side slump faults. Some of the faults in the flanks of the Paradox anticline may have been active in each of these phases. Valley side slump shears segment the remains of the anticline limbs. All of these faults were essentially expressions of the long term salt migration, subsequent hollowing out of the salt plug and collapse of the crest. Modern movement on the fault relics should be limited to creep of rock masses toward the valley. The only recordable seismic events in the area should be either man-made or cliff rock-falls.

Faults in the vicinity of the Site are associated by the USGS Quaternary fault database, No. 2286, 2008, with the Paradox diapiric anticline. This database shows the Paradox Valley faults as having movement as recently as Pleistocene, although no evidence of Holocene-age movement has been documented. USGS classifies faults according to three categories – A, B, or C. Class A faults show geologic evidence of Quaternary-age activity of tectonic origin. Class C faults show no evidence of Quaternary deformation. Class B faults are those that exhibit geologic evidence of Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the available geologic evidence is too weak to confidently assign the feature to Class A or C. These faults are judged to be non-capable (not generators of seismicity) according to the Criterion 4E of 6CCR 1007-1, Part 18, Appendix A (CDPHE, 2001).

Significant faults within a radius of 62 miles (100 km) of the Site are listed in Table 3.3-1, with parameters reported in the USGS fault database (USGS, 2008). The first seven of these are all associated with Paradox Member salt diapirs. The State of Colorado Earthquake and Fault Map (CGS, 2002) classifies the Paradox Valley fault system as displacing middle to early Quaternary deposits (approximately 130,000 to 2 million years old); it is not recognized as displacing late Quaternary deposits (younger than 130,000 years). The Paradox Valley bedrock faults are covered by Quaternary deposits which extensive trenching showed to be undisturbed.

Table 3.3-1
Significant Faults in the Region [1]

Fault Name	Length (miles)	Distance from Site (miles)	Fault Type	Strike Angle	Slip Rate (mm/yr) [2]	Recent Deformation
Paradox Valley	35	< 1	Normal	N46W	< 0.02	Quaternary
Big Gypsum Valley	21	17	Normal	N54W	< 0.2	Quaternary
Unnamed at northwest end of Paradox Valley	3	19	Normal	N2W	< 0.2	Quaternary
Atkinson Mesa	25	19	Normal	N63W	< 0.2	Quaternary
Pinto Mesa	12	21	Normal	N43W	< 0.2	Quaternary
Sinbad Valley	20	22	Normal	N50W	< 0.2	Quaternary
Lisbon Valley	24	23	Normal	N47W	< 0.2	Quaternary
Pine Ridge	4	22	Normal	N72W	< 0.2	Quaternary
Dolores	9	25	Normal	N67W	< 0.2	Quaternary
Pine Mountain	19	28	Normal	N52W	< 0.2	Quaternary
Monitor Creek	19	39	Normal	N86W	< 0.2	Quaternary
Roubideau Creek	16	39	Normal	N74W	< 0.2	Latest Quaternary
Shay graben	25	31	Normal	N66E	< 0.2	Quaternary
Moab and Spanish Valley	42	31	Normal	N52W	< 0.2	Quaternary
Ridgeway	15	43	Normal	N87E	< 0.2	Quaternary
Log Hill Mesa graben	6	50	Normal	N32W	< 0.2	Late Quaternary
Busted Boiler	11	50	Normal	N5W	< 0.2	Late Quaternary
Red Rocks	24	56	Normal	N59W	< 0.2	Quaternary
Needles	18	59	Normal	N10E	< 0.2	Latest Quaternary

[1] Source: USGS, 2008.
[2] 1 mm is equal to 0.04 inches.

Some of the potentially active faults in Colorado have been assigned MCEs (maximum credible earthquakes) by Kirkham and Rogers (1981) based on the length of the fault, age of the latest movement, and recurrence interval of the past earthquakes. Figure 3.3-10 shows their assigned magnitudes of MCEs for the more significant faults in Colorado. Of those nearest to the Site, the Busted Boiler and Ridgway faults have been deemed to have potential to generate magnitude 6.25. The Red Rocks fault has been assigned magnitude 6.75. Kirkham and Rogers (1981) estimated the possible MCE from Paradox Basin salt anticline faults which penetrate to basement to be about magnitude 5.

Historical Seismicity. The seismicity of Colorado has been characterized as being low to moderate (Kirkham and Rogers, 1981) partly due to limited seismographic coverage in western Colorado, and to the relatively few sizable earthquakes in the recent record.

Induced Seismicity. Many recorded earthquakes in Colorado have been caused by man's activities. The best known examples of induced seismicity in Colorado are those induced by the disposal of waste fluids at the Rocky Mountain Arsenal near Denver, and secondary oil recovery by reservoir flooding with water in the Rangely oil field (Sheehan et al., 2003). Some seismicity is also caused in the northern Paradox Valley by deep injection of saline water by the BOR (Paradox Valley Unit -

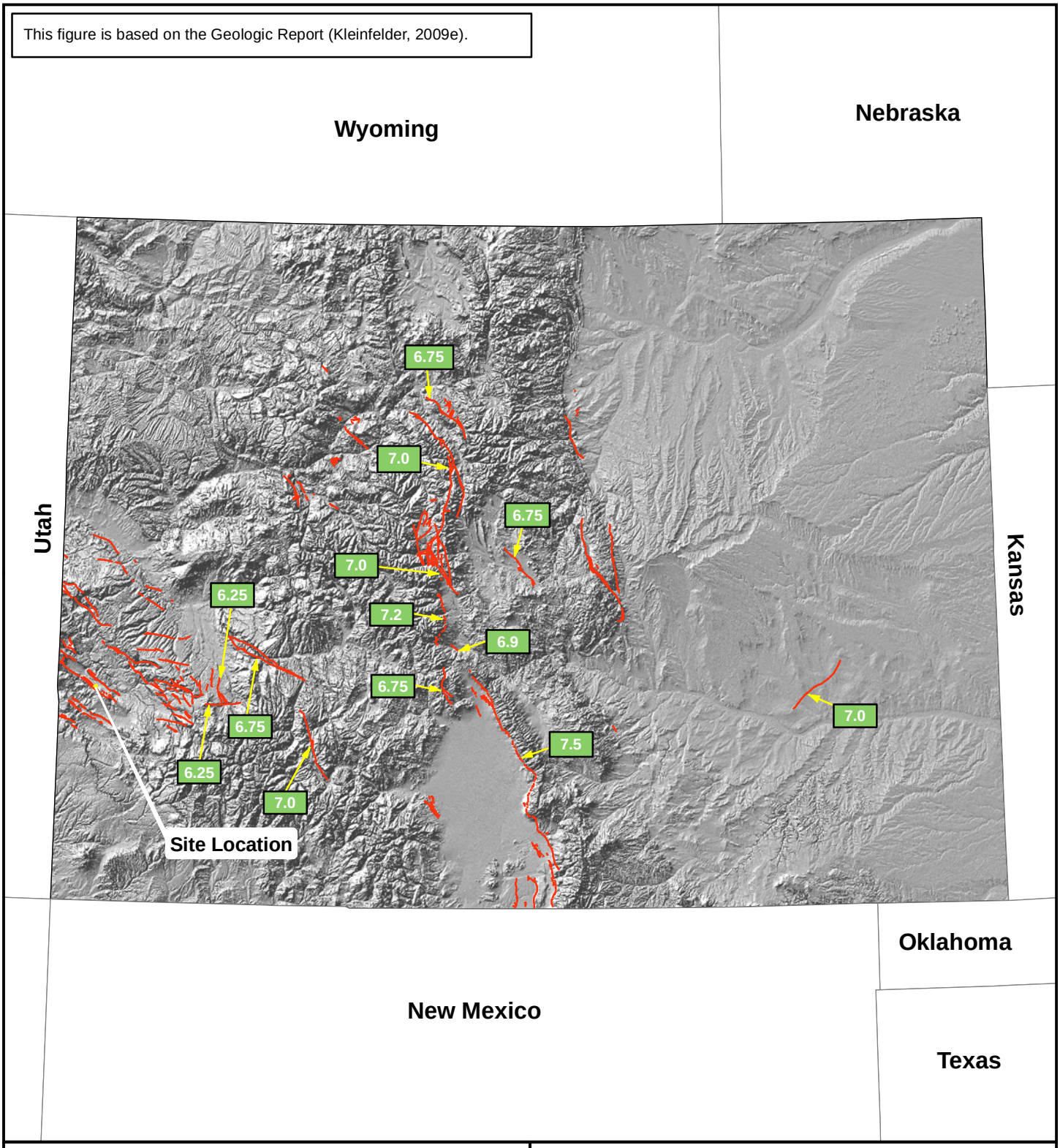


Figure 3.3-10

Magnitude of Maximum Credible Earthquakes in Colorado

PVU), as part of attempts to limit the salinity in the Colorado River as required by a 1944 U.S.-Mexico treaty, amended in 1974 to address water quality, and enacted as the Colorado River Basin Salinity Control Act of 1974. BOR installed a series of extraction wells to intercept brine flowing from the Paradox Valley into the Dolores River, and a deep (total depth about 3.0 miles) injection well as shown on Figure 3.3-11. Since 1991, the PVU has injected more than 1 billion gallons of shallow brine into deep Paleozoic and Pre-Cambrian strata (Ake et al., 2005).

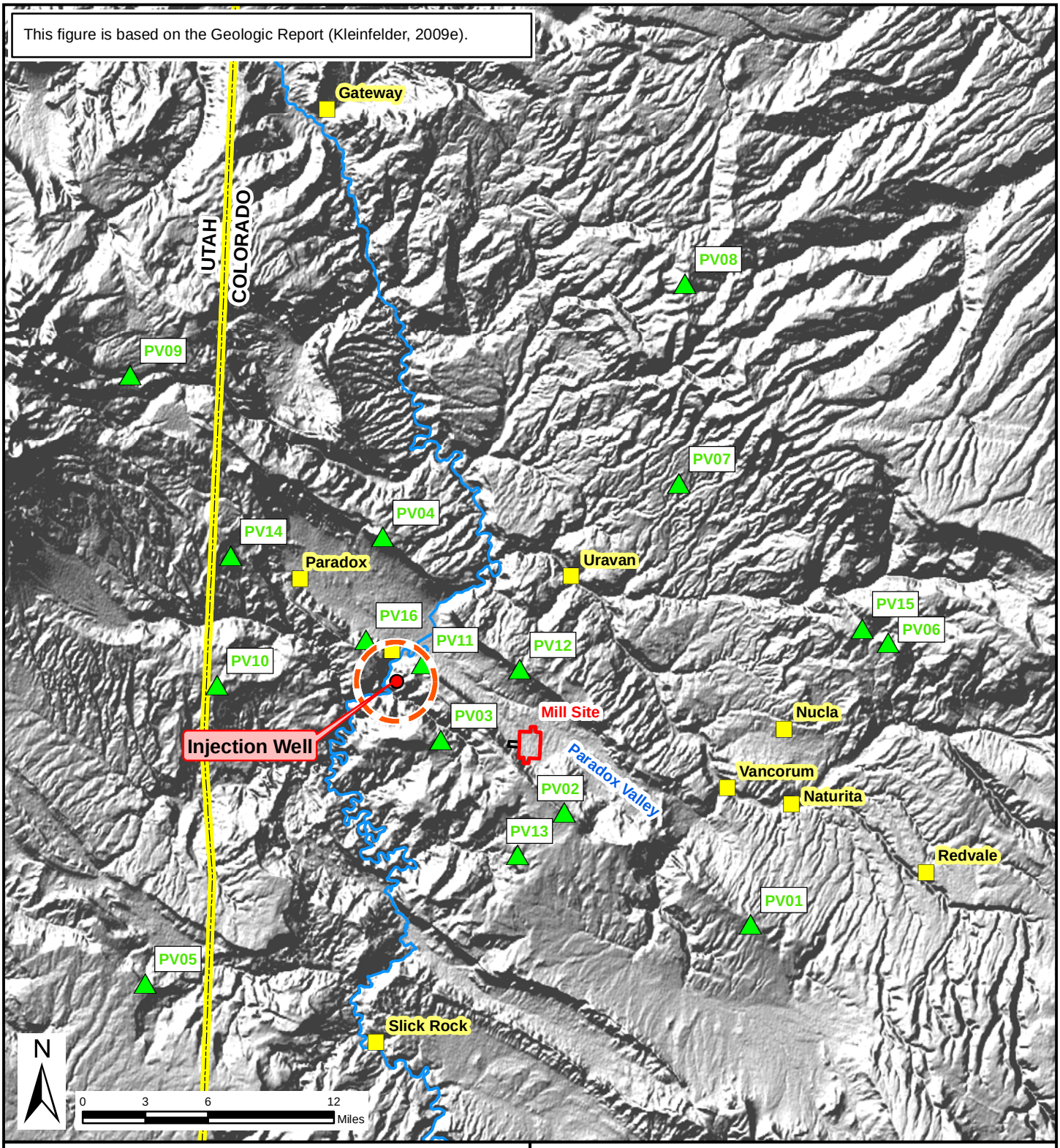
The PVU installed the Paradox Valley Seismic Network (PVSN) and began monitoring the local, reinjection seismicity starting in 1985. The PVSN has operated continuously since 1985, covering about 2,124 square miles area. Presently, the PVSN operates 15 stations, of which the two closest stations to the salt injection site have three-component sensors, while the other stations have only vertical-component sensors.

The PVU brine injection has induced over 4,000 surface-recorded seismic events since the beginning of the injection process in 1991, of which more than 3,000 occurred since the beginning of continuous injection process in 1995, with the largest event of magnitude 4.3 occurring in May, 2000 (CGS, 2002; Ake et al., 2005). More than 99.9 percent of the total 4,000 events were smaller than magnitude 2.0 and were not felt at the surface (Ake et al., 2005). The seismicity rate was much higher in the initial phases of injection, with an average rate about 82 per month, and a peak of 172 events in January, 1999. BOR modified their injection strategy in July 1999 with 20 days of shutdown every 6 months to dissipate fluid pressures, but this did not lead to a reduction to an acceptable level of events. In June 2000, the BOR modified their strategy again, dropping the pumping rate, which did lead to significant reduction to about 9 events per month, with none greater than magnitude 2.8. According to Ake et al. (2005), the induced seismicity at the PVU is closely related to the injection rate. Ninety five percent of the recorded events occur in an asymmetric zone surrounding the deep injection well, at up to 1.9 miles distance. A secondary zone of induced seismicity is located about 5 miles to the northwest of the well. By understanding the relationship between small earthquakes and injection parameters (in particular injection rate), the operations at the PVU have been modified to minimize the likelihood of future larger, damaging earthquakes (Ake et al., 2002).

Wastewater injection induces earthquakes by lubricating movement on existing faults, but mostly by reducing effective stress (the injection pressure takes some of the load off rock solids, reducing friction).

Natural Earthquakes. According to the USGS, more than 400 earthquake tremors of magnitude 2.5 or higher have occurred in Colorado since 1870 (Sheehan et al., 2003). The magnitude of Colorado's largest historical earthquake, in 1882, is estimated to be 6.6 ± 0.6, and it was located somewhere in north-central Colorado (Spence et al., 1996).

The largest known natural earthquake in the vicinity of the Site was magnitude 5.5 in 1960 earthquake near Ridgway, about 37 miles to the northeast (Sheehan et al., 2003; Blume and Sheehan, 2003). Several earthquakes of magnitude 4.0 or higher have occurred in this region with the most recent one being a magnitude 4.1 on November 7, 2004, west of Montrose. Significant historical earthquakes in the region are tabulated in Table 3.3-2.



Seismic Network
Local Municipalities
Property Boundary
Well Field Boundary
Dolores River
Approximate 3-km Radius Around Injection Well

Figure 3.3-11

Paradox Valley Unit Locations of Wells and Seismic Network

Table 3.3-2
Significant Historic Earthquakes in the Region[1]

Date	Location	Magnitude	Intensity
1913, Nov. 11	Ridgeway area	--	VI
1944, Sep. 9	Montrose/Basalt	--	VI
1960, Oct. 11	Montrose/Ridgeway	5.5	V
1966, Jan. 23	CO-NM border near Dulce, NM	5.5	VII
1966, Sep. 4	Near Montrose	4.2	--
1967, Jan. 12	East of Grand Junction	4.4	--
1967, Apr. 4	Near Montrose	4.5	--
1971, Nov. 12	South of Grand Junction	4.0	--
1994, Sep. 14	Southwest of Montrose	4.6	--
2000, May 27	West of Montrose	4.4	--
2004, Nov. 7	West of Montrose	4.1	--

[1] Source: Colorado Earthquake Hazard Mitigation Council, 2008.

A search was performed of historical earthquakes greater than magnitude 3.0 within a radius of 125 miles from the Site in the catalog maintained by Advanced National Seismic System (ANSS). This composite catalog of world-wide earthquakes covers a period from 1898 to the present, merging master earthquake catalogs from contributing ANSS member institutions. The member institutions include several regional and national seismic networks (Kleinfelder, 2009e). This search yielded 101 events in the search area between 1898 and 2008.

The Colorado Earthquake Hazard Mitigation Council (2008) states that the historical record allows that an earthquake of magnitude 6.5 to 7.3 could possibly occur somewhere in the state, but the record is too sparse to predict return periods of any size event with any confidence. All known faulting in the vicinity of the Site is associated with non-tectonic structures.

Ground Motions. Ground motion parameters, in terms of peak ground acceleration (PGA) and/or spectral acceleration, are used to design earthquake-resistant structures. Guidelines from the seismic design criteria of the 2006 International Building Code (IBC), and based on National Seismic Hazards Maps by the USGS, were used to obtain these parameters. Ground motion parameters obtained from the IBC for the design of structures are presented in detail in Kleinfelder (2009e). Under IBC guidelines, the MCE is defined as an event having a 2 percent chance in 50 years of occurring (return period of 2,475 years). The PGA associated with the MCE for the Site is 0.161g, where “g” is the acceleration of gravity. The most likely earthquake to produce these motions is projected to have a magnitude of about 4.8 at a distance of 9.6 miles from the Site.

3.3.1.4 Geologic Hazards

Geologic hazards of potential interest to the Site include slope instability, flooding and headward erosion, karst or dissolution features, faulting, seismicity, liquefaction, and collapsible soils. Volcanism is another potential geologic hazard that NRC has identified in its guidelines (NRC, 2003a). Each geologic hazard is discussed below.

Slope Instability. Natural slopes over most of the Site are flat and are not susceptible to mass movement. The southern end of the Site extends to the valley side, where steeper slopes occur. Even including the slumped block of the Morrison Formation to the southeast, bedrock strata in the vicinity of the Site show stable slopes, covered in pinyon-juniper trees of considerable age (centuries), and show no signs of recent mass movement or rock falls. Even where there are tall

cliffs of Triassic rock elsewhere in the valley, there are few evident recent rock falls or perched boulders likely to be loosed by a moderate earthquake.

Flooding and Headward Erosion. Minor flood hazard may exist in the small drainages on the southwest corner of the Site where short, steep gullies are etched on the valley side below Davis Mesa. Several of the active channels exhibit headward erosion.

Karst or Dissolution Features. No evidence of karst subsidence or active dissolution was observed on the Site or in the vicinity, except for one small sinkhole (Figure 3.3-6), approximately 0.5 mile north of the proposed evaporation pond area. This sinkhole is localized and, at the surface, is approximately 5 feet in diameter and 4 feet deep. As confirmed by additional geologic reconnaissance and mapping, no other evidence of sinkhole development was identified within the boundaries of the Site or in the adjacent areas.

Faulting. The Site is within the fault-bounded Paradox Valley; but all faulting in the area is related to diapiric salt doming and subsequent arch collapse when the salt was eroded from beneath it. Because the faulting was not tectonic but due to salt migration, which is long past, it is improbable there should be any seismicity associated with faulting in the vicinity, and faults are classified as “Class B” by the USGS, judged to be non-capable of seismicity according to the Criterion 4E of 6 CCR 1007-1, Part 18, Appendix A (CDPHE, 2001). Extensive trenching demonstrated that late Quaternary soils overlying the buried faults at the Site were not disturbed or displaced.

Seismicity. Ground motion parameters obtained from the 2006 IBC for the design of the structures indicated there is a 2 percent chance in 50 years that the Site might experience a PGA equal to or greater than 0.16g (16 percent of the earth’s gravitational acceleration). The most likely earthquake to produce these motions would have a magnitude of about 4.8, at a distance of 10 miles from the Site.

Liquefaction. Liquefaction of soils by an earthquake is improbable. Potential for liquefaction may occur where there is some likelihood of earthquakes. The primary factors affecting liquefaction potential of a soil deposit are: (1) level and duration of seismic ground motions; (2) soil type and consistency; and (3) depth to groundwater.

Collapsible Soils. The presence of collapsible soils within the upper layers of overburden soils was identified as an issue to be addressed during construction and operation of the facility in the *Amendment No. 2 Geological Investigations Work Plan* (Kleinfelder, 2008a).

Volcanism. Volcanism does not pose a credible hazard in the area. Remnants of igneous rocks in the region are either tens of millions of years old, or hundreds of miles away (and extinct).

3.3.2 Soils

In accordance with Section 5.3.3 of NUREG 1748 (NRC, 2003a), a soil survey of the Site was conducted and reported in the *Soil Survey Report* by Kleinfelder (2009f). The purpose of the survey was to characterize the soils at the Site and to determine if hydric soils were present. Hydric soils are soils formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil horizon. Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation, and are indicators of potential jurisdictional USACE water features. This is discussed further in Section 3.5.1.4 – Wetlands. The 1967 published soils survey for the project area (Delta-Montrose Area

Soil Survey) is out of print and not available from the Natural Resource Conservation Service (NRCS, 2009a). Therefore, updated soil survey data was acquired through the NRCS Soil Data Mart Web Site or the NRCS Web Soil Survey. Kleinfelder unitized the NRCS Web Soil Survey database (U. S. Department of Agriculture - USDA, 2008) to compare with collected field data.

3.3.2.1 USDA Web Soils Data

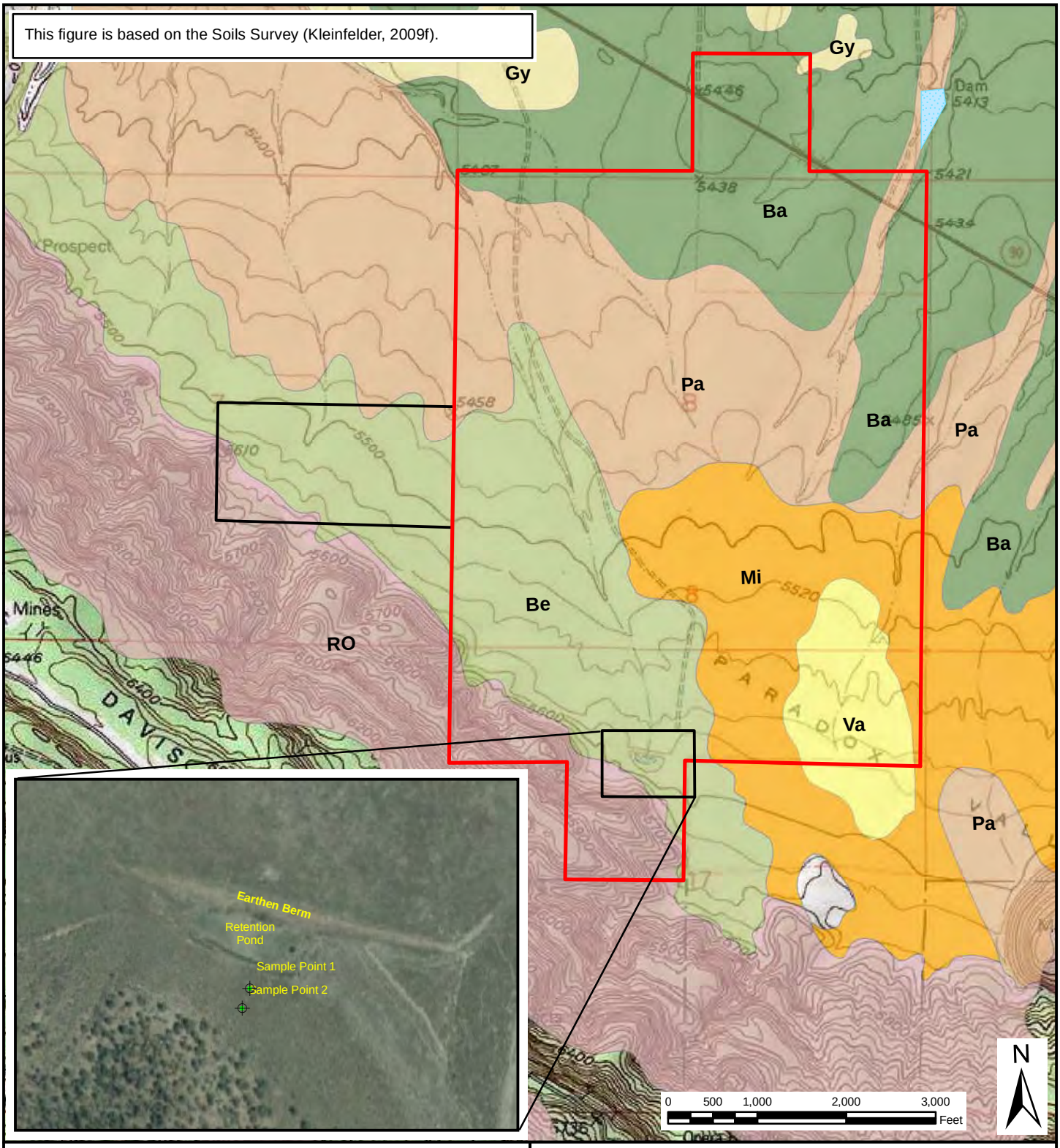
Based on the NRCS Web Soil Survey data (USDA, 2008) the soils at the Site are comprised of six soil series which include the Barx, Begay, Gypsiorthids, Mikim, Paradox, and Vananda soil series as well as the Rock Outcrop landform. Figure 3.3-12 provides a map showing the extent of these soils series within the Site. Table 3.3-3 also provides the acres of each mapping unit that is within the Site and provides a summary of the soil series general characteristics.

The soils are derived from alluvium from the surrounding sandstone and shale bluffs to the south of the valley and the majority of the soils (72.8 percent) have fine sandy loam textures (USDA, 2008). The soils are slightly sloping, and have deep profiles with restrictive layers greater than 80 inches in depth, except the Rock Outcrop landform. The soils are nonsaline to slightly saline at depths and all are considered nonsodic. The soils have moderately high to high saturated conductivities and the available water capacity varies by soil type. The water table depth is greater than 80 inches (USDA, 2008). The USACE (2006) literature did not identify hydric soils as being present at the site, although, the USDA (2008) soil survey data indicates that the Vananda Series is partially hydric in some areas. Field investigations did not identify the presence of hydric soils within the Site (see Section 3.3.2.3). The following section provides a description of each of the soils series within the Property Boundary.

Barx Series (Ba). The Barx series consists of very deep, well-drained soils that form in alluvium and reworked eolian material derived from sandstone and has between 0 to 35 percent rock fragments (gravel and cobbles) in its profile. Within the Site, Barx soils are on alluvial fans. Slopes range from 3 to 6 percent. The series has a moderate to high saturated conductivity and has a high available water capacity. This soil is natural to moderately alkaline and strongly alkaline at depth. The soil is nonsaline to slightly saline. Depth to water table is more than 80 inches, wind erodibility is low, and it is slightly susceptible to erosion. The series is considered prime farmland if irrigated.

Begay Series (Be). The Begay series consists of very deep, well-drained soil that formed in alluvium derived mainly from sandstone. In the project area the Begay soils are on alluvial fans, and have slopes of 1 to 6 percent. The series is slightly to moderately alkaline, nonsaline, and nonsodic. The series has a high saturated conductivity and the water table is greater than 80 inches in depth. The soil profile contains between 0 to 15 percent rock fragments and is moderately susceptible to wind erosion. The water erosion hazard is slight. The series is considered prime farmland, if irrigated.

Gypsiorthids Series (Gy). The Gypsiorthids series only comprises about 0.6-acre of the Site, north of SH 90. This soil consists of deep, well-drained soils that formed on valley floors. The soils consist of residium weathered from gypsum. Although the Gypsiorthids soils are typically found on slopes that range from 3 to 25 percent, within the Site the soil is nearly level. This series is moderately alkaline, very slightly saline to slightly saline and is not sodic. The soil may contain up to 85 percent gypsum. The soil has a moderately high to high saturated conductivity and has a low available water capacity. The soil susceptibility to wind erosion and water erosion is moderate. The series is not considered a prime farmland soil.



Property Boundary
Well Field Boundary

Soil Descriptions

- Ba Barx fine sandy loam, 3 to 6 percent slopes
- Be Begay fine sandy loam, 1 to 6 percent slopes
- Gy Gypsiorthids, 3 to 25 percent slopes
- Mi Mikim loam, 1 to 6 percent slopes
- Pa Paradox fine sandy loam, 1 to 4 percent slopes
- RO Rock outcrop
- Va Vananda silty clay, 1 to 6 percent slopes

Figure 3.3-12

NRCS Soils Data Map
Montrose County, Colorado

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Table 3.3-3
Soil Series and General Characteristics within the Project Area [1]

NRCS Soil Mapping Units	Soil Mapping Unit Name	Composition of Mapping Unit (percent)	Acres within Site (percent composition)	Depth to restrictive layer [2]	Saturated Conductivity [3]	Available Water Capacity [4]	Salinity (maximum - Electrical Conductivity mmhos/cm) [5]	Sodium Adsorption Ratio- SAR (maximum) [6]	Topsoil suitability Rating; limiting factors and (Optimum depth) [7]	Prime Farmland Designation [8]	Hydric [9]
15	Barx fine sandy loam, 3 to 6 percent slopes (Ba)	85	187.38 (21.3)	> 80 in	Moderately high to high (0.60 top 2.00 in/hr)	High 9.5 inches	Nonsaline to slightly saline (2.0 to 4.0)	10.0	Fair; Low organic matter content, carbonate content – Alkalinity (9-15 inches)	Prime farmland, if irrigated	No
18	Begay fine sandy loam, 1 to 6 percent slopes (Be)	85	197.41 (22.5)	> 80 in	High (2.0 top 6.00 in/hr)	Moderate 8.0 inches	Nonsaline (0.0 – 2.0)	10.0	Fair: Low organic (12-16 inches)	Prime farmland, if irrigated	No
49	Gypsiorthids, 3 to 25 percent slopes (Gy)	85	0.59 (<0.01)	> 80 in	Moderately high to high (0.60 to 2.0 in/hr)	Low 5.1 inches	Very slightly saline to slightly saline (4.0 to 8.0)	N/A	Fair; Salinity (6-12 inches)	No	No
56	Mikim loam, 1 to 6 percent slopes (Mi)	90	144.71(16.4)	> 80 in	Moderately high to high (0.60 to 2.0 in/hr)	Moderate 8.3 inches	Nonsaline (0.0 to 2.0)	10.0	Fair (9 inches)	Prime farmland, if irrigated	No
73	Paradox fine sandy loam, 1 to 4 percent slopes (Pa)	85	243.60 (27.8)	> 80 in	Moderately high to high (0.60 to 2.0 in/hr)	High 9.2 inches	Nonsaline (0.0 to 2.0)	N/A	Good (12-19 inches)	Prime farmland, if irrigated	No
87	Rock outcrop Unweathered bedrock (RO)	90	56.61 (6.4)	0 to 4 in to lithic bedrock	Very low to low (0.00 to 0.00 in/hr)	N/A	N/A	N/A	Not rated	No	No
104	Vananda silty clay, 1 to 6 percent slopes (Va)	85	49.70 (5.6)	> 80 in	Low to moderately low (0.01 to 0.06 in/hr)	Moderate 9.0 inches	Nonsaline to slightly saline (2.0 to 8.0)	15.0	Poor Clay content, Sodium and Salinity (<6 inches)	No	Partially hydric
		Total	**880.0 (100)**								

[1] Source: NRCS, 2009b.
[2] Restriction layers limit plant growth by restricting the limits of the rooting zone. They also impede or restrict the movement of soil water vertically through the soil profile. The restrictive layer hardness and thickness have a significant impact on the ease of mechanical excavation.
[3] Estimates of saturated hydraulic conductivity are based on soil properties and include texture, structure, pore size, density, organic matter, and mineralogy.
[4] Available water capacity is the volume of water that should be available to plants if the soil, inclusive of fragments, were at field capacity. It is commonly estimated as the amount of water held between field capacity and wilting point, with corrections for salinity, fragments, and rooting depth.
[5] Electrical conductivity is a measure of the concentration of water-soluble salts in soils and is used to determine saline soils. High concentrations of neutral salts, such as sodium chloride and sodium sulfate, may interfere with the absorption of water by plants because the osmotic pressure in the soil solution is nearly as high or higher than that in the plant cells. Salts may also interfere with the exchange capacity of nutrient ions, thereby resulting in nutritional deficiencies in plants. (Salinity Classes: Nonsaline = 0-2 mmhos cm^{-1}; Very slightly Saline = 2-4 mmhos cm^{-1}; Slightly Saline 4-8 mmhos cm^{-1}; Moderately Saline 8-16 mmhos cm^{-1}; Strongly Saline > 16 mmhos cm^{-1})
[6] Soils that have values for sodium adsorption ratio of 13 or more may have an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity and aeration, and a general degradation of soil structure.
[7] Topsoil ratings are based the upper 40 inches of the soil according to NRCS (2009) and are based on the soil properties that affect plant growth; the ease of excavation, loading and spreading the material affect the reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material. Onsite management is needed during salvaging operations to validate these interpretations and to confirm the identity of the soil on-site.
[8] Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, and few or no rocks. Its soils are permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time, and it either does not flood frequently during the growing season or is protected from flooding.
[9] A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soils along with hydrophytic vegetation and wetland hydrology are used to define wetlands.

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Mikim Series (Mi). The Mikim series consists of very deep, well-drained soils that formed in alluvium derived from shale. Mikim soils in the project area are found on alluvial fans and in drainages and have a slope range from 1 to 6 percent. This series is slightly to moderately alkaline, nonsaline, and nonsodic. The soil has a moderately high to high saturated conductivity and the available water capacity is moderate. The soil profile may contain between 0 to 15 percent rock fragments. The soil has a slight water erosion hazard and the wind erodibility hazard is moderate. The Mikim loam is considered prime farmland, if irrigated.

Paradox Series (Pa). The Paradox series consists of deep, well-drained soils that formed in alluvium derived from red sandstone. Paradox soils are on nearly level to gently sloping broad alluvial fans and old alluvial valley floors. Slopes are from 1 to 4 percent. This series is mildly to moderately alkaline, nonsaline, and moderately permeable. The series has a high available water capacity and rock fragments range from 0 to 15 percent throughout the profile, but are usually less than 1 percent. The soil has a slight water erosion hazard and the wind erodibility hazard is moderate. This series is considered prime farmland, if irrigated.

Rock Outcrop (RO). The Rock Outcrop landform is located on slopes between 40 and 120 percent on the southwestern corner of the Site. This landform comprises approximately 6.4 percent (56.61 acres) of the Site. Unweathered sandstone bedrock is typically at a depth of 0 to 4 inches.

Vanada Series (Va). The Vanada soils are deep, well-drained soils that formed from alluvium derived from shale. Within the Site, the Vanada series are on alluvial fans and are nearly level to gently sloping with slopes of 1 to 6 percent. The soil is moderately to strongly alkaline, nonsaline and potentially slightly sodic at depths. The soil has a low to moderately low hydraulic conductivity and a moderate available water capacity. The water table depth is greater than 80 inches. The soil has a slight water erosion hazard and the wind erodibility hazard is moderate. The soil is not a considered a prime farmland soil but in some areas the soil is partially hydric. As previously noted, field investigations within the Site did not locate hydric soils.

3.3.2.2 Field Observations

The six USDA soil series identified by the NRCS Web Soil Survey (Barx, Begay, Gypsiorthids, Mikim, Paradox, and Vananda) were recognized at the Site. Rock outcropping accounts for about 6.5 percent of the Site, located in the southwest corner (Figure 3.3-12). The soil observations at the site closely represented the extent and range of characteristics described in the NRCS Web Soil Survey. The soils were observed to be well-drained. The soil profiles were observed to have little or no soil horizon differentiation in the upper 24 inches.

The soils observed in the northern portion of the Site tended to be sandy loam to fine sandy loam with typical hues in the 5YR range (MacBeth, 2000). It was observed that water from rain and snow melt events takes some time to infiltrate past the first few inches (Kleinfelder, 2009f). The soil appeared to be dry under approximately 6 inches of saturated soil during the winter and spring surveys. Drainage features across the Site were characterized as discontinuous ephemeral streams (Meyer, 2008).

Biological soil crusts, also known as crytogamic, microbiotic, cryptobiotic, and microphytic crusts (Belnap and Lange, 2001), were observed sporadically. Biological soil crusts were observed to cover less than 5 percent of the Site, with the highest concentrations located under big sage (*Artemicia tridentate*). Biological soil crusts are made up primarily of cyanobacteria (formerly blue-green algae), green and brown algae, microfungi, mosses, liverworts, and lichens (Rosentreter et al., 2007). The organisms on the soil increase soil stability, contribute carbon to

the underlying soil, convert atmospheric nitrogen into bio-available nitrogen, and retain water (Belnap and Lange, 2001).

3.3.2.3 Hydric Soil Field Investigations

Soils sample locations to determine the potential presence of hydric soils were selected based on drainage features and areas of potential ponding or inundation. Ponded or inundated areas were identified as areas where earthen berms were previously constructed to retain seasonal surface water flows related to storm events or snowmelt. Soils along the drainage features (Figure 3.3-12) were evaluated to determine whether hydric soils were present. Soils at two sample plots within identified potential wetlands were evaluated by digging 12-inch soil pits (Figure 3.3-12).

Methods used to determine if hydric soils were present were in accordance with the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (USACE, 2006). All drainage features, and ponded or inundated areas were observed and evaluated for soil types and characterized based on USACE Waters of the U.S. Final Wetland Delineation guidance (Meyer, 2008). The sample points were dug to the depth needed to document a hydric indicator, or to confirm the absence of hydric indicators (USACE, 2006). Soils were compared to the Munsell ® Soil Color Charts (MacBeth, 2000) to evaluate the color, hue, and chroma of representative soils. Soils were also observed for oxygen reduction reactions (redox) features associated with anaerobic conditions. Redox features were characterized by their size, distinction, and frequency of occurrence.

The locations of the two soil sample points are shown in Figure 3.3-12. Sample Point 1 (SP1) is an atypical soil profile of the Site. The presence of organic material is indicative of above normal soil moisture. The soil profile consisted of the top 4 inches of clay loam with approximately 10 percent organic material. The color of the top 4 inches was dark brown (7.5YR3/4) (MacBeth, 2000). From 4 to 12 inches below ground surface (bgs), the profile changed to a sandy loam with a yellowish-red color (5YR4/6) (MacBeth, 2000). The soil profile did not exhibit hydric characteristics under the guidelines within the Pocket Guide to Hydric Soil Field Indicators (Wetland Training Institute - WTI, 2006).

Sample Point 2 (SP2) was a typical soil profile for the Site. The soil profile consisted of the top 2 inches of loam with plates of clay that restrict water infiltration (strictures), and flake off at the touch. The color of the top 2 inches was brown (7.5YR4/4) (MacBeth, 2000). From 2 to 12 inches bgs, the profile changed to a sandy loam with a yellowish-red color (5YR4/6) (MacBeth, 2000). The soil profile did not exhibit hydric characteristics under the guidelines within the Pocket Guide to Hydric Soil Field Indicators (WTI, 2006).

3.4 WATER RESOURCES

The NRC guidelines (NRC, 1982a and 2003a) for Environmental Review of Nuclear Material Safety and Safeguards, and CDPHE (2001) both require baseline characterization of water resources, comprising surface water and groundwater, their use patterns, and pathways they present to possible migration of any impacts of the Proposed Action, drawing on public documents and performing such additional work as needed to complete the characterization.

Regional hydrology reports have been published by the USGS (Robson and Banta, 1995) and the CGS (Topper et al., 2003). Other studies were conducted in the 1980s to assess the potential of the salt deposits in the project area for nuclear waste repositories (Weir et al., 1983;

Hite and Lohman, 1973). The contribution of salt to the Colorado River by the Dolores River cutting across the salt formations was investigated by the BOR, who instituted pumped interception of brines, and installed a seismic monitoring network to observe effects of deep injection.

Energy Fuels initiated baseline hydrological characterization studies in 2007, leading to surface hydrology, groundwater, and water supply reports by Golder (2008e and 2009d). These reports followed work plans (Kleinfelder, 2008b; Golder, 2008d) drafted to fulfill the requirements of the NRC guidelines (NRC, 2003a), in particular Section 6.3.4 of NUREG 1748, Description of Water Resources. Work performed to support these reports included public literature searches, installation of geotechnical borings, groundwater monitoring wells, pumping test and observation wells, monitoring those wells to determine groundwater quality and flows, and performing pumping tests to assess supply well yield, and identifying and assessing off-site wells and springs and water rights.

Water resources and the work performed to characterize them are discussed in this section. The precipitation and recharge initiating the hydrological cycle of the Site is discussed in Section 3.6, Meteorology, Climatology and Air Quality. The stratigraphic framework of the groundwater aquifer systems is presented in Section 3.3, Geology and Soils.

3.4.1 Surface Hydrology

Administratively, the Site lies in Colorado Division of Water Resources District 61, within Division 4 (Montrose). The Site lies between the Dolores and San Miguel rivers, 9 miles southwest of their confluence.

3.4.1.1 Surface Waterbodies

The Dolores and San Miguel rivers both originate in the San Juan Mountains to the southeast. The San Miguel River, with headwaters near Telluride, is un-dammed; the Dolores, which has headwaters just the other side of Lizard Head Pass from the San Miguel River, is dammed near the Town of Dolores, Colorado, in the BOR-managed McPhee Reservoir, which supplies irrigation water to Montezuma and Dolores counties and to the Ute Mountain Indian Reservation.

The San Juan Mountains, and the La Sals at the north end of Paradox Valley, gather snowpack and are heavily forested, so that they sustain some baseflows in the rivers after spring runoff through the summer months when precipitation is limited to sporadic thunderstorms. The San Miguel River is a perennial braided stream in an incised channel, the Dolores River is a highly sinuous incised stream with much less alluvial bed load, and frequently becomes a string of disconnected pools in summer when water is held for irrigation. Alluvium in the reach of the Dolores crossing Paradox Valley mostly comes from the valley itself. All of the watercourses between the two rivers within 15 miles of the Site are ephemeral and flow only in storm events.

Paradox Valley is named for the fact that the Dolores River crosses its long axis at the settlement of Bedrock, 7 miles north of the Site. The valley is in fact a collapsed anticline, a trough between the flanks of a fold, not a river-cut valley. The Site is in the southeast end of this valley, and contains shallow ephemeral channels draining northwest to the Dolores River. At the northwest end of Paradox Valley, a small stream, West Paradox Creek, drains from the south flank of the La Sal Mountains, past the settlement of Paradox, and into the Dolores River. East Paradox Creek is an ephemeral water course draining the southeast end of the valley to the Dolores. The Dolores River is similarly a divide in alluvial and bedrock groundwater. Figure 3.4-

1 illustrates the hydrologic isolation of the Site; no surface water other than storm runoff enters, leaves, or passes close to the Site. All perennial surface water is more than 7 miles from the Site.

3.4.1.2 Surface Water Quality

There is no perennial surface water in the immediate vicinity of the Site, and description of surface water quality requires sampling infrequent snow melt and storm runoff events. Energy Fuels installed water samplers in some of the larger drainages, and was able to collect samples from some storms and snowmelt events.

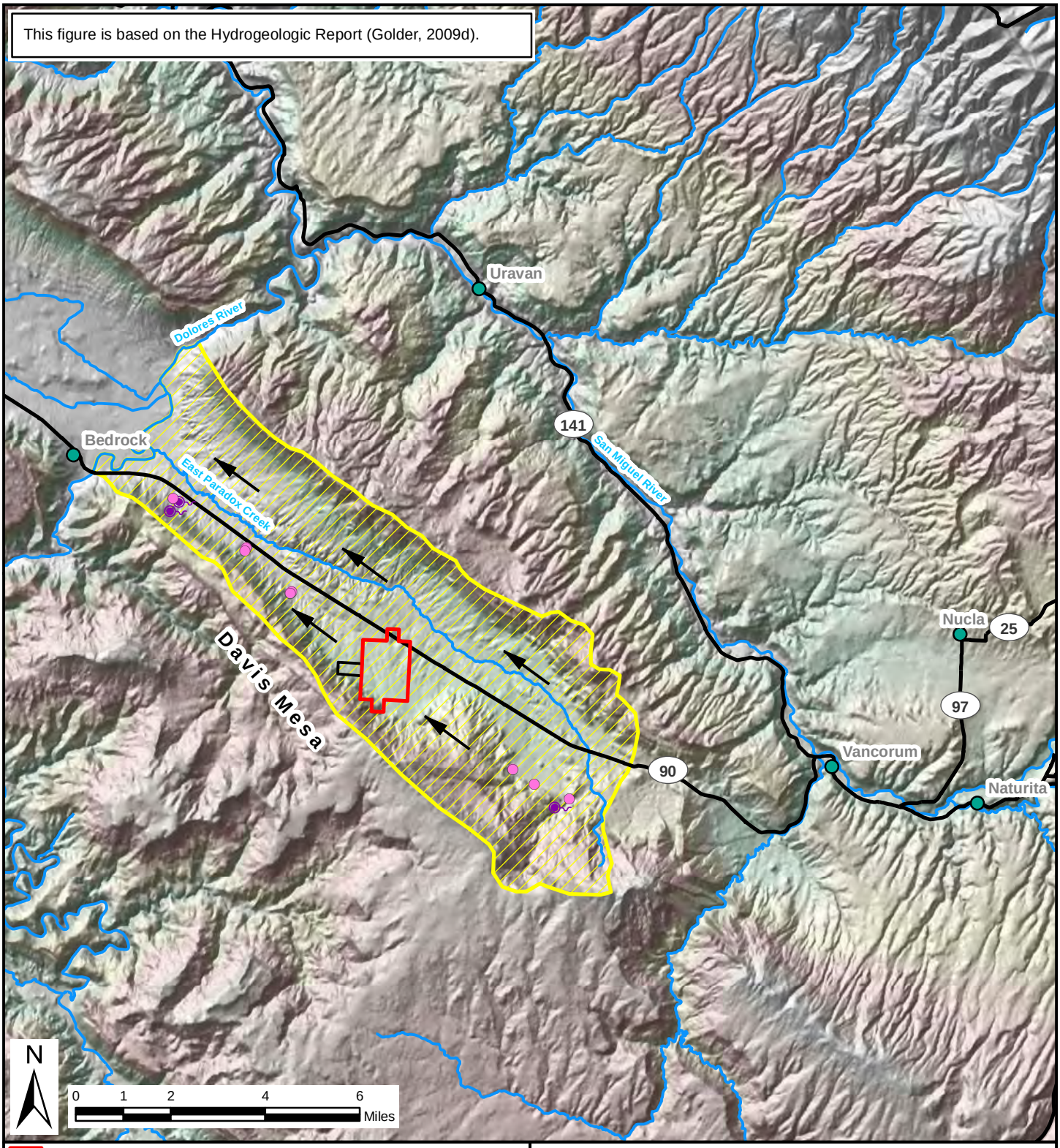
The nearest surface water is the Dolores River at Bedrock. The CDPHE-Water Quality Control Commission (WQCC) designated use classifications for the Lower Dolores River Basin, stream segment COGULD02, Mainstem of the Dolores River from the Little Gypsum Valley Bridge at the San Miguel/Montrose County line to the Colorado/Utah border, are Aquatic Life Warm 1, Recreation Class E, and Agriculture (CDPHE, 2007).

The CDPHE-WQCC defines the designated uses as follows (CDPHE, 2008a):

> Class 1 - Warm Water Aquatic Life 1. These are waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species.
>
> Recreation Class E. Existing Primary Contact Use. These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.
>
> Agriculture. These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

The Clean Water Act requires states to compile a list of waterbodies, known as the 303(d) list, that do not meet water quality standards for their designated uses. The 303(d) list or 305(b) report that the CDPHE provides to the EPA lists the Dolores River as impaired due to iron concentrations and is considered a high priority section requiring a TMDL (total maximum daily load) analysis. The TMDL is an estimate of the greatest amount of a specific pollutant that a waterbody or stream segment can receive without violating water quality standards. This amount includes a margin of safety, waste load allocating (for point sources) and a load allocation (for non-point sources and natural background). The TMDL process is a method of analyzing pollution sources and allocating responsibility among these sources. At this time the CDPHE has not completed a TMDL for the Dolores River section near the Site (CDPHE, 2008b).

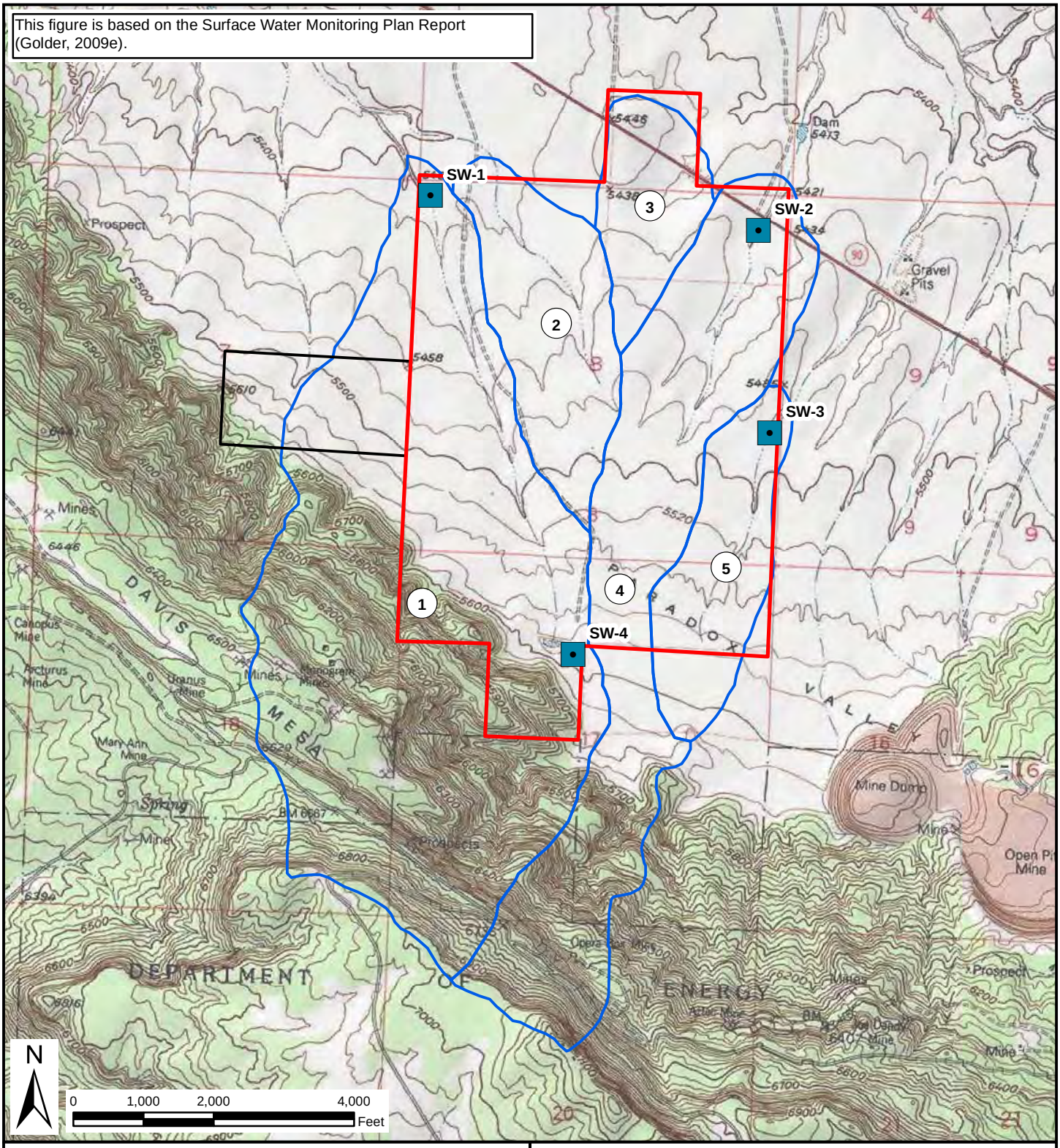
Surface water samples were collected from snow-melt and rain runoff events, from four stations within the Site. Locations of the box collectors are shown in Figure 3.4-2. Sampling events and analytical data are given in Table 3.4-1. The header of Table 3.4-1 shows the type of event as snow-melt (SM), or rain (P) with the precipitation recorded in the rain gauge at the particular station. Analyses included trace metals, dissolved and total, radionuclides, total dissolved solids (TDS), total suspended solids (TSS), nitrate + nitrite, and fluoride. Table 3.4-1a presents the quality control analyses (duplicate sample results) and water quality standards applicable to the reach of the Dolores River crossing Paradox Valley (the receiving stream).



Property Boundary
Well Field Boundary
Vicinity Wells (Chinle Formation)
Springs (Chinle Formation)
Surface Drainage Area

Figure 3.4-1

Site Location and Drainage Area



Sampler Location and ID
Property Boundary
Well Field Boundary
Drainage Basin and ID

Figure 3.4-2

Surface Water Sampler Locations

Table 3.4-1
Surface Water Data

Surface Water Sample ID		SW-1										SW-2		SW-3									SW-4
Date		2/12/08	9/29/08	10/6/08	1/27/09	5/3/09	5/27/09	6/22/09	6/30/09	7/13/09	7/28/09	2/12/08	1/27/09	2/12/08	9/29/08	10/6/08	1/27/09	5/27/09	6/22/09	6/30/09	7/13/09	7/28/09	7/28/09
Type of Event		SM	P - 0.6"	P - 0.7"	SM	SM	P - 1.4" X	P - 0.3"	P - 1.0"	P - 0.4'	P - 0.20"	SM	SM	SM	P - 0.5"	P - 0.8"	SM	P - 1.2"	P - 0.4"	P - 1.0"	P - 0.4"	P - 0.25"	P - 0.7"
Parameter	**Unit**																						
Field Parameters																							
Temperature	deg C	NM	16.1	4.7	2.1	21.2	23.1	24.1	19.6	23.8	15.8	NM	2.3	NM	15.2	2.3	1.1	21.5	26.2	21.5	26.1	20.2	21.1
pH	s.u.	NM	7.83	8.51	8.59	7.97	NM	7.52	7.24	7.75	8.18	NM	8.53	NM	7.72	8.48	8.37	NA	7.42	7.41	7.24	8.19	7.69
Specific Conductivity	µS/cm	NM	188	198	161	253	193	217	167	228	253	NM	120	NM	193	135	173	118	112	115	143	158	194
Dissolved Oxygen	mg/L	NM	6.24	7.62	S	NM	NM	NM	NM	3.07	0.14	NM	S	NM	6.09	4.41	S	NM	NM	NM	2.63	2.81	1.3
Oxidation-reduction Potential	mV	NM	148	191	143	148	149	NM	NM	116	79	NM	133	NM	188	165	168	153	NM	NM	103	94	123
General Water Quality																							
Nitrate+Nitrite as N	mg/L	0.7	9.16	1.91	<2	1.14	0.4	2.00	0.12	0.66	<0.1	0.4	<2	0.4	60.2	0.79	<2	0.5	0.65	0.10	0.20	<0.1	<0.1
Total Dissolved Solids (TDS)	mg/L	1240	4720	1170	910	270	1200	790	460	720	550	930	870	1580	1280	1320	630	2510	1050	1260	930	520	240
Total Suspended Solids (TSS)	mg/L	920	36000	3500	2700	3430	6400	2980	2960	2760	1270	1600	610	700	1940	1800	7600	3400	3810	3950	4690	2740	570
Fluoride	mg/L	0.1	<1	<1	<0.5	0.1	<4	0.2	0.2	0.2	<0.1	<0.1	<0.5	<0.1	0.1	<1	<0.5	<4	0.2	0.1	0.2	0.1	<0.1
Dissolved Metals																							
Aluminum	mg/L	0.08	<0.2	0.14	0.12	0.08	0.83	0.14	0.06	0.47	0.22	0.08	0.16	0.14	0.12	1.16	0.07	0.73	0.18	0.06	0.59	0.37	0.18
Antimony	mg/L	0.0005	<0.002	0.0012	0.0004	0.0008	0.0008	0.001	0.0015	0.0011	0.0011	<0.0004	0.0009	0.0005	0.0008	0.0016	0.0008	0.0008	0.0011	0.0014	<0.004	0.0013	0.0012
Arsenic	mg/L	0.0062	0.0067	0.0120	0.0034	0.0075	0.0156	0.0104	0.0078	0.0068	0.0098	0.0047	0.0058	0.0031	0.026	0.0231	0.0074	0.008	0.0056	0.0040	0.0062	0.0075	0.0051
Barium	mg/L	0.119	0.29	0.133	0.132	0.132	0.520	0.126	0.125	0.156	0.265	0.102	0.106	0.061	0.101	0.486	0.151	0.254	0.107	0.088	0.190	0.263	0.338
Beryllium	mg/L	<0.002	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	<0.002	<0.002	<0.002
Cadmium	mg/L	<0.0001	<0.0005	0.0002	<0.0001	0.0001	0.0005	0.0002	<0.0001	0.0002	0.0002	<0.0001	<0.0001	0.0002	<0.0001	0.0004	<0.0001	0.0003	<0.0001	<0.0001	0.0002	0.0002	<0.0001
Copper	mg/L	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.01	0.09	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	0.03	0.08	<0.01
Iron	mg/L	NA	0.14	0.09	0.07	1.20	0.22	0.07	0.18	0.20	0.28	NA	0.03	NA	1.69	0.10	0.05	2.04	0.09	0.04	0.24	0.30	0.26
Lead	mg/L	<0.0003	0.0009	0.0007	0.0002	0.0003	0.0017	0.0015	0.0001	0.0009	0.0085	0.0002	0.0002	0.0003	0.0002	0.0026	0.0002	0.0023	0.0003	<0.0001	0.002	0.0070	0.0015
Manganese	mg/L	NA	0.641	0.228	<0.005	0.226	0.553	0.206	0.074	0.426	0.601	NA	0.033	NA	0.025	0.645	0.046	0.21	0.015	0.024	0.427	0.417	0.216
Mercury	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	mg/L	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	mg/L	NA	0.0041	0.0017	0.0017	0.0028	0.0145	0.0054	0.0022	0.0066	0.0082	NA	0.0017	NA	0.004	0.0034	0.0021	0.036	0.0034	0.0013	0.0028	0.0046	0.0019
Potassium	mg/L	17.5	17.0	15.0	17.1	16.5	19.5	20.3	17.1	24.1	29.4	9.1	6.5	8.4	13.0	9.8	13.4	10.3	8.1	8.6	9.7	10.7	14.4
Selenium	mg/L	<0.001	<0.0005	0.0003	0.0003	0.0004	0.0005	0.0008	0.0004	0.0007	0.0056	<0.001	0.0002	<0.001	0.0007	0.0002	0.0002	0.0004	0.0005	0.0003	0.001	0.0062	0.0004
Silver	mg/L	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	mg/L	<0.0001	<0.0005	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium	mg/L	0.0032	0.0005	0.0001	0.0005	0.0010	0.0005	0.0004	0.0009	0.0005	0.0006	0.0020	0.0003	0.0004	0.0003	0.0002	0.0018	<0.0002	<0.0001	0.0001	0.0003	0.0003	0.0005
Vanadium	mg/L	0.023	<0.03	0.018	0.013	0.011	0.011	0.025	0.024	0.034	0.032	0.010	0.006	0.010	0.015	0.019	0.014	<0.01	0.016	0.007	0.030	0.026	0.021
Zinc	mg/L	NA	0.003	0.010	0.007	0.011	0.020	0.028	0.003	0.026	0.494	NA	0.003	NA	0.02	0.026	0.005	0.042	0.021	0.003	0.015	0.085	0.055
Total Metals																							
Antimony	mg/L	<0.004	NA	<0.002	NA	<0.002	NA	NA	NA	NA	NA	<0.004	NA	<0.004	NA	<0.002	NA	NA	NA	NA	NA	NA	<0.0008
Arsenic	mg/L	0.033	NA	0.050	NA	0.039	NA	NA	NA	NA	NA	0.020	NA	0.029	NA	0.048	NA	NA	NA	NA	NA	NA	0.008
Cadmium	mg/L	0.003	NA	0.0045	NA	0.0045	NA	NA	NA	NA	NA	0.003	NA	0.003	NA	0.0034	NA	NA	NA	NA	NA	NA	0.0005
Chromium	mg/L	0.12	0.6	0.08	0.07	0.14	0.15	0.09	0.08	<0.1	0.07	0.10	0.06	0.11	0.12	0.10	0.09	0.09	0.09	0.10	<0.1	0.07	<0.02
Lead	mg/L	0.041	NA	0.0891	NA	0.0689	NA	NA	NA	NA	NA	0.043	NA	0.052	NA	0.0925	NA	NA	NA	NA	NA	NA	0.0081
Mercury	mg/L	<0.0002	NA	<0.0002	NA	<0.0002	NA	NA	NA	NA	NA	<0.0002	NA	<0.0002	NA	<0.0002	NA	NA	NA	NA	NA	NA	<0.0002
Selenium	mg/L	0.0010	NA	0.0024	0.0020	0.0015	NA	NA	NA	NA	NA	<0.001	0.0019	<0.001	NA	0.0022	0.0033	NA	NA	NA	NA	NA	0.0009
Thallium	mg/L	0.003	NA	0.0033	NA	0.0026	NA	NA	NA	NA	NA	<0.001	NA	<0.001	NA	0.0024	NA	NA	NA	NA	NA	NA	<0.0002

Surface Water Sample ID		SW-1										SW-2		SW-3									SW-4
Date		2/12/08	9/29/08	10/6/08	1/27/09	5/3/09	5/27/09	6/22/09	6/30/09	7/13/09	7/28/09	2/12/08	1/27/09	2/12/08	9/29/08	10/6/08	1/27/09	5/27/09	6/22/09	6/30/09	7/13/09	7/28/09	7/28/09
Type of Event		SM	P - 0.6"	P - 0.7"	SM	SM	P - 1.4" X	P - 0.3"	P - 1.0"	P - 0.4'	P - 0.20"	SM	SM	SM	P - 0.5"	P - 0.8"	SM	P - 1.2"	P - 0.4"	P - 1.0"	P - 0.4"	P - 0.25"	P - 0.7"
Parameter	**Unit**																						
Radionuclides – Dissolved																							
Gross Alpha	pCi/L	73	2.3	0.26	1.6	1.6	2.6	2.7	2.8	3.3	3.6	56	1.6	75	150	0.0	4.9	0.05	0.5	2.1	2.7	1.1	3.8
Radium-226	pCi/L	NA	NA	0.23	0.16	0.68	0.33	0.77	0.68	0.58	1.2	NA	0.0	NA	NA	0.52	0.21	0.17	0.31	0.13	0.3	0.58	1.9
Radium-228	pCi/L	NA	NA	0.6	0.37	0.5	2.1	0.71	1.1	0.6	0.64	NA	0.99	NA	NA	2.3	1.1	0.66	1.6	0.51	1.2	1.1	0.6
Thorium-230	pCi/L	NA	NA	-0.12	-0.05	-0.02	-0.08	-0.07	-0.15	0.29	0.57	NA	0.03	NA	NA	-0.36	0.09	0.07	-0.01	0.09	-0.2	0.22	0.6
Thorium-232	pCi/L	NA	NA	0.04	-0.04	0.03	-0.02	0.0	-0.03	0.03	0.1	NA	0.07	NA	NA	-0.15	0.03	0.02	0.0	0.03	-0.05	0.1	0.03
Radionuclides – Total																							
Radium-226	pCi/L	20	21	NA	17	62	46	20	30	35	21	9.4	10	12	19	NA	3.7	15	22	28	27	29	13
Radium-228	pCi/L	7.8	2.5	NA	3.7	5.5	16	7.3	5.2	4.8	4.8	11	2.7	11	6	NA	3.9	12	18	4.6	10	5.1	3.8
Thorium-230	pCi/L	11	21	NA	0.01	28	83	17	23	34	30	5.2	0.05	11	13	NA	0.06	24	13	12	18	17	4.2
Thorium-232	pCi/L	1.98	3.83	NA	0.0	5.67	12.6	2.47	1.86	4.74	4.62	2.71	-0.05	2.99	4.93	NA	0.14	6.63	4.86	3.11	3.09	5.03	0.33

Notes:
NA - Not Analyzed
NM - Not Measured
P - 0.5" - Precipitation and Intensity (in total inches)
S-Saturated
SM – Snowmelt
X - SW-1 5/27/09 Measured at #1 Met station - cows broke gauge at site

Shading indicates a concentration or activity level above of a surface water standard applicable at segment 3a of the Dolores River.

Regulatory References:
CDPHE WQCD Regulation No. 31 - The Basic Standards and Methodologies for Surface Water (amended 1/14/08)
CDPHE WQCD Regulation No. 35 - Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins (amended 2/12/07)
EPA CFR40 Part 440 Subpart C - Uranium, Radium and Vanadium Ores Subcategory

Table 3.4-1a
Surface Water Quality Control and Regulatory Standards

Surface Water Sample ID		Equipment Rinsate	DUP-1 (SW-3)	DUP-2 (SW-1)	DUP-3 (SW-3)	DUP-4 (SW-1)	DUP-5 (SW-3)	DUP-6 (SW-4)	CDPHE Agriculture	CDPHE Dolores Segment 3a	CDPHE Aquatic Class 2	CDPHE Recreational Class E	EPA 40 CFR Part 440
Date		2/12/08	9/29/08	9/26/08	5/27/09	6/22/09	7/13/09	7/28/09					
Type of Event		SM	P - 0.5"	P - 0.6"	P - 1.2"	P - 0.3"	P - 0.4"	P - 0.7"					
Parameter	**Unit**												
Field Parameters													
Temperature	deg C	NM	15.2	16.1	21.5	24.1	26.1	21.1					
pH	s.u.	NM	7.72	7.83	NA	7.52	7.24	7.69		6.5-9.0	6.5-9.0	6.5-9.0	6.0-9.0
Specific Conductivity	µS/cm	NM	193	188	118	217	143	194					
Dissolved Oxygen	mg/L	NM	6.09	6.24	NA	NA	2.63	1.3	<3.0	<5	<6	<3	
Oxidation-reduction Potential	mV	NM	188	148	153	NA	103	1.23					
General Water Quality													
Nitrate+Nitrite as N	mg/L	NA	NA	NA	NA	NA	NA	NA	100	100			
Total Dissolved Solids (TDS)	mg/L	NA	NA	NA	NA	NA	NA	NA					
Total Suspended Solids (TSS)	mg/L	NA	NA	NA	NA	NA	NA	NA					30(1);20(2)
Fluoride	mg/L	NA	NA	NA	NA	NA	NA	NA					
Dissolved Metals													
Aluminum	mg/L	NA	0.21	0.58	1.80	0.09	0.16	0.27					
Antimony	mg/L	NA	0.0006	0.0006	0.0008	0.0015	0.0013	<0.0004					
Arsenic	mg/L	NA	0.0117	0.0290	0.0099	0.0081	0.0078	0.0036			0.34(3);0.15(4)		1.0(max);0.5(1)
Barium	mg/L	NA	0.295	0.251	0.783	0.115	0.115	0.780					
Beryllium	mg/L	NA	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002					
Cadmium	mg/L	NA	0.0001	0.0004	0.0006	0.0001	<0.0001	0.0002					
Copper	mg/L	NA	0.02	<0.01	<0.01	0.02	0.01	0.01					
Iron	mg/L	NA	0.12	0.45	0.75	0.08	0.09	0.43					
Lead	mg/L	NA	0.0002	0.0024	0.0030	0.0004	0.0006	0.0029					
Manganese	mg/L	NA	0.080	0.848	0.297	0.042	0.209	0.228					
Mercury	mg/L	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002			0.0014(3); 0.00001(4)		
Molybdenum	mg/L	NA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					
Nickel	mg/L	NA	0.0031	0.0050	0.0279	0.0055	0.0023	0.0032					
Potassium	mg/L	NA	17.0	17.6	11.7	21.5	13.3	14.3					
Selenium	mg/L	NA	0.0006	0.0005	0.0004	0.0009	0.0007	0.0023			0.0184(3); 0.0046(4)		
Silver	mg/L	NA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					
Thallium	mg/L	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001					
Uranium	mg/L	NA	0.0003	0.0004	0.0002	0.0007	0.0006	0.0011					
Vanadium	mg/L	NA	0.021	0.014	0.005	0.029	0.020	0.023					
Zinc	mg/L	NA	0.007	0.024	0.149	0.006	0.004	0.120					1.0(1);0.5(2)
Total Metals													
Antimony	mg/L	<0.0004	NA	NA	NA	NA	NA	NA					
Arsenic	mg/L	<0.0005	NA	NA	NA	NA	NA	NA	0.1(2)	0.1			
Cadmium	mg/L	<0.0001	NA	NA	NA	NA	NA	NA	0.01(2)	0.01			
Chromium	mg/L	<0.01	NA	NA	NA	NA	NA	NA	0.1(2)	0.1			
Lead	mg/L	<0.0001	NA	NA	NA	NA	NA	NA	0.1(2)	0.1			

Surface Water Sample ID		Equipment Rinsate	DUP-1 (SW-3)	DUP-2 (SW-1)	DUP-3 (SW-3)	DUP-4 (SW-1)	DUP-5 (SW-3)	DUP-6 (SW-4)	CDPHE Agriculture	CDPHE Dolores Segment 3a	CDPHE Aquatic Class 2	CDPHE Recreational Class E	EPA 40 CFR Part 440
Date		2/12/08	9/29/08	9/26/08	5/27/09	6/22/09	7/13/09	7/28/09					
Type of Event		SM	P - 0.5"	P - 0.6"	P - 1.2"	P - 0.3"	P - 0.4"	P - 0.7"					
Parameter	**Unit**												
Mercury	mg/L	<0.0002	NA	NA	NA	NA	NA	NA					
Selenium	mg/L	<0.0001	NA	NA	NA	NA	NA	NA	0.02(2)	0.02			
Thallium	mg/L	<0.0001	NA	NA	NA	NA	NA	NA					
Radionuclides – Dissolved													
Gross Alpha	pCi/L	0.76	NA	NA	NA	NA	NA	NA					
Radium-226	pCi/L	NA	NA	NA	NA	NA	NA	NA					10(1);3.0(2)
Radium-228	pCi/L	NA	NA	NA	NA	NA	NA	NA					
Thorium-230	pCi/L	NA	NA	NA	NA	NA	NA	NA					
Thorium-232	pCi/L	NA	NA	NA	NA	NA	NA	NA					
Radionuclides – Total													
Radium-226	pCi/L	0.08	NA	NA	NA	NA	NA	NA	5	5	5	5	30(1);10(2)
Radium-228	pCi/L	2.5	NA	NA	NA	NA	NA	NA					
Thorium-230	pCi/L	-0.33	NA	NA	NA	NA	NA	NA	60	60	60	60	
Thorium-232	pCi/L	-0.04	NA	NA	NA	NA	NA	NA					

Notes:
Standards
(1) - Maximum value
(2) - 30-day average value
(3) – Acute
(4) - Chronic

Regulatory References:
CDPHE WQCD Regulation No. 31 - The Basic Standards and Methodologies for Surface Water (amended 1/14/08)
CDPHE WQCD Regulation No. 35 - Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins (amended 2/12/07)
EPA CFR40 Part 440 Subpart C - Uranium, Radium and Vanadium Ores Subcategory

There is large variability in turbidity (TSS) and TDS between samples. These concentrations may be expected to be affected by many factors, such as the moisture and capillary cohesion of soil surface (crust), the rainfall rate and size of rain drops, presence of stock, and others. There is no significant correlation between TSS and TDS, gauge rainfall, or dissolved or total metals or radionuclide concentrations ("dissolved" concentrations are analyzed after filtration to 0.45 micron; "total" metal concentrations are analyzed after acid digestion of the water sample with its suspended solids). Total radionuclides and metals exceed dissolved concentrations. Total radionuclides and suspended solids exceed water quality criteria applicable to the Dolores River receiving reach; these are highlighted in the table.

3.4.2 Groundwater

3.4.2.1 Regional Hydrogeology

There have been many publications on regional hydrogeology of the Paradox Basin, but little specifically on Paradox Valley itself. Notable regional hydrologic studies include *Regional Hydrology of the Dolores River Basin, Eastern Paradox Basin* (Weir et al., 1983), *Regional Hydrology of the Blanding-Durango Area, Southern Paradox Basin* (Whitfield et al., 1983), and *Geohydrology of Mesozoic Rocks in the Upper Colorado River Basin in Arizona, Colorado, New Mexico, Utah, and Wyoming, Excluding the San Juan Basin* (Freethey and Cordy, 1991). Additional studies have focused on the geology in the region, including *Geologic Appraisal of Paradox Basin Salt Deposits for Waste Emplacement* (Hite and Lohman, 1973), *Geochemistry and Hydrodynamics of the Paradox Basin Region, Utah, Colorado, and New Mexico* (Hanshaw and Hill, 1969), and *Geology of the Pennsylvanian and Permian Cutler Group and Permian Kaibab Limestone in the Paradox Basin*, *Southeastern Utah and Southwestern Colorado* (Condon, 1997). These studies provide the following information regarding the regional hydrogeology.

- Three aquifer systems are recognized regionally in the studies above, namely alluvium, upper Paleozoic and Mesozoic strata, and lower Paleozoic strata. The Hermosa Formation is a regional aquitard between upper and lower bedrock aquifers.

- Alluvial groundwater along the San Miguel and Dolores rivers is in direct connection with surface water. River alluvium contains outwash sand and gravel from the San Juan Mountains. Alluvium in Paradox Valley is derived from weathering of the valley sides and consists of silt and sand, with some clay and gravel (Golder, 2009d), and is recharged by direct precipitation and runoff from the valley sides.

- The upper bedrock aquifer consists of all strata younger than (above) the Hermosa Formation. The Dolores, Chinle, and Moenkopi formations contain sandstones and shales, and are regionally considered to be aquitards (Topper et al., 2003), along with the Hermosa Formation. The upper aquifer has recharge and discharge patterns that are strongly linked to local topography and locally flows northwest to the Dolores River (Weir et al., 1983; Topper et al., 2003). Relatively short flowpaths and predominantly continental quartz sandstones give the upper aquifer generally low dissolved solids content.

- The Hermosa Formation isolates the upper and lower aquifer systems (Topper et al., 2003; Freethey and Cordy 1991; Weir et al., 1983; Whitfield et al., 1983). It contains thick, low permeability shales and salt deposits (particularly the Paradox Member) which raise dissolved solids concentrations in strata immediately above and below.

- The lower bedrock aquifer consists of limestone and marine sandstones; in the Paradox Basin the top of the lower aquifer consists of the Leadville Limestone, which has fracture and karst permeability, and carries brines, and oil and gas. Groundwater in the lower aquifer flows below the influence of local topography, toward the Colorado River (Freethey and Cordy, 1991).

Recharge derives from precipitation which ranges from 24 inches (60 cm) per year at high elevations (such as the La Sal and San Juan mountains), when it is predominantly from snowfall, to approximately 12 inches (about 30 cm) per year at lower elevations, when it is largely from fall thunderstorms. Meteorology is discussed fully in Section 3.6.

The Dolores River forms a groundwater divide for alluvial and upper bedrock aquifers regionally and in Paradox Valley in particular. This means that northwest and southeast ends of the valley are hydrologically separated by the Dolores, except in the deep, saline Leadville Limestone (regional lower aquifer).

3.4.2.2 Site Groundwater

The Site is within Paradox Valley, a collapsed anticline domed upward by a salt diapir (a buoyant, plastic salt flow) formed by the Paradox Member, and then sapped by dissolution of the salt core. Mesozoic and upper Paleozoic strata comprising the regional bedrock aquifer system outside the valley dip away from the valley, while within the valley, down-dropped remnants of the anticline flanks form a limited aquifer, referred to here as the valley margin Triassic aquifer. Recharge outside of the valley flows away from the anticline. The alluvial floor of the valley is largely underlain by the very low permeability, confining strata of the Hermosa Formation, including the core of the salt diapir derived from the Paradox Member. The location of the Site in the southeast end of Paradox Valley (Figure 3.4-1) isolates it from regional aquifers. Groundwater (and surface water) within the catchment boundary (shown as a yellow line in the figure) flows to the Dolores River, to which it discharges. Groundwater outside the boundary flows away from the valley, toward the San Miguel or Dolores rivers.

Although numerous reports have been published on regional hydrogeology, none has focused on the hydrogeology of the eastern Paradox Valley. The regional studies name the Mesozoic formations, including Navajo Sandstone, Wingate Sandstone, and the Entrada Sandstone as important components of the upper bedrock aquifer, but these are largely absent at the Site due to their removal by erosion of the collapsed anticline crest. Figure 3.4-3 shows a stratigraphic column similar to that in Section 3.3., Geology and Soils, but with groundwater bearing units at the Site noted to the right. Of the Mesozoic strata present outside the valley, only portions of Chinle and Moenkopi formations are present inside the valley. The Hermosa Formation is a shale aquitard between upper and lower aquifers, and also an aquitard where it has truncated Mesozoic strata. Not shown in the figure is the alluvial veneer. The degree of hydraulic connection between the Mesozoic strata outside the valley and the valley margin Triassic aquifer inside it is unknown. To the extent that the faulting disrupts the hydraulic connection by offsets and low permeability gouge, the valley margin Triassic aquifer may be partially isolated from regional bedrock aquifers.

This figure is based on the Hydrogeologic Report (Golder, 2009d).

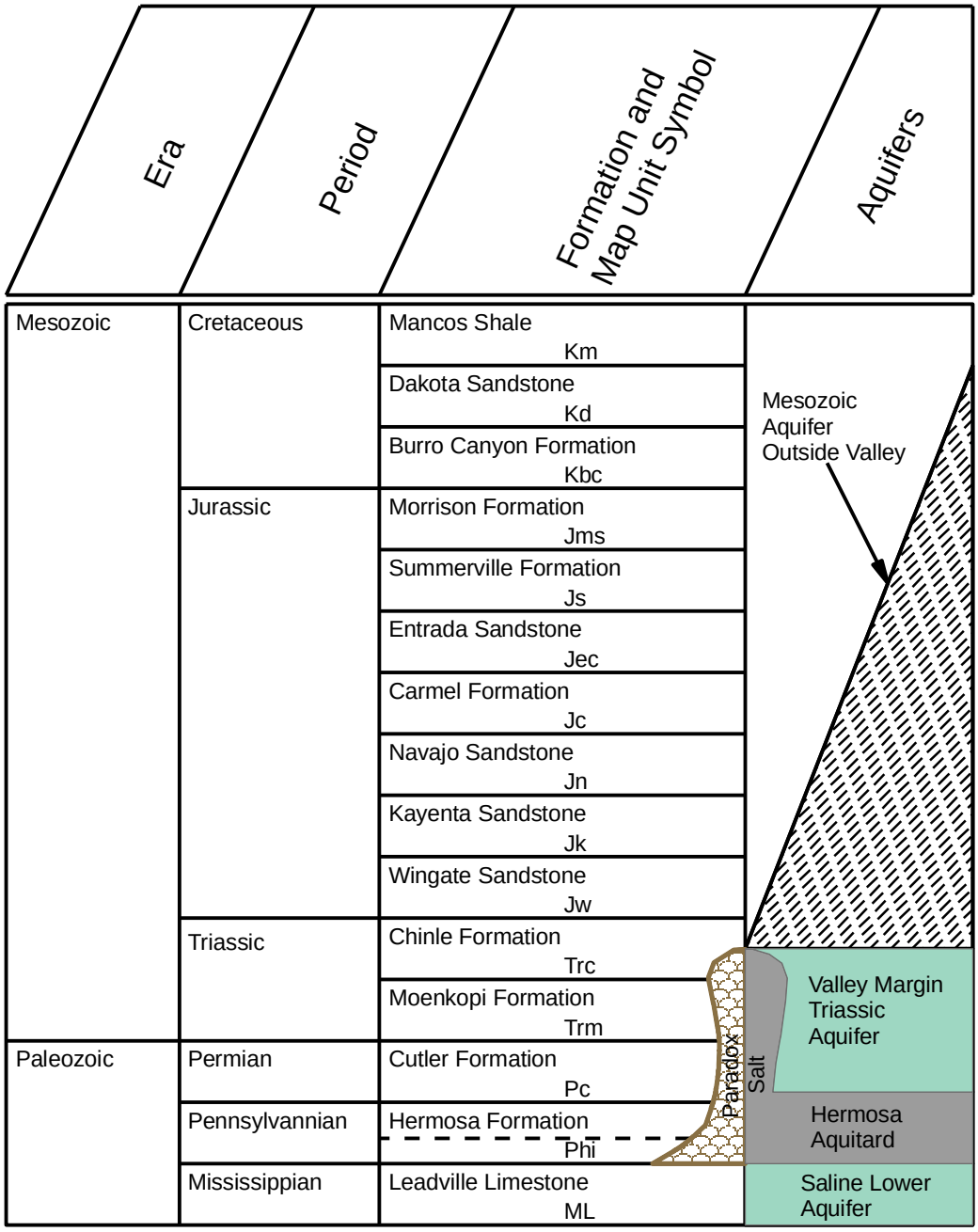


Figure 3.4-3

Schematic Stratigraphic Section Paradox Valley

Energy Fuels conducted a two-year site assessment of groundwater from fourth quarter 2007 through third quarter 2009 (Golder, 2009d). Of 35 borings, nine were completed as monitoring wells, three as pumping test – production wells, and six as observation piezometers for the pumping tests. Borehole and well locations are shown in Figure 3.4-4. Pumping tests were performed in 2008, and eight quarters of groundwater samples were analyzed. Aquifer hydraulic and water quality, pumping test analyses, and potential water supply yield are reported in the *Hydrogeologic Report* (Golder 2009d).

Borehole lithologies identified four formations with hydrologic significance at the Site:

1. Valley floor alluvium, shed by the valley sides, up to 150 feet (46 m) thick, and carrying some flow from direct infiltration and runoff from the valley sides north to the Dolores River.
2. Chinle Formation – occurring in faulted valley margin blocks at the Site and bearing some groundwater in its lower part.
3. Moenkopi Formation – underlies the Chinle Formation and also may contain groundwater in some locations.
4. Hermosa Formation – shale and salt of the Paradox Member, which truncates the Chinle and Moenkopi formations near the center of the valley, and underlies them under Davis Mesa.

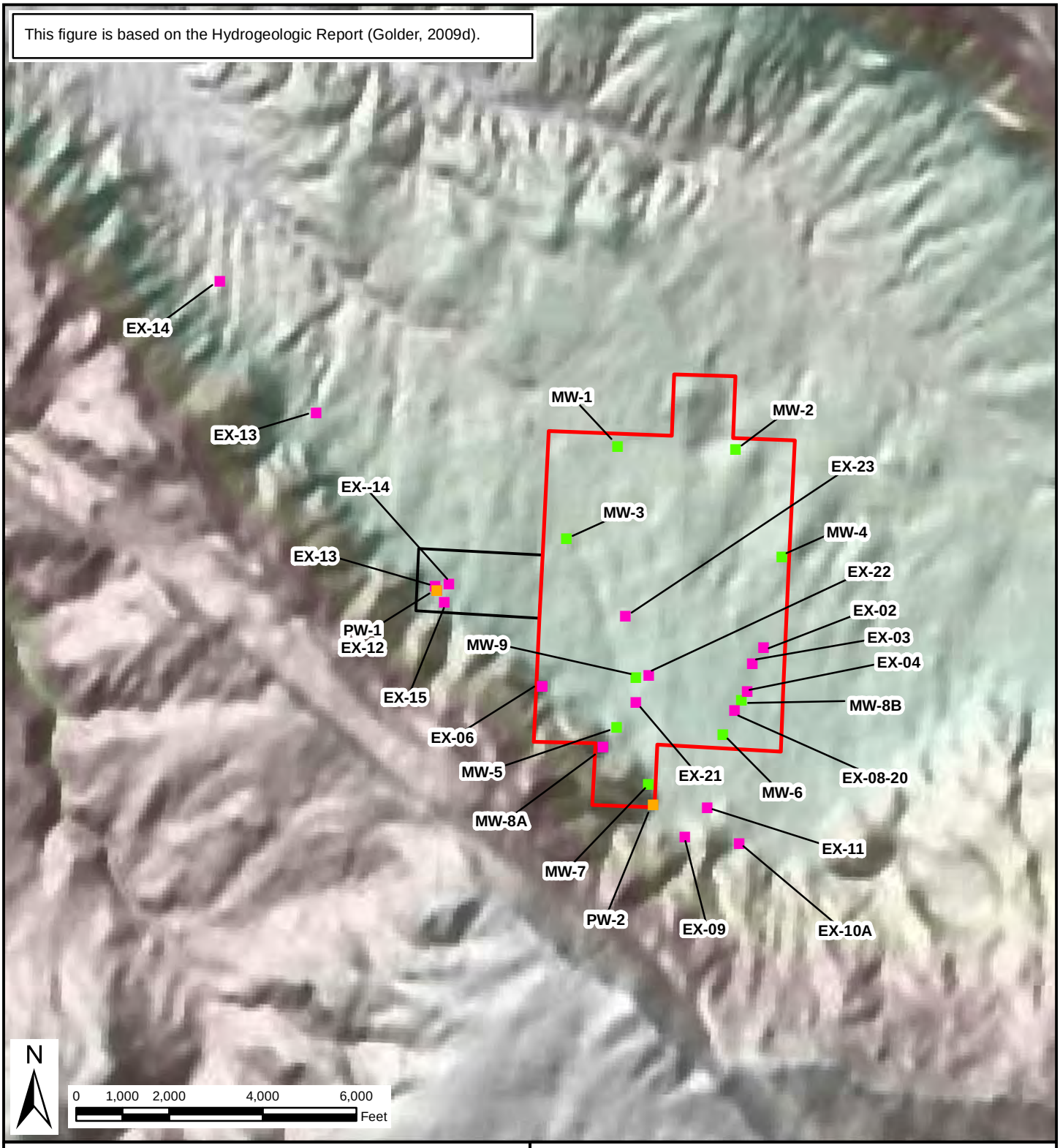
Alluvium was sampled by borings. It is up to 150 feet (46 meters) thick, but with almost no saturated thickness. According to the *Hydrogeologic Report* (Golder, 2009d) there is no water in the alluvium. Alluvial sediments encountered in borings are described as sand with basal gravels, which probably drain the small amount of direct infiltration to narrow channels incised in bedrock. One such gully in the bedrock surface is clearly evident beneath the Site in a contour map in Figure 3.3-9 (Section 3.3, Geology and Soils).

Partial sections of the Chinle and Moenkopi formations constitute the valley margin Triassic aquifer (with slivers of Wingate Sandstone). Site investigations show that this aquifer inside the valley, at the foot of Davis Mesa, is recharged by infiltration on the valley side, and the edge of the mesa is likely a groundwater divide. Groundwater south of this divide flows away from the Paradox Valley to discharge to the Dolores River, just as groundwater on the north side of the valley flows northeast to the San Miguel River.

Typical geologic cross sections through the Site are shown in Figure 3.3-4 (Section 3.3, Geology and Soils). These sections are located within the valley, as shown in Figure 3.4-3, running onto the lower valley slope at the southwest end. These have no vertical exaggeration. Sections show faulted blocks of purple and orange Triassic strata of limited extent, which constitute the only bedrock aquifer of the Site. The Chinle and Moenkopi formations extend from Davis Mesa to approximately the alignment of the fault labeled Fault #3 on Figure 3.4-3. While these two formations are not generally known as aquifers, the faulting and jointing of the valley margin appear to both connect them and give them secondary permeability.

The main characteristics of this valley bedrock Triassic aquifer are:

- Recharge on the valley sides, with flow toward the valley axis;
- Some hydraulic connection to the Mesozoic strata outside the valley, although the edge of Davis Mesa appears to be a groundwater divide;



Exploratory Borings
Monitoring Wells
Production Wells
Property Boundary
Well Field Boundary

Figure 3.4-4

Boreholes & Well Locations for Groundwater Characterization

- Northwest-trending faults contributing secondary permeability; and
- The Hermosa Formation forming a practically impermeable basement, truncating the valley margin Triassic aquifer on its northeast side, and also leaking salt into adjacent groundwater.

Groundwater in the valley margin Triassic aquifer flows away from the divide at the edge of the mesa to the northeast, toward the faulted contact with the Paradox salt. Flow turns northward at the contact, toward the Dolores River. Groundwater flow directions in the Site aquifer can be gauged from the potentiometric map of Figure 3.4-5. Flow is to the northeast into the valley, with contours suggesting recharge also from the slump block of the Morrison Formation to the southeast. Connection between the Morrison Formation slump block and the Moenkopi-Chinle block is not clear. Wells north of this aquifer (MW-1 to MW-4) are completed in the Hermosa Formation, and are dry.

In spring and summer 2008, hydraulic testing was conducted in the valley margin Triassic aquifer to both evaluate its water supply potential and to further characterize the Site groundwater regime. Testing and analyses are included in the *Hydrogeologic Report* (Golder (2009d). Testing consisted of:

- Nine short term (approximately 4-hour) pumping tests,
- Three long-term (48-hour) pumping tests, and
- Three rising-head/falling-head slug tests.

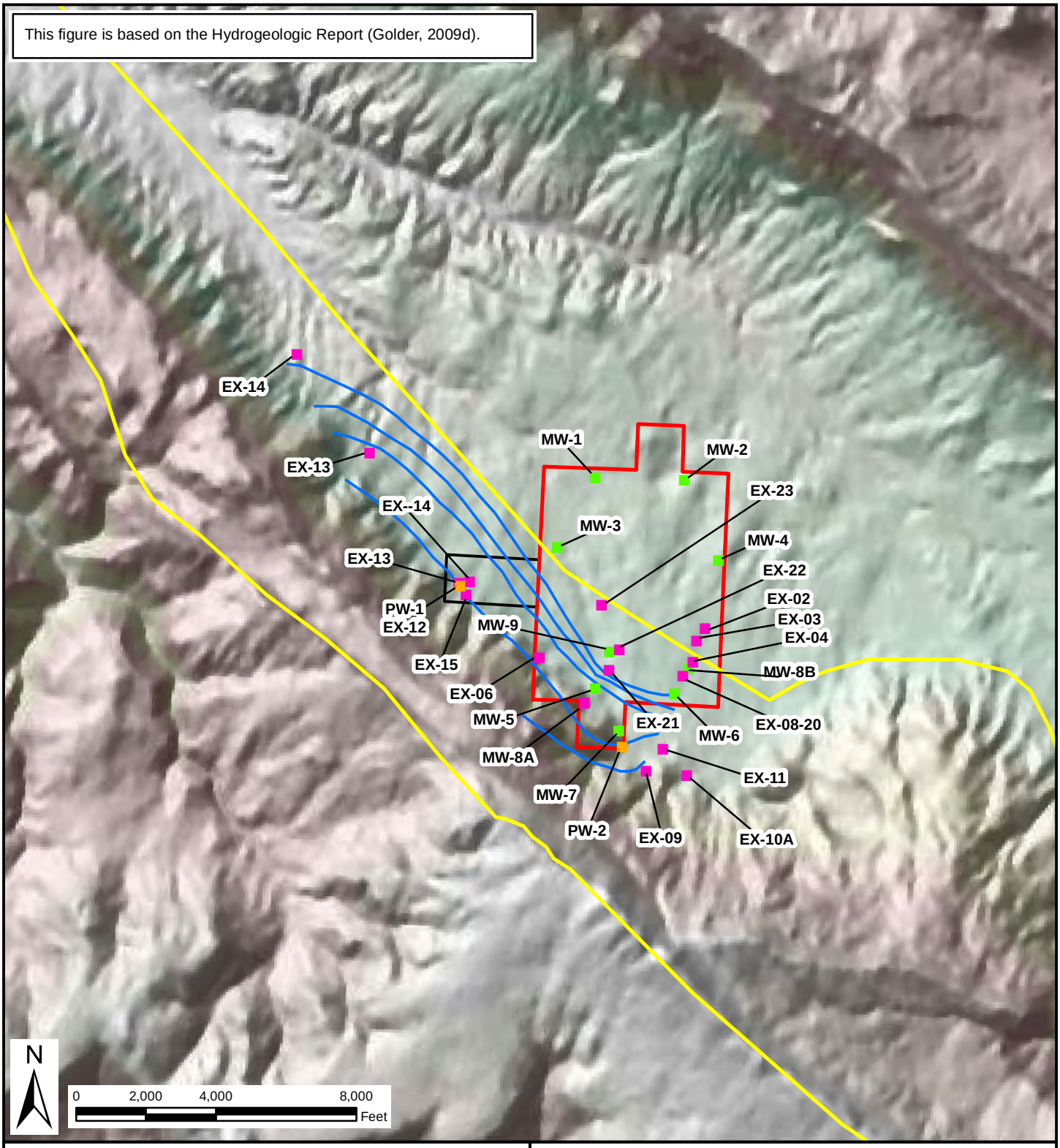
Discharge rates during the short-term pumping tests ranged from 4.7 to 39.8 gpm and in the long-term pumping tests from 10.3 to 67.5 gpm. The three long term tests were conducted simultaneously, with a cumulative yield of 130 gpm from PW-1, PW-2, and PW-3. Locations of the characterization boreholes and wells are shown in Figure 3.4-4. Results of analyses of the pumping tests are given in Table 3.4-2.

The average conductivity for the tested locations is 3×10^{-3} centimeters per second (cm/s), which is higher than expected for Chinle-Moenkopi. The range of hydraulic conductivity estimated from the testing is narrow, but the storativity is relatively low, which suggests extensive fracturing contributing secondary permeability. Lateral groundwater pore velocity estimated from Darcy's Law is approximately 7 feet per day - ft/d in the valley margin Triassic aquifer under the south end of the Site.

3.4.2.3 Existing Wells and Springs

Water wells and springs in the vicinity of the Site were located through Colorado Division of Water Resources (CDWR) database searches and field investigations. Field investigations were conducted to verify the existence, location, and condition of water wells located in close proximity. Owners of wells completed in the Chinle Formation and the BOR (operator of the Paradox Valley Unit) were also contacted to obtain additional well information such as withdrawal rates and use.

Water Wells. Table A-1 and Figure A-1 in the *Hydrogeologic Report (*Golder, 2009d) show the 46 water wells or permitted locations identified within the study area other than wells permitted and installed by Energy Fuels. Of these, 45 have been permitted with the state, and one older well identified by the BLM as the Prospector Well was not permitted. Some of the permits have not been exercised, and some others have been abandoned. Permitted well counts by formation, based on depth and location, are as follows:



Exploratory Borings
Monitoring Wells
Production Wells
Inferred GroundwaterContours
Approximate Limits of Valley Margin Triassic Aquifer
Property Boundary
Well Field Boundary

Figure 3.4-5

Potentiometric Surface Map

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Table 3.4-2
Summary of Aquifer Properties

Boring/ Well ID	Category of Boring/Well	Phase of Testing	Pumping Rate (gpm)[1]	Total Pumping Time (hours)	Maximum Observed Drawdown (ft)	Phase of Test for Analysis	Solution Type	Estimated Transmissivity (cm^2/s) [4]	Estimated Aquifer Thickness (ft)	Estimated Hydraulic Conductivity (cm/s) [4]	Estimated Storativity
EX-5	Exploration Hole	Phase 1	19.8	6	45.38	Pumping (step test)	Cooper-Jacob - Confined	0.5	55	3×10^{-4}	--
						recovery	Theis (Recovery)	0.3	55	2×10^{-4}	--
EX-6	Exploration Hole	Phase 1	27.8	6.7	29.14	Pumping (step test)	Cooper-Jacob - Confined	10	48	7×10^{-3}	--
						recovery	Theis (Recovery)	6	48	4×10^{-3}	--
EX-7	Exploration Hole	Phase 1	19.4	6.7	27.54	Pumping (step test)	Cooper-Jacob - Confined	11	60	6×10^{-3}	--
						recovery	Theis (Recovery)	10	60	5×10^{-3}	--
EX-8	Exploration Hole	Phase 2	26.2	4	19.2	pumping	Cooper-Jacob - Confined	11	60	6×10^{-3}	--
						recovery	Theis (Recovery)	10	60	5×10^{-3}	--
EX-10	Exploration Hole	Phase 2	14.9	5	16.7	pumping	Cooper-Jacob - Confined	0.8	60	4×10^{-4}	--
						recovery	Theis (Recovery)	6	60	3×10^{-3}	--
EX-11	Exploration Hole	Phase 2	8.8	4	47.9	pumping	Cooper-Jacob - Confined	0.2	60	9×10^{-5}	--
						recovery	Theis (Recovery)	0.5	60	3×10^{-4}	--
EX-12	Exploration Hole	Phase 2	39.8	6	3.57	pumping	Cooper-Jacob - Confined	10	60	6×10^{-3}	--
						recovery	Theis (Recovery)	32	60	2×10^{-2}	--
EX-15	Exploration Hole	Phase 2	14.4	6	53.78	pumping	Cooper-Jacob - Confined	0.8	91.1	3×10^{-4}	--
						recovery	Theis (Recovery)	3	91.1	9×10^{-4}	--
MW-6	Monitor Well	Phase 1	4.71	5	18.31	Pumping (step test)	Cooper-Jacob - Confined	0.5	30	6×10^{-4}	--
MW-7	Monitor Well	Phase 3	--	--	2.1	pumping	Theis - Confined	3	40	3×10^{-3}	3×10^{-4}
						recovery	Agarwal (CJ) - Confined	4	40	3×10^{-3}	3×10^{-4}
MW-8b	Monitor Well	Phase 2	slug test	--	--	falling head	Dagan - Unconfined	--	--	1×10^{-4}	--
						rising head	Dagan - Unconfined	--	--	2×10^{-4}	--
MW-9	Monitor Well	Phase 2	rising head test	--	--	rising head	Bouwer-Rice - Unconfined	--	--	2×10^{-8}	--
PW-1	Production Well	Phase 3	52.1 [2]	48.0	45.6 [2]	pumping	Theis - Distance-Drawdown	3	30	3×10^{-3}	3×10^{-5}
PW-1 OB-A	Observation Well	Phase 3	--	--	12.5	pumping	Theis - Confined	3	30	4×10^{-3}	2×10^{-5}
						recovery	Agarwal (CJ) - Confined	4	30	4×10^{-3}	1×10^{-5}
PW-1 OB-B	Observation Well	Phase 3	--	--	5.8	pumping	Theis - Confined	3	30	4×10^{-3}	3×10^{-5}
						recovery	Agarwal (CJ) - Confined	7	30	8×10^{-3}	4×10^{-5}
PW-2	Production Well	Phase 3	10.3	48.0	33.5	pumping	Theis - Distance-Drawdown	4	40	3×10^{-3}	5×10^{-4}
PW-2 OB-A	Observation Well	Phase 3	--	--	2.6	pumping	Theis - Confined	4	40	3×10^{-3}	7×10^{-4}
						recovery	Agarwal (CJ) - Confined	4	40	3×10^{-3}	1×10^{-3}
PW-2 OB-B	Observation Well	Phase 3	--	--	NR [3]		--	--	--	--	--
PW-3	Production Well	Phase 3	67.5	48.0	54.2	pumping	Theis - Distance-Drawdown	4	80	1×10^{-3}	1×10^{-2}
PW-3 OB-A	Observation Well	Phase 3	--	--	8.2	pumping	Cooper-Jacob - Unconfined	4	80	2×10^{-3}	1×10^{-2}
						recovery	Agarwal (CJ) - Unconfined	5	80	2×10^{-3}	1×10^{-2}
PW-3 OB-B	Observation Well	Phase 3	--	--	2.0	pumping	Cooper-Jacob - Unconfined	8	80	3×10^{-3}	9×10^{-3}
						recovery	slow recovery, could not be analyzed	--	--	--	--

Notes:
[1] gpm: gallons per minute
[2] Pumping rate and max drawdown listed for final pumping rate. At a pumping rate of 66 gpm during first 5 hours of test, a maximum drawdown of 53.6 feet was observed.
[3] NR: No response observed during pumping test
[4] cm/s: centimeters per second; cm^2/s: centimeters squared per second

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- Chinle/Moenkopi formations (11);
- Paradox Valley alluvium (10);
- Dolores River alluvium (16); and
- other (9).

A summary of the permitted wells for each aquifer is presented below. Additional details and informational references are provided in Table A-1 in the *Hydrogeologic Report* (Golder, 2009d).

Chinle/Moenkopi Formation Wells The wells permitted in the Chinle and Moenkopi formations are all located near the toe of Davis and Monogram mesas. These are:

- Four domestic wells currently in use (permit numbers 226684, 234136, 253522, and 269575): Supply for Hurdle, Herron, Boren, and Fehlmann/Davis residences, respectively);
- One domestic well not in use (permit number 91065): This supplied the Herron residence (previously owned by J. Russell) with domestic and livestock water until 2003, when it went dry and was replaced by well with permit number 234136;
- One stock well currently in use (permit number 258704): This is located on public land administered by the BLM, and used for watering cattle;
- Two intermittent or dry wells (permit numbers 86582 and 86583): Well with permit number 86582 produces water in wet years, and well with permit number 86583 is dry; and
- Three wells permitted but not installed (permit numbers 190027, 257495, and 279209): Owners indicated that well with permit numbers 190027 and 257495 were not installed, and well with permit number 279209 was drilled but was not completed.

Alluvial Wells Permitted alluvial wells are located near the central axis of the valley. Although some may have been intermittent producers, none are currently being used as follows:

- Inoperable wells (permit numbers 36544, 91066, and 102922): Well 36544, located immediately east of the Site, was installed by the landowner who has since passed away. An inspection in May 2008 found that the casing had collapsed. The windmill at well with permit number 91066 is broken and the well is not in use. Well with permit number 102922 was found to have an obstruction in the casing (possibly a stuck submersible pump) when inspected in June 2009;
- Wells abandoned or not installed (permit numbers 190026, 190028, 102923, 138759, 218930, and 226716): These wells do not appear to currently exist, based on interviews and field inspections; and
- “Prospector Well”: This well is located on the north side of the valley. It was sampled by the BLM in 1980, and water was of relatively poor quality with a specific conductivity of 3,350 micro Siemens per centimeter (*u*S/cm), and dissolved sulfate concentration of 2,300 mg/L. The current status of the well is unknown.

Dolores River Alluvial Wells These wells are located along the east bank of the Dolores River and are completed in river alluvium. Most are extraction wells for the BOR's desalinization plant as follows:

- Ten BOR extraction wells (permit numbers 26278, 26729, 26281, 23654, 23655, 23656, 23658, 23659, 23660, and 26280): These wells are currently pumping at a combined rate of about 230 gpm. The water is pumped to a desalinization plant, filtered water is discharged into the river below Paradox Valley and the extracted brine is disposed of in a deep injection well;
- Four abandoned BOR wells (permit numbers 23662, 23663, 23667, and 1997009); and
- Two domestic and stock wells (permit numbers 234100 and 268908): Well with permit number 234100 is 43-foot deep, and located at a residence just north of SH 90 on the right bank. This well may be upstream of the Paradox salt contacts and relatively fresh. Well with permit number 268908 is located in the center of the valley near the BOR wells, and was probably not completed because of high salinity.

Other Aquifers Nine wells apparently do not fit the previous classes. Many are indicated to be on the valley side or on the mesas. Some appear to be incorrectly located, or to be monitoring wells for mining activity as follows:

- Two active monitoring wells (permit numbers 48086 and 48088): Wells are completed in the Entrada Sandstone at an underground mine immediately south of the Site and are dry;
- Three abandoned wells (permit numbers 8547, 25277, and 32483): Well with permit number 8547 is an abandoned monitoring well for an underground mine. Well with permit number 25277 may have been installed to supply water to the change room for the open pit mine east of the Site. The mine operator, Cotter Corporation, could not locate this well and it is presumed abandoned. Well with permit number 32483 ("Dalton well") belongs to the reclaimed Nill Mine. This mine was wet. Water was pumped from the mine for livestock use until the mine was reclaimed and sealed; and
- Four incorrectly located wells (permit numbers 21384, 29990, 29991 and 115739): The given coordinates for these four wells place them on BLM-administered land, but the BLM has no record of them. Wells with permit numbers 29990 and 29991 were filed by the DOE. The DOE indicated that they were probably monitoring wells installed in Section 35 near the Durita Site, which is located in Township 46 North, Range 16 West, rather than Township 46 North, Range 17 West as listed in the CDWR database. Similar errors may apply to the other two wells.

Springs. Three springs identified within the study area are shown in Table A-2 and Figure A-1 in the *Hydrogeologic Report* (Golder, 2009d), named Stone Spring, Merrill Spring, and Oublier Spring. A field assessment in June 2009 found Merrill Spring and Stone Spring, approximately 5 miles northwest of the Site, issue from the Chinle Formation on the southwest side of the valley. Merrill Spring was not flowing at the time of the visit. Stone Spring provides water to two households on the Boren property through a PVC pipe. Flow from Stone Spring was estimated to be approximately 10 gpm. Oublier Spring, located approximately 4 miles southeast of the Site, was determined to flow from near the base of the Salt Wash Member of the Morrison Formation.

3.4.2.4 Groundwater Quality

Groundwater quality in the vicinity of the Site has been assessed by groundwater samples collected from 20 locations over the eight-quarter period from October 2007 to August 2009 (Golder, 2009d). The sampling locations included:

- monitoring wells MW-5, MW-6, MW-7, MW-8b, MW-9;
- production wells PW-1, PW-2, PW-3;
- exploratory holes EX-5, EX-6, EX-7, EX-10, EX-12, EX-15, EX-23; and
- four domestic wells and one spring used for domestic purposes.

Groundwater at, and in the immediate vicinity of, the Site is magnesium-calcium, sulfate-bicarbonate type, as is shown in a Piper or trilinear diagram in Figure 3.4-6. The ratios of major cations are shown in the left triangle, and anions in the right, while the quadrilateral combines the two. Each point represents a ratio of average concentrations for a well. All groundwater has near-neutral pH (7-8). The single sample collected from Monitoring well MW-9 is not shown on the Piper diagram, as the well was completed in a low permeable formation and could not be developed properly for collecting representative water samples.

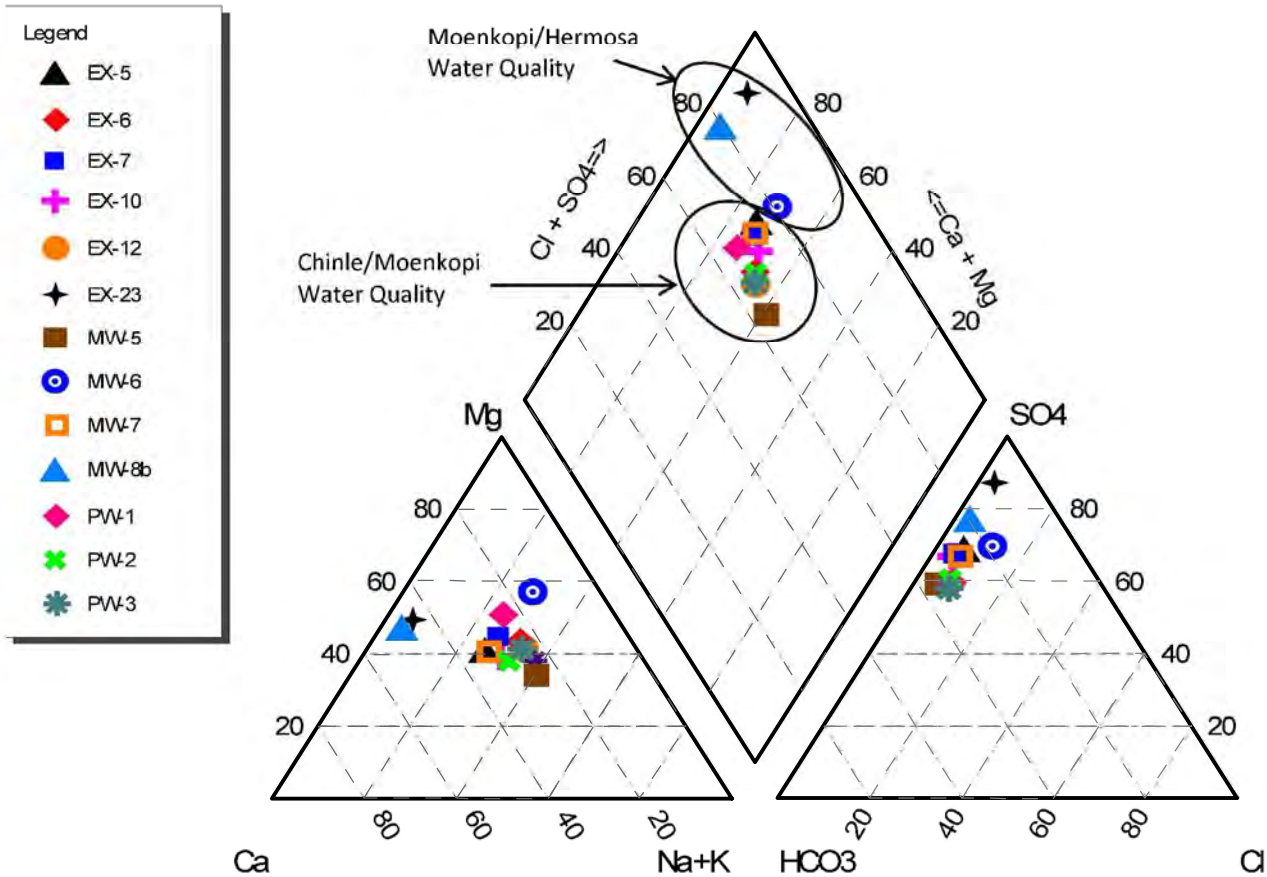
TDS concentrations are higher at the base of the Chinle Formation and in the Moenkopi Formation than in the upper Chinle, due to longer residence time in the aquifer for deeper, older water, and on the north edge of the aquifer, due to proximity to the Hermosa Formation. Shallower As illustrated in Figure 3.4-7, Chinle groundwater (Wells MW-5, MW-7, MW-9, PW-1, PW-2, and PW-3) has TDS between 600 and 1,100 mg/L, while deeper water (Wells MW-6 and MW-8b) has TDS 1,100 to 3,040 mg/L. Deeper water also shows negative oxidation-reduction potential (ORP) values, and detectable concentrations of sulfide and ammonia. That is, the water solutes are reduced with respect to reduction-oxidation state. Co-existence of sulfate and sulfide indicates active microbial sulfate reduction, presumably fueled by organic compounds diffusing out of the Hermosa shales (Dexter Dyer, 2003).

The concentrations of several parameters in the groundwater are consistently above the CDPHE Domestic Water Supply and Agricultural standards (CDPHE, 2008c). These constituents are highlighted in Table 3.4-3, and discussed below. Most of these exceedances of standards in the baseline water samples are due to the native conditions of diffusion of salts from the Paradox Member and uranium from the Morrison Formation. Elevated selenium, arsenic, and uranium concentrations are typical in groundwater in the Salt Wash Member of the Morrison Formation.

Arsenic: Arsenic concentrations are above the domestic supply standard of 0.01 mg/L in samples from PW-1, PW-3, EX-6, EX-7, and EX-12. The highest concentration was measured in the sample from PW-1 (0.0177 mg/L)..

Sulfate: Sulfate concentrations are above the domestic water supply standard of 250 mg/L in all the wells sampled at the Site. Dissolution of natural salts present in the Moenkopi, Chinle and Hermosa formations, particularly anhydrite and gypsum, is responsible for sulfate concentrations above the standard. The concentrations are highest at wells MW-6 and MW-8b, and borehole EX-23 (which was drilled into the top of the Hermosa Foromation). The highest reported concentration of sulfate in a sample from a monitoring or production well was 1,810 mg/L for a sample from monitoring well MW-8b collected in July 2008. The highest reported sulfate concentration in the Moenkopi/Chinle screened wells was 480 mg/L in MW-7.

This figure is based on the Hydrogeologic Report (Golder, 2009d).



Notes:
- Data are shown for one representative sample at each location.
- PW: Production Well
- MW: Monitoring Well
- EX: Exploratory Hole

Figure 3.4-6

Piper Water Quality Diagram

This figure is based on the Hydrogeologic Report (Golder, 2009d).

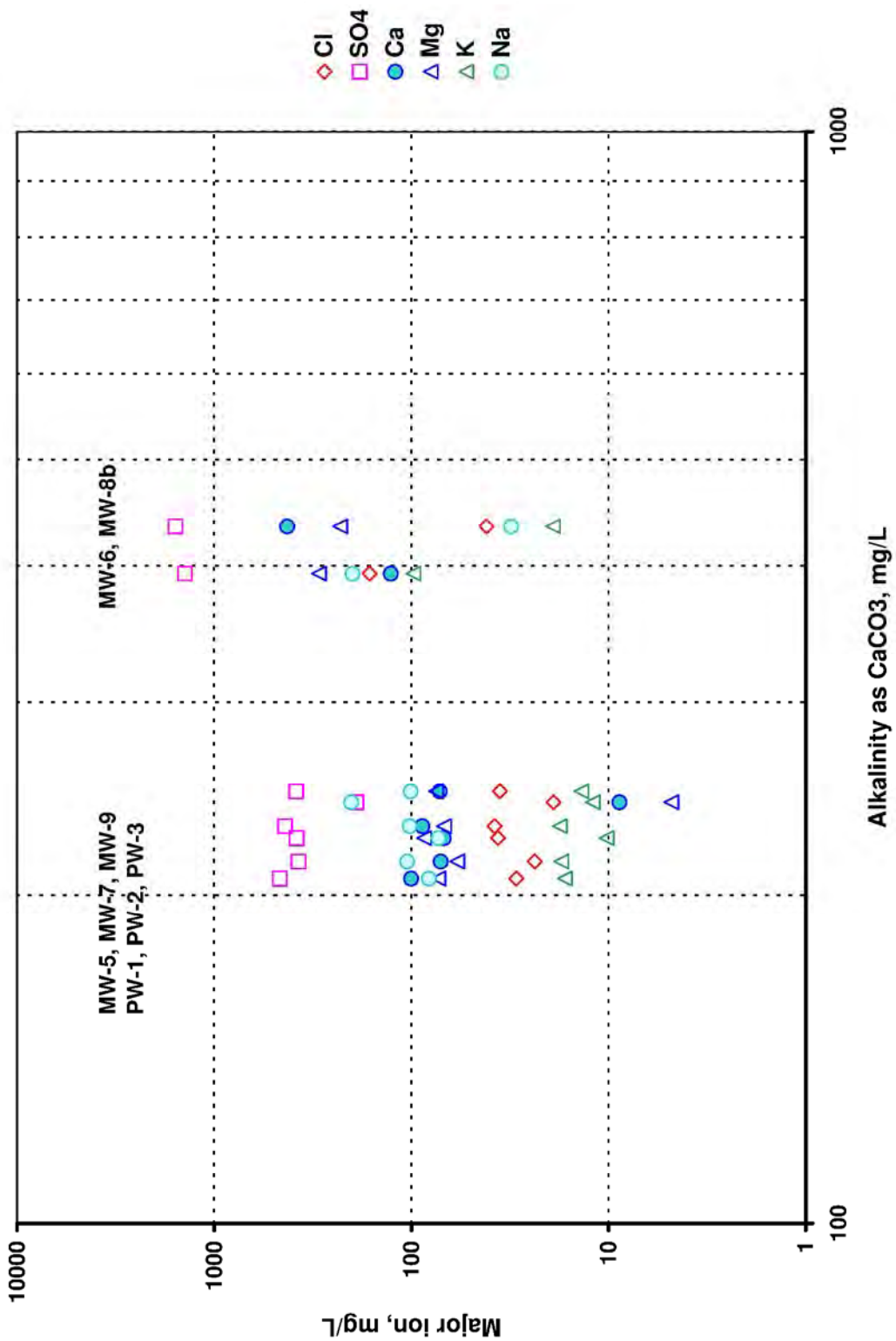


Figure 3.4-7

Major Ions

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Table 3.4-3
Analytical Data for Monitoring Well Samples

Analyte	CDPHE Domestic Water Supply Standards[1]	CDPHE Agricultural Standards[1]	MW-5							MW-6								MW-7						MW-8B					MW-9[2]
			1/31/08[2]	4/30/08	8/7/08	11/14/08	2/19/09	4/30/09	7/31/09	10/16/07	1/29/08	4/29/08	8/7/08	11/14/08	2/18/09	4/28/09	7/28/09	6/7/08	9/9/08	11/13/08	2/18/09	4/29/09	7/31/09	7/21/08	11/13/08	2/18/09	4/29/09	7/29/09	9/10/08[2]
Dissolved Metals																													
Aluminum (mg/L)	None	5	0.23	<0.03	0.04	0.04	0.32	0.05	0.05	<0.1	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.05	<0.03	<0.03	<0.03	<0.03	<0.03	<0.06	<0.06	0.09	<0.03	<0.06	0.07
Arsenic (mg/L)	0.01	0.1	0.0015	0.0021	0.0025	0.0028	0.0027	0.0032	0.0017	<0.001	<0.001	0.0006	0.001	<0.01	0.002	<0.03	0.006	0.0073	0.0046	0.0059	0.0062	<0.03	0.0054	0.002	<0.01	0.003	0.007	0.007	0.0111
Barium (mg/L)	2.0	None	0.034	0.021	NA	NA	NA	NA	NA	<0.1	NA	0.024	NA	NA	NA	NA	NA	0.016	NA	NA	NA	NA	NA	0.038	NA	NA	NA	NA	0.044
Boron (mg/L)	None	0.75	0.59	0.53	0.47	0.46	0.45	0.42	0.41	2.20	2.30	2.27	2.5	2.36	2.39	2.36	2.35	0.21	0.31	0.31	0.36	0.34	0.33	0.36	0.48	0.52	0.47	0.46	2.63
Cadmium (mg/L)	0.005	0.01	0.0002	<0.0001	NA	NA	NA	NA	NA	<0.005	NA	0.0001	NA	NA	NA	NA	NA	<0.0001	NA	NA	NA	NA	NA	<0.0002	NA	NA	NA	NA	<0.0001
Calcium (mg/L)	None	None	69.8	76.6	69.1	69.5	70.2	72.0	69.5	109	123	121	133	132	137	131	131	92.6	101.0	100	103	104	101	495	368	385	500	384	8.8
Cesium (mg/L)	None	None	<0.0002	<0.0002	NA	NA	NA	NA	NA	<0.1	NA	<0.0002	NA	NA	NA	NA	NA	<0.0002	NA	NA	NA	NA	NA	<0.0004	NA	NA	NA	NA	<0.0002
Chromium (mg/L)	0.1	0.1	<0.01	<0.01	NA	NA	NA	NA	NA	<0.005	NA	<0.01	NA	NA	NA	NA	NA	0.03	NA	NA	NA	NA	NA	<0.02	NA	NA	NA	NA	<0.01
Copper (mg/L)	1	0.2	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	0.02	<0.01
Iron (mg/L)	0.3	5	0.19	<0.02	<0.02	0.04	0.22	<0.02	0.06	1.46	<0.04	<0.04	<0.04	<0.04	0.12	<0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.12	0.91	<0.04	1.48	1.43	0.03
Lead (mg/L)	0.05	0.1	0.0020	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	0.0001	<0.001	<0.0004	<.0001	<0.0002	<0.002	<0.0002	<0.0002	<0.0002	0.00010	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.002	<0.0002	<0.0002	<0.0002	<0.0001
Magnesium (mg/L)	None	None	54.5	61.2	60	57.4	58.7	59.3	58.4	261	284	288	309	295	304	299	312	61.0	75.0	72.9	77.0	76.0	76.0	230	217	228	254	218	4.8
Manganese (mg/L)	0.05	0.2	0.042	0.012	0.028	0.025	0.053	0.015	0.021	0.060	0.010	0.01	<0.01	0.020	<0.01	<0.01	0.015	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.33	1.43	0.81	0.937	1.15	0.019
Mercury (mg/L)	0.002	0.01	<0.0002	<0.0002	NA	NA	NA	NA	NA	<0.001	NA	<0.0002	NA	NA	NA	NA	NA	<0.0002	NA	NA	NA	NA	NA	<0.0002	NA	NA	NA	NA	<0.0002
Molybdenum (mg/L)	0.035	None	0.03	0.03	0.02	0.01	<0.01	0.02	<0.01	<0.1	<0.02	0.030	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	0.01	0.01	<0.01	0.02	<0.01	0.04	<0.02	<0.02	<0.01	<0.02	0.06
Nickel (mg/L)	0.1	0.2	<0.01	<0.01	NA	NA	NA	NA	NA	0.05	NA	<0.01	NA	NA	NA	NA	NA	<0.01	NA	NA	NA	NA	NA	<0.02	NA	NA	NA	NA	<0.01
Potassium (mg/L)	None	None	17.6	18.1	19.0	16.9	16.9	16.3	16.8	91.0	98.4	95.4	105	99.7	97.2	93.0	102	18.1	16.8	16.9	16.4	15.5	16.2	16.7	20.8	19.7	20.3	18.2	12.0
Selenium (mg/L)	0.05	0.02	0.0170	0.0358	0.0200	0.0231	0.0206	0.0231	0.0207	0.003	0.027	0.1660	0.0321	0.236	0.0478	0.0413	0.217	0.0273	0.0279	0.0309	0.0280	0.0270	0.0236	0.079	0.010	0.0007	0.0002	0.0004	0.0017
Sodium (mg/L)	None	None	136	127	109	95.0	89.9	88.2	88.8	172	205	190	219	208	206	190	200	79.2	82.7	82.2	83.1	80.2	81.3	34.1	29.7	29.4	32.8	29.8	202
Uranium (mg/L)	0.03	None	0.0760	0.0896	0.106	0.1100	0.1030	0.1070	0.0911	<0.0003	<0.0002	<0.0001	<0.003	<0.002	0.0003	<0.0002	<0.0002	0.0775	0.1030	0.1080	0.0986	0.0952	0.0970	0.0578	0.033	0.0861	0.0164	0.0143	0.0245
Vanadium (mg/L)	None	0.1	0.007	0.006	0.012	0.009	0.013	0.008	0.007	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.018	0.014	0.016	0.010	0.015	0.014	<0.01	<0.01	<0.01	<0.005	<0.01	0.025
Zinc (mg/L)	5	2	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.01	0.02	<0.01
General Water Quality																													
Alkalinity as $CaCO_3$ (mg/L)	None	None	240	234	203	207	205	203	211	392	394	386	387	397	399	388	406	154	198	218	223	222	228	426	436	389	449	474	243
Carbonate as $CaCO_3$ (mg/L)	None	None	<2	<2	5	<2	13	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	4	4	<2	<2	<2	<2	<2	<2	11
Bicarbonate as $CaCO_3$ (mg/L)	None	None	240	234	203	207	192	203	211	478	394	386	387	397	399	388	406	154	198	218	218	218	228	426	436	389	449	474	232
Chloride (mg/L)	250	None	21	22	33	24	24	21	21	142	170	160	170	160	170	160	170	25	28	30	32	31	30	48	37	40	42	41	19
Fluoride (mg/L)	4.0	2	0.4	0.5	0.6	0.6	0.5	0.7	0.5	0.3	0.3	0.4	0.4	0.4	0.3	0.4	0.3	0.7	0.6	0.6	0.5	0.5	0.5	0.7	0.6	0.5	0.6	0.5	1.0
Ammonia as N (mg/L)	None	None	0.08	0.23	0.06	0.10	<0.05	<0.05	<0.05	1.01	0.8	0.95	1.05	1.06	0.91	1.01	0.98	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.12	<0.05	0.09	0.05	<0.5
Nitrate/Nitrite as N(mg/L)	10.0	100	1.09	1.20	2.51	2.17	1.96	2.26	2.31	<0.1	<0.02	<0.02	0.06	<0.02	0.03	0.02	0.05	0.61	0.85	0.72	0.77	0.75	0.69	0.04	<0.02	0.03	0.04	<0.02	10.2
Silica (mg/L)	None	None	17.7	17.4	17.5	14.4	16.1	14.2	15.4	10.3	10.7	10.7	11.4	9.8	10.0	9.5	10.7	15.8	19.7	17.5	19.3	17.4	18.3	11.7	17.3	18.5	20.2	16.9	11.8

Analyte	CDPHE Domestic Water Supply Standards[1]	CDPHE Agricultural Standards[1]	MW-5							MW-6								MW-7						MW-8B					MW-9[2]
			1/31/08[2]	4/30/08	8/7/08	11/14/08	2/19/09	4/30/09	7/31/09	10/16/07	1/29/08	4/29/08	8/7/08	11/14/08	2/18/09	4/28/09	7/28/09	6/7/08	9/9/08	11/13/08	2/18/09	4/29/09	7/31/09	7/21/08	11/13/08	2/18/09	4/29/09	7/29/09	9/10/08[2]
Sulfate (mg/L)	250	None	390	370	390	370	370	360	360	1330	1400	1070	1490	1460	1490	1460	1560	460	460	460	480	470	460	1810	1370	1450	1680	1540	190
Sulfide as S (mg/L)	None	None	0.04	<0.02	<0.02	<0.02	<0.08	<3	<0.2	NA	13.4	10.3	11.9	11.5	12.4	13.2	11.6	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.9	0.61	0.19	0.05	0.44	0.10
Total Organic Carbon (mg/L)	None	None	12	8	NA	NA	NA	NA	NA	<1	NA	12	NA	NA	NA	NA	NA	9	NA	NA	NA	NA	NA	29	NA	NA	NA	NA	18
Total Dissolved Solids (mg/L)	None	None	840	820	820	770	790	770	770	2400	2740	1140	2670	2750	2760	2800	2770	850	930	970	940	930	970	3040	2520	2560	2980	2850	610
Total Suspended Solids (mg/L)	None	None	120	780	NA	78	350	337	237	13.3	<5	<5	NA	13	<5	<5	<5	<5	5	9	<5	<5	<5	833	18	<5	<5	<5	168
Dissolved Radionuclides																													
Gross Alpha (pCi/L)[3]	15[3]	None	50	65	49	49	41	44	56	11.1	17.0	12	9.7	<7.6	12	<6.8	11	36	56	42	45	51	70	42	23	7	11	15	26
Gross Beta (pCi/L)	4 mrem/yr	None	32	41	32	30	27	24	31	92.8	140.0	91	110	99	96	81	93	34	33	40	29	33	36	23.0	24.0	23	20	22	20
Radium-226 (pCi/L)	5 (Ra 226 and 228)	5 (Ra 226 and 228)	0.53	0.33	0.42	<0.35	0.3	0.37	0.34	1.6	2.2	1.9	3.3	1.9	2.1	2	1.6	<0.35	<0.25	<0.4	<0.28	<0.17	0.17	12.0	0.54	0.49	0.89	0.33	<0.45
Radium-228 (pCi/L)			NA	NA	NA	NA	NA	NA	1.9	NA	NA	NA	NA	NA	NA	NA	4.4	NA	NA	NA	NA	NA	0.29	NA	NA	NA	NA	1.5	NA
Calculated Values																													
Charge Balance (%)	None	None	2.9	6.4	1.5	0.8	0.8	2.4	0.8	-3.5	-1.2	7.8	0.7	-0.6	-0.7	-1.2	-2.2	0.4	3.0	0.3	0.3	0.7	0.7	-2.5	-0.5	0.5	2.7	-4.9	3.1
Field Parameters																													
Temperature (°C)	None	None	12.4	17.7	16.3	15.8	14.5	18.8	16.9	17.9	18.0	18.8	19.0	18.8	17.9	18.7	19.6	18.7	15.8	15.6	14.6	15.7	19.9	18.4	15.3	14.6	16.0	17.4	17.6
pH (std. units)	6.5-8.5	6.5-8.5	10.3	7.5	7.5	7.9	8.0	7.8	7.8	7.7	5.3	7.0	6.9	7.0	7.1	6.9	7.1	8.0	7.8	7.6	7.6	7.4	7.6	6.4	6.8	6.8	6.7	6.8	8.2
Specific Conductivity (mS/cm)	None	None	2.34	1.19	1.23	1.10	1.04	1.09	1.16	3.17	5.32	3.14	3.43	3.29	3.51	3.29	3.27	1.06	1.28	1.25	1.34	1.29	1.29	3.06	3.00	2.81	2.94	3.02	0.99
Dissolved Oxygen (mg/L)	None	None	6.0	2.1	5.9	5.8	6.8	12.2	7.4	2.6	1.5	0.0	0.1	0.1	0.1	0.2	0.1	2.2	4.0	3.8	4.8	5.6	3.4	6.1	0.3	0.3	0.7	0.1	2.1
ORP (mV)[4]	None	None	--	--	203	150	86	72	106	--	-310	-373	-361	-331	-330	-355	-354	29	161	138	88	62	169	-123	-154	-199	-203	-189	154

NOTES:

(1) CDPHE, Water Quality Control Commission, 5 CCR 1002-41, Regulation 41, *The Basic Standards for Ground Water*, Effective May 31, 2008

(2) Results for MW-9 qualified by Kleinfelder due to slow recharge of MW-9; groundwater sample may contain drill water

(3) The gross alpha standard does not include gross alpha from radon and uranium. However, the laboratory results include the alpha contribution from radon and uranium.

(4) ORP: Oxidation Reduction Potential

- Concentrations detected below the practical quantitation limit are shown as the detected value. Undetected concentrations are shown as less than the method detection limit.

- NA: Not Analyzed. Cesium, cadmium, barium, nickel, chromium, mercury and total organic carbon were generally analyzed in the initial sampling event only.

Selenium: Selenium concentrations have been measured above the Colorado agricultural standard of 0.02 mg/L in several samples from exploration holes, the domestic well, monitoring wells, and production well PW-3. Selenium concentrations in EX-15, EX-23, MW-6, and MW-8b are above the domestic water supply standard of 0.05 mg/L. Selenium may be derived from gypsum and anhydrite in the Hermosa Formation, and also from sulfides in the reduced uranium-bearing strata of the Salt Wash Member of the Morrison Formation because it readily substitutes for sulfur in sulfates and sulfides. The highest selenium concentration from a monitoring or production well was 0.24 mg/L from a sample collected at MW-6 in November 2008.

Boron: Boron is above the agricultural standard of 0.75 mg/L in samples from MW-6, MW-9, EX-15, and EX-23. The highest boron concentration reported in a Site water sample was 2.6 mg/L from MW-9 in September 2008. Boron minerals are known in the Hermosa Formation evaporites, and the potential for commercial extraction of boron has been considered (Mayhew, 1965). Mayhew reports brines up to 0.1 percent boron in the Hermosa Formation.

Iron: Iron concentrations are above the domestic water supply standard of 0.3 mg/L in samples from PW-1, PW-2, MW-6 and MW-8b. At PW-1 and PW-2, elevated iron concentrations may be derived from the steel casing used for well construction. At PW-1 and PW-2, iron concentrations from the fourth quarter 2008 through the third quarter 2009 range from 2.88 mg/L (PW-1, fourth quarter 2008) to 21.2 mg/L (PW-2, first quarter 2009). These higher concentrations are indicative of ferrous iron, Fe^{++}, because ferric iron, Fe^{3+}, is relatively insoluble. The ferrous iron is compatible with observed reducing conditions in deeper wells. Samples collected in August 2008 during the pumping tests showed iron at substantially lower concentrations than in follow-up samples months later (0.02 mg/L at PW-1 and 0.12 mg/L at PW-2), suggesting iron dissolving in a redox reaction from casing, probably microbially mediated. Elevated iron concentrations were initially reported in MW-6 and MW-8b, but concentrations decreased in more recent sampling events.

Manganese: Manganese concentrations are above the domestic water supply standard of 0.05 mg/L in samples from MW-5, MW-6, MW-8b, PW-1, PW-2, and EX-23. The highest manganese concentration from a monitoring or production well was 1.4 mg/L from a sample collected at MW-8b in November 2008. The elevated manganese concentrations in PW-1 and PW-2 are also likely derived from steel casings installed in these wells.

Uranium and gross alpha: Uranium concentrations and gross alpha activity levels are above the domestic water supply standards of 0.03 mg/L (uranium) and 15 picocuries per Liter (pCi/L) (gross alpha) in most wells. However, the gross alpha analyses included uranium and radon, so these results cannot be directly compared to the water quality standard, which specifically excludes the alpha contributions from these two elements. It is likely that the majority of the gross alpha in the groundwater is attributable to uranium, which is an ore in the Morrison Formation.

Chromium, molybdenum, and nitrate/nitrite have also been detected at the Site at concentrations above CDPHE standards; however, these detections are not consistently above standards. Shallow nitrates are likely due to livestock. Trace metals may also be derived from the steel casing. Where present in the bedrock aquifer, chromium must be in the trivalent form because the deep water is reduced.

3.4.3 Water Usage

No surface water resources exist within the southern Paradox Valley. Some shallow washes have been bermed in the past to retain surface water, but these have been washed out and have not been maintained. The Dolores River is approximately 7 miles northwest of the Site, and not considered a water resource for the Site.

Eight permitted wells are known in the south valley, all of which are completed in the Chinle Formation. Five of these are operational, and three are known to be dry or inoperable. Table 3.4-4 summarizes known information about these wells, and the two springs to the northwest of the Site, which also emanate from the Chinle Formation. Their locations and available water quality information are provided in the *Hydrogeologic Report* (Golder, 2009d).

3.5 ECOLOGICAL RESOURCES

3.5.1 Vegetation

3.5.1.1 Baseline Data

Ecological studies including baseline flora and fauna data were collected to fulfill the objectives specified in NRC NUREG-1748, *Environmental Review Guidance for Licensing Actions Associated with NMSS Programs* (NRC, 2003a), as well as guidance provided in NRC Regulatory Guide 3.8, *Preparation of Environmental Reports for Uranium Mills* (NRC, 1982a) Surveys for vegetation were conducted by Kleinfelder during four seasons starting in Summer 2007 and continuing through Spring 2008 (Kleinfelder, 2009g). Concurrently, wildlife, wildlife habitat, and point bird surveys were conducted (Kleinfelder, 2009h). In August 2009, WestWater Engineering surveyed an added 80-acre parcel (well field) for vegetation and wildlife resources (WestWater, 2009). Additionally, WestWater Engineering conducted a survey for Colorado hookless cactus within appropriate habitat.

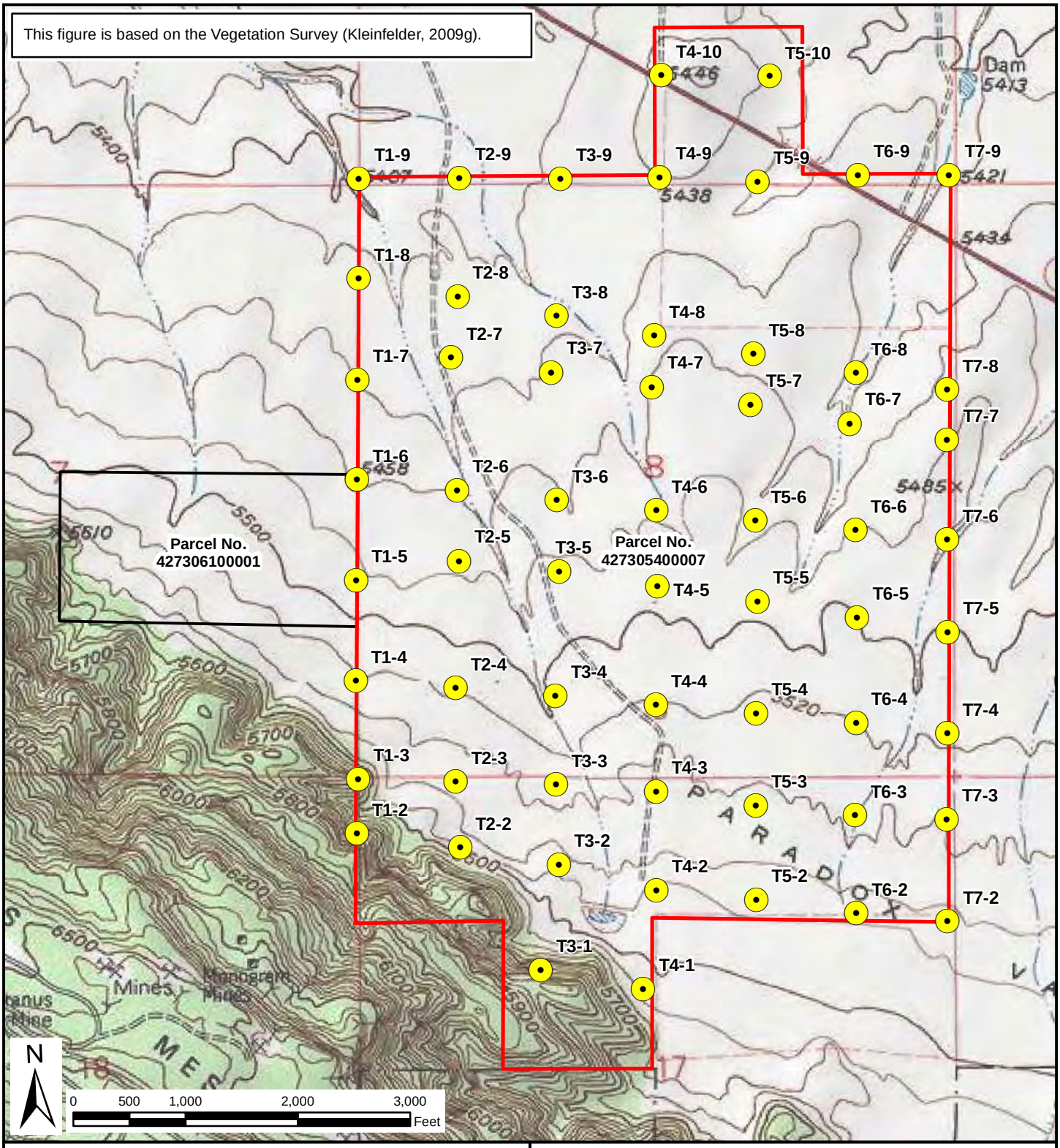
3.5.1.2 On-Site Survey Methodology

Vegetation surveys were conducted on 880 acres on multiple dates during four seasons by Kleinfelder from 2007 through 2008 to establish the vegetation baseline for the Site (Kleinfelder, 2009g). Line-transect sampling, modified from Buckland et al. (2007), was used to collect site-specific vegetation data. Seven transects were systematically established north to south approximately 300 yards apart from east to west. Sample points were positioned every 300 yards on each transect using dead reckoning techniques with a compass and rangefinder; 60 sample points were established on a sampling grid (Figure 3.5-1). Summer 2007 vegetation surveys were completed on odd-numbered sample points for each of the seven transects from August 20 through August 24, 2007. Fall 2007 vegetation surveys were completed on even-numbered sample points on September 18 and 19, 2007. Winter 2007/2008 vegetation surveys were conducted on odd-numbered sample points on January 16 and 17, 2008. Spring 2008 vegetation surveys were conducted on all sample points to evaluate seasonal changes (May 19 and 20, 2008). Vegetation measurements sampled included: canopy height, diameter at breast height (DBH) of the closest three trees, percent ground cover (living vegetation), percent debris cover (non-living vegetation), and the vegetative cover associated with the five most dominant plant species in descending order. In addition to sampling vegetation as described above, a wetland and vegetation assessment of 10 ephemeral streams and a non-jurisdictional retention

Table 3.4-4
Off-Site Water Wells and Springs in the Chinle Formation

Permit #	Proposed for Monitoring (Yes/No)	Owner/Name	Well Depth (ft)	Well Yield (gpm)	Depth to Water (ft)	Construction Date	Distance from Site Boundary (miles)	Status	Permitted Use
Wells									
258704	Yes	BLM	280	15	168	2/28/2004	2.6	Operational	Stock
269575	Yes	Fehlmann, Lin D. & Davis, Robert M.	302	8	158	1/21/2007	3.2	Operational	Domestic & Stock
226684	Yes	Hurdle, Sylvia S.	320	14	134	7/30/2000	4.0	Operational	Domestic
253522	Yes	Boren, Verl	100	20	28(1)	--	5.0	Operational	Domestic
234136	Yes	Herron, William & Katherine Gray	255	10	157	10/26/2001	4.0	Operational	Domestic
91065	No	Russell, John D.	143	10	103	1st use: 5/16/1978	4.0	No longer in use	Domestic & Stock
86582	No	Blackburn Ranches	160(2)	15	Varies(2)	--	3.2	Intermittent use only	Stock
86583	No	Blackburn Ranchettes	160(2)	0	Dry(2)	--	3.2	Dry(2)	Stock
Springs									
NA	Yes	Stone Spring (used by Verl Boren)	NA	~10(3)	NA	NA	4.8	Flowing	--
NA	No	Merrill Spring	NA	--	NA	NA	4.7	Dry in June 2009	--

Notes:
Well information provided from the CDWR, Well Permit Database, accessed September 30, 2008 and June 19, 2009.
NA: Not Applicable
(1) Depth to water provided from personal communication between Verl Boren and Energy Fuels Resources Corporation, June 17, 2009. Depth to water from state permit database is 40 ft.
(2) Information provided from personal communication between Dan Cooper and Dick White of Energy Fuels Resources Corporation, October 1, 2008.
(3) Information obtained from site visit to Boren property on June 17, 2009.



Sample Points
Property Boundary
Well Field Boundary

Figure 3.5-1

Habitat Assessment Sample Points

pond was conducted within the Site during Fall 2007 and Spring 2008 (Kleinfelder, 2008c). Vegetation types were recorded and compared against Colorado State and U.S. Fish and Wildlife Service (USFWS) Federal Threatened and Endangered Species Lists. Representative samples for plants that were not identified in the field, due to time constraints and identification keys, were placed in an 8 ½ inch by 11 inch plant press. Samples were dried in the press for at least 5 days. Identification was completed using a regional dichotomous key in conjunction with a dissecting stereo microscope (Kleinfelder, 2008c and 2009g).

Subsequent to the vegetation sampling conducted in 2007 and 2008, Energy Fuels included an additional 80-acre parcel west of the Site. Vegetation types within the additional parcel were determined through aerial photography, field identification of plants, and on-the-ground assessments of plant abundance surveyed on August 24, 2009 (WestWater, 2009). Identification of plant species was aided by using pertinent published field guides (Anthony et al., 2007; Kershaw et al., 1998; Weber and Wittman, 2001; and Whitson et al., 2004).

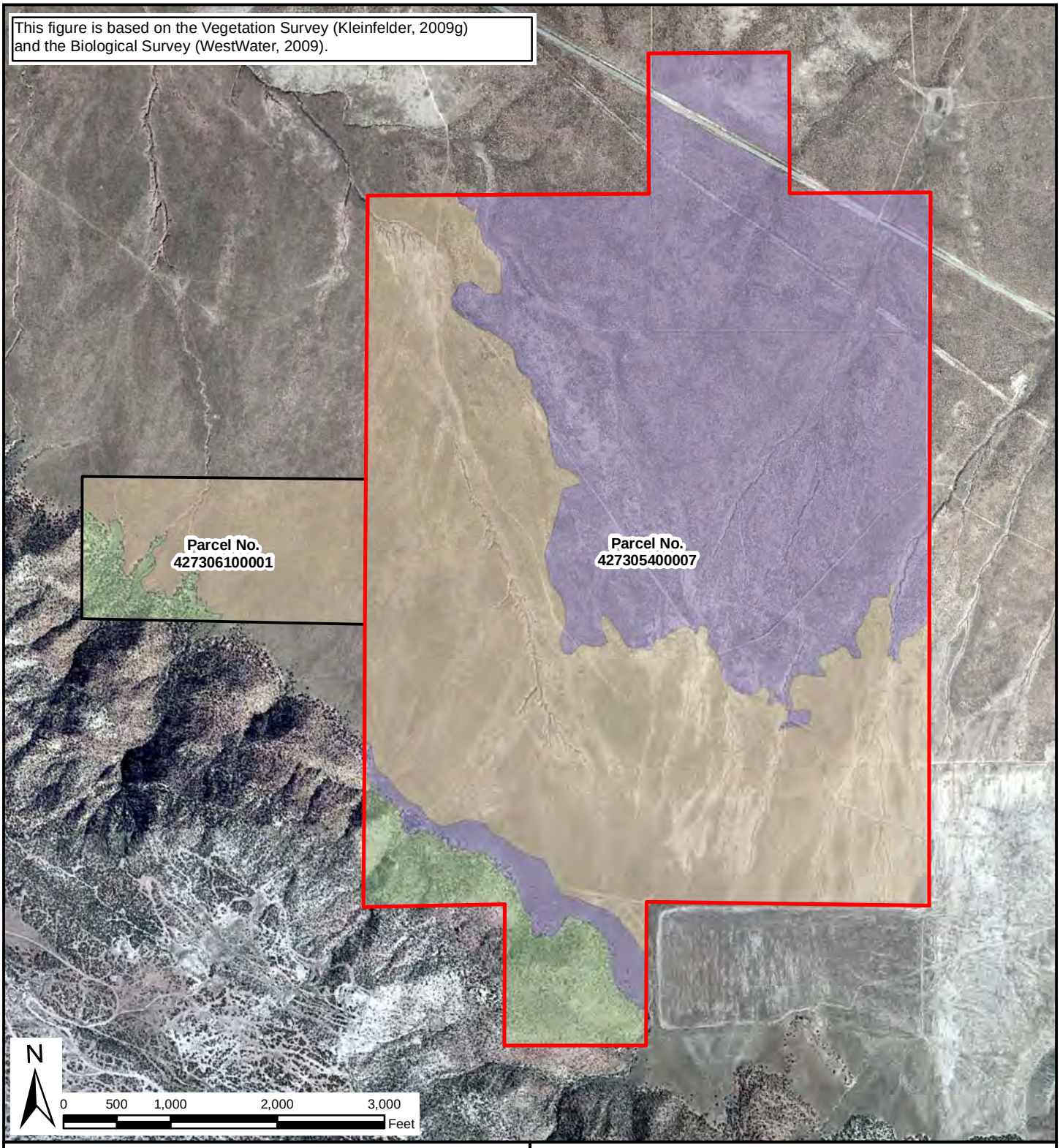
3.5.1.3 Vegetation Cover Types

Three dominant vegetation communities are located within the Site and include 1) pinyon-juniper vegetation along the bluffs in the southwest portion of the Site, 2) big sagebrush habitat located in a narrow strip adjacent to the pinyon-juniper habitat and on the northeast half of the Site, and 3) a mixed grassland habitat located in the central portion of the Site between both big sagebrush habitats. According to the former landowner, existing grasslands was sagebrush-dominated in the past, but sagebrush was removed by mechanical means and the area has since taken on a more native grassland appearance. The woodlands are dominated by Utah juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulus*) mixed with Colorado (singleleaf) ash (*Fraxinus anomala*), forbs, and grasses. The shrublands within the Site are characterized by big sagebrush (*Artemisia tridentata*), prickly pear (*Opuntia* spp.), and various grasses. Invasive downy brome (*Bromus tectorum*), also known as cheatgrass, is prevalent on the Site, especially in the mixed grassland and in the understory of the shrubland community.

The dominant vegetation communities were mapped by Kleinfelder (2009g) and WestWater (2009) using GIS, aerial photography, and ground reconnaissance (see Figure 3.5-2). Table 3.5-1 provides the acreage and percent of total area of the three dominant vegetation communities within the Site. Plants identified within the Site during survey efforts are provided in Table 3.5-2.

Table 3.5-1
Acreage and Percent of Total Area of the Three Dominant Vegetation Communities within the Site

Dominant Vegetation Community	Acres	Percent of Total Area
Pinyon-Juniper Woodland	50.72	5.8
Big Sagebrush	427.20	48.5
Mixed Grasslands	402.08	45.7
Total	**880.00**	**100.0**



Property Boundary
Well Field Boundary

Dominant Vegetation Communities

Pinyon-Juniper Woodland
Big Sagebrush
Mixed Grasslands

Figure 3.5-2

Dominant Vegetation Communities

Table 3.5-2
Plants Documented within the Site During Vegetation Surveys[1]

Common Name [2]	Scientific Name	Dominant Vegetation Types Located
Trees		
Colorado (singleleaf) ash	*Fraxinus anomala*	PJ
Utah juniper	*Juniperus osteosperma*	PJ, BS
Pinyon pine	*Pinus edulus*	PJ
Shrubs		
Utah serviceberry	*Amelanchier utahensis var. utahensis*	PJ
Big sagebrush	*Artemisia tridentate*	BS, MG
Four-wing saltbrush	*Atriplex canescens*	BS, MG
Mountain Mahogany	*Cercocarpus montanus*	PJ
Mormon tea	*Ephedra virdis var. virdis*	PJ
Rubber rabbitbrush	*Ericameria nauseosa*	MG
Cliff fendlerbush	*Fendlera rupicola*	PJ
Yucca	*Yucca baccata*	PJ, BS
Forbs		
Curveseed butterwort	*Ceratocephala testiculata*	MG
Nipple cactus	*Coryphantha zizipara*	PJ, BS
Herb sophia*	*Descurainia Sophia*	MG
Hedgehog cactus	*Echinocereus triglochidiatus*	PJ, BS
Redstem filaree*	*Erodium cicutarium*	MG
Broom snakeweed*	*Gutierrezia sarothrae*	PJ, BS, MG
Four o'clock	*Mirabilis multiflora*	PJ
Prickly pear	*Opuntia spp.*	BS, MG
Plantain	*Plantago major*	BS, MG
Russian thistle*	*Salsola iberica*	BS, MG
Mustard	*Family Brassicaceae*	BS, MG
Grasses		
Indian ricegrass	*Acnatherum hymenoides*	PJ, BS
Bentgrass	*Agrostis palustris*	PJ, BS, MG
Three-awn grass	*Aristida spp.*	PJ, BS, MG
Blue grama	*Bouteloua gracilis*	BS, MG
Downy brome*	*Bromus tectorum*	PJ, BS, MG
Needle-and-thread grass	*Hesperostipa comata*	PJ, BS, MG
Galleta grass	*Hilaria jamesii*	BS, MG
Fox-tailed barley	*Hordeum jubatum*	BS
Witchgrass	*Panicum capillare*	PJ, BS, MG
Sand dropseed	*Sporobolus cryptandrus*	BS, MG
Sixweeks fescue	*Vulpia octoflora*	BS, MG

[1] Sources: WestWater Engineering, 2009 and Kleinfelder, 2009g.
[2] An asterisk (*) indicates non-native, invasive weeds.
[3] Dominant Vegetation Types: PJ = pinyon-juniper woodlands, BS = big sagebrush, and MG = mixed grasslands.

None of the species that are dominant in the big sagebrush type or the mixed grassland type are particularly palatable to livestock. In the big sagebrush type, big sagebrush predominates, but is not particularly palatable to cattle because volatile oils can cause rumen stasis (Stubbendieck et al., 1992). Broom snakeweed (*Gutierrezia sarothrae*) is a predominant subshrub in both vegetation types but is an indicator of livestock overgrazing, an accumulator of selenium, and poisonous to sheep and cattle (Stubbendieck et al., 1992; Whitson et al., 2004). Another shrub, gray or rubber rabbitbrush (*Chrysothamnus* (*Ericameria nauseosa*) *nauseosus*) was also present but is worthless forage for livestock and, like snakeweed, is often associated with overgrazing (Whitson et al., 2004). Fourwing saltbush (*Atriplex canescens*) is a shrub and also present in big sagebrush and mixed grasslands within the Site and may provide some forage value for cattle (McKean, 1976).

The only native forbs identified within the Site were prickly pear, a native but a problem in overgrazed pastures, and unidentified species of mustard (*Brassicaceae*) which were possibly tansymustard (*Descurainia pinnata*) and/or desert princesplume (*Stanleya pinnata*). If present, both are worthless forage for livestock. Kleinfelder (2009g) also reported Russian thistle (*Salsola iberica*), a noxious weed, and only has forage value early in the growing season. All vegetation types are infested with cheatgrass, a noxious weed and indicator of heavy grazing (Stubbendieck et al., 1992), but which has some forage value early in the growing season before the inflorescence emerges (Whitson et al., 2004). Another non-native invasive species, redtop bent or creeping bentgrass (*Agrostis stolonifera* var. *palustris*) is common in the mixed grasslands and is good forage for cattle. Other grasses occur within the Site and include non-native redstem filaree (*Erodium cicutarium*), native blue grama (*Bouteloua gracilis*), and galleta (*Hilaria jamesii*), all of which provide good forage while green. However, none of them would be considered dominant (Kleinfelder, 2009f). Native sixweeks fescue (*Vulpia octoflora*) is also present on the Site but provides little forage value (Stubbendieck et al., 1992).

Also, a non-jurisdictional wetland feature (retention pond) and ten linear stream features (nine discontinuous ephemeral streams and one stream connected to East Paradox Creek) are located within the Site. Vegetation types located at these wetland and waterbody features were dominated by the adjacent upland vegetation types, although some plants associated with wetlands were documented.

<u>Pinyon-Juniper Woodlands</u> Pinyon-juniper woodlands are common in western Montrose County and are found from 4,500 to 9,000 feet, although most commonly between 5,000 and 7,000 feet. At higher elevations they occur on south and west facing slopes (Lyon and Sovell, 2000; Schrupp et al., 2000). In Colorado, there are approximately 5 million acres of pinyon-juniper habitat (Brown, 1994), of which 70 percent occurs within the Colorado Plateau Ecoregion (Colorado Partners in Flight, 2008).

Pinyon and juniper trees within western Colorado are typically short and widely spaced as a result of coarse, sandy, and shallow soils with low fertility. Understory can range from almost barren to a diverse mixture of shrubs, forbs, and grasses. However, in sites with more moisture, the canopy becomes denser and the understory vegetation decreases. Several different species of pinyon and juniper trees occur within the western United States but in western Colorado, the species found include pinyon pine and Utah juniper, with Rocky Mountain juniper (*Juniperus scopulorum*) occurring mostly in mesic sites (Lyon and Sovell, 2000). Generally in western Colorado pinyon pine and juniper are co-dominant, although pinyon is more tolerant of cold and juniper more tolerant of drought (Mutel and Emerick, 1992 in Lyon and Sovell, 2000). As a result, juniper occurs at lower elevations and is often mixed with sagebrush and desert shrubs, while pinyon pine is found at higher elevations (Lyon and Sovell, 2000; Peet 1988 in Schrupp et al., 2000). Tree height and density generally increases with elevation (Schrupp et al., 2000).

The pinyon-juniper woodland community comprises 50.72 acres of the 880-acre Site (5.8 percent). Three habitat sample points were surveyed within this community. Total vegetation cover is 20.6 percent, where debris cover and bare soil is 15.0 percent and 64.4 percent, respectively. Total ground cover is 35.6 percent (Table 3.5-3). The dominant overstory species is pinyon pine and Utah juniper, with the following species represented within the understory (Table 3.5-2): Colorado (singleleaf) ash, Utah serviceberry, mountain mahogany, Mormon tea (*Ephedra virdis var. virdis*), cliff fendlerbush (*Fendlera rupicola*), and various forbs and grasses (Kleinfelder, 2009g and WestWater, 2009). A list of the five dominant species documented in descending order during each sampling site visit are provided in Appendices A and B in the *Vegetation Survey* (Kleinfelder 2009g).

Big sagebrush is the most common understory of the pinyon-juniper woodlands in the region surrounding the Site, but other shrub species may include: rabbitbrush (*Chrysothamnus* spp.,), shadscale (*Atriplex confertifolia*), four-wing saltbush, tamarisk (*Tamarix ramosissima*), greasewood (*Sarcobatus vermiculatus*), snakeweed (*Gutierrezia sarothrae*), and winterfat (*Krascheninnikovia lanata*) at lower elevations; and mountain mahogany (*Cercocarpus montanus*), Gambel's oak (*Quercus gambelii*), serviceberry, mountain snowberry (*Symphoricarpos oreophilus*), mountain lover (*Pachystima myrsinites*), Oregon grape (*Mahonia aquifolium*), and elk sedge (*Carex garberi*) at higher elevations. The herbaceous understory is often sparse and includes needle-and-thread (*Hesperostipa comate*), Indian ricegrass (*Acnatherum hymenoides*), blue grama, galleta, Sandburg bluegrass (*Poa secunda*), and bottlebrush squirreltail (*Elymus elymoides*). Common forbs include hairy golden aster (*Heterotheca villosa*), twin bladderpod (*Physaria acutifolia*), roughseed cat's-eye (*Cryptantha flavoculata*), and scarlet globemallow (*Sphaeralcea coccinea*) (Lyon and Sovell, 2000 and Schrupp et al., 2000). Most of these understory species were not observed within the Site (see Table 3.5-2). Downy brome is the most frequent non-native invasive species (Lyon and Sovell, 2000) and was observed during vegetation surveys.

Succession after disturbance (i.e., fire) within pinyon-juniper woodlands will progress from annual grasses to perennial grasses, shrubs, and then finally pinyon-juniper, although this process may take up to 300 years creating a mosaic of different successional stages on the landscape (Lyon and Sovell, 2000).

Table 3.5-3 provides the canopy heights, canopy cover, DBH, percent ground cover of living vegetative material, percent debris cover (dead vegetative material), and percent bare ground for the three habitat sample points within the pinyon-juniper woodland community recorded by Kleinfelder (2009g) in the *Vegetation Survey*.

Table 3.5-3
General Vegetation Characteristics for the
Pinyon-Juniper Woodland Community within the Piñon Ridge Mill Site[1]

Vegetation Community	Average Canopy Height (Feet)	Average Canopy Cover (percent)	Maximum DBH (inches)	Average DBH (inches)	Average Ground Cover (percent)	Average Debris Cover (percent)	Average Bare Ground (percent)
Pinyon-Juniper Woodland	14.8	11.7	5.4	4.1	20.6	15.0	64.4

[1] Source: Kleinfelder, 2009g.

Sagebrush Shrublands Sagebrush shrublands occur within a variety of climatic conditions, including low-elevation, semi-desert habitats and moist, cool, mountainous areas. Within the Colorado Plateau, sagebrush is found at elevations of approximately 4,000 feet to 10,000 feet (Colorado Partners in Flight, 2008). It is often a major component of pinyon-juniper communities (Lyon and Sovell, 2000).

In Montrose County, four species of sagebrush are common and have a wide ecological range resulting in overlap between their ranges: black sage (*Artemesia nova*), big sagebrush, mountain big sage (*Artemisia tridentata sp. vaseyana*), and silver sage (*Artemisia cana*). Black sage tends to be compact/cushion-like and grows in very dry areas, on alkaline soils, and in shallow sandy soils or on windswept ridges in pinyon-juniper woodland, whereas big sagebrush occupies deep soils in the valleys and is the tallest of the species. Mountain big sage is the most abundant species, occupying higher, cooler sites on shallower and drier soils, and is the most common species in pinyon-juniper woodlands. Silver sage is at higher elevations with ponderosa pine and aspen (Lyon and Sovell, 2000; Schrupp et al., 2000).

The big sagebrush community comprises 427.20 acres of the 880-acre Site (48.5 percent). Twenty-eight habitat sample points were surveyed for this community. Total vegetation cover is 51.5 percent, and debris cover and bare soil is 16.6 percent and 31.9 percent, respectively. Total ground cover is 68.1 percent (see Table 3.5-4). The dominant overstory species is big sagebrush, with the following species represented as secondary species or within the understory (Table 3.5-2): Utah juniper, four-wing saltbush, yucca (*Yucca baccata*), and various forbs and grasses including, but not limited to broom snakeweed, prickly pear, bentgrass, blue grama, galetta grass, and fox-tailed barley (*Hordeum jubatum*). Cheatgrass was prevalent within the big sagebrush community (Kleinfelder, 2009g and WestWater, 2009). A list of the five dominant species documented in descending order during each sampling site visit are provided in Appendices A and B in the Vegetation Survey (Kleinfelder, 2009g).

Table 3.5-4 provides the average percent ground cover of living vegetative material, percent debris cover (dead vegetative material), and percent bare ground recorded for 28 habitat sample points within the big sagebrush community by Kleinfelder (2009g).

Table 3.5-4
General Vegetation Characteristics for the Big Sagebrush Community within the Site[1]

Vegetation Community	Average Ground Cover (percent)	Average Debris Cover (percent)	Average Bare Ground (percent)
Big Sagebrush	51.5	16.6	31.9

[1] Source: Kleinfelder, 2009g.

Other shrubs found in association with sagebrush communities in western Colorado in the region surrounding the Site include bitterbrush (*Purshia* spp.) and mountain snowberry. Grasses, especially bunchgrasses, are common components of sagebrush habitats. Some grass species not identified during survey efforts within the project area but are known to occur within the region surrounding the Site include wheatgrass species (*Pseudoroegneria* spp.), muttongrass (*Poa fendleriana*), Indian paintbrush (*Castilleja* spp.), hairy golden aster, rough-seed cat's-eye, scarlet globemallow, sand aster (*Corethrogyne filaginifolia*), junegrass (*Koeleria macrantha*), Arizona fescue (*Festuca arizonica*), Idaho fescue (*F. idahoensis*), and several milkvetches (*Astragalus* spp.) (Lyon and Sovell, 2000; Colorado Partners in Flight, 2008; Schrupp et al., 2000). As with pinyon-juniper woodlands, the most common non-native species is cheatgrass (Lyon and Sovell, 2000) as was observed within the Site.

Sagebrush will not sprout from roots after a disturbance (i.e., fire), but must come back from seed. Reestablishing sagebrush from seed is a slow process that can take 15 to 30 years. Wildfires probably sculpted a landscape mosaic of sagebrush stands of varying age interspersed with grassy open areas on the scale of tens to thousands of hectares (Colorado Partners in Flight, 2008).

The primary use of sagebrush habitats by humans has been for livestock grazing. However, heavy grazing tends to increase sagebrush cover and decrease perennial bunch grasses, allowing other shrubs such as rabbitbrush and snakeweed to increase, or other non-native species to invade (USDA, 1972 in Lyon and Sovell, 2000). In some cases land managers remove the shrub cover through plowing, burning, chaining, or herbicide treatment to increase forage for grazing of domestic livestock or wildlife (Colorado Partners in Flight, 2008; Lyon and Sovell, 2000). Other factors compromising the ecological integrity of sagebrush shrublands include invasion by exotic (e.g., cheatgrass) or native (e.g., pinyon-juniper) plant species, conversion to agricultural, residential, and other developed land types, and changes in natural fire regimes (Colorado Partners in Flight, 2008).

Mixed Grasslands Mixed grasslands in western Colorado are generally dominated by relatively deep-rooted grasses, such as needle-and-thread, that use soil moisture below 0.5 meters (1.6 feet) during the typically dry summers (NatureServe, 2009; Lyon and Sovell, 2000). The mixed grasslands can be found at elevations from 4,100 to 8,800 feet at a variety of sites including stream terraces, plains, valleys, canyon floors, gentle hillslopes, knolls, and bluffs. Soils associated with the mixed grasslands are variable and may include sand, cobbles, sandy, silt, and clay loams, and silty clay (NatureServe, 2009). These coarse soils allow for rapid infiltration and storage of winter and summer precipitation (Kleiner, 1968; Daubenmire, 1970; Kleiner and Harper, 1977; Thilenius et al., 1995 in NatureServe, 2009). Trees and large shrubs are generally absent, often as a result of seasonal drought, occasional fires, and grazing by domestic animals and wildlife. A few trees such as cottonwoods (*Populus deltoides*), oaks (*Quercus* spp.), and willows (*Salix* spp.) grow near rivers and streams, and hundreds of species of flowers grow among the grasses (Colorado Partners in Flight, 2008 and NatureServe, 2009).

The mixed grassland community within the Site was sagebrush-dominated in the past, according to the landowner, but sagebrush was removed by mechanical means and the area has since taken on a more native grassland appearance. The mixed grassland community comprises 402.08 acres of the 880-acre Site (45.7 percent). Twenty-nine habitat sample points were surveyed for this community. Total vegetation cover is 55.7 percent, and average debris cover and bare soil were 20.2 percent and 24.1 percent, respectively. Total ground cover is 75.9 percent (Table 3.5-5). The dominant grass species is bentgrass, sixweeks fescue, and the invasive, non-native cheatgrass. Also interspersed throughout the mixed grassland community is big sagebrush, four-wing saltbush, fox-tailed barley, galleta grass, prickly pear, blue grama, and herb sophia (*Descurainia sophia*) (Kleinfelder, 2009g and WestWater, 2009). Table 3.5-2 provides a complete list of species documented within the mixed grassland community during vegetation surveys. A list of the five dominant species documented in descending order during each sampling site visit are provided in appendices A and B in the *Vegetation Survey* (Kleinfelder 2009g).

Table 3.5-5 provides the average percent ground cover, percent debris cover, and percent bareground recorded for 29 habitat sample points within the mixed grassland community by Kleinfelder (2009g).

Table 3.5-5
General Vegetation Characteristics for the Big Sagebrush Community within the Site[1]

Vegetation Community	Average Ground Cover (percent)	Average Debris Cover (percent)	Average Bareground (percent)
Mixed Grasslands	55.7	20.2	24.1

[1] Source: Kleinfelder, 2009g.

Within the region surrounding the Site, vegetation cover within the mixed grassland community is relatively sparse to moderate (10 to 40 percent) and is generally dominated by needle-and-thread (Lyon and Sovell, 2000; NatureServe, 2009). Other typical grass species represented at lower cover and not identified within the Site include Letterman's needlegrass (*Achnatherum lettermanii*), Purple threeawn (*Aristida purpurea*), bottlebrush squirreltail, junegrass, saline wildrye (*Leymus salinus*), muttongrass, Sandburg bluegrass, and alkali sacaton (*Sporobolus airoides*) (Lyon and Sovell, 2000; NatureServe, 2009). Forbs associated with mixed grasslands have cover that ranges from sparse to moderate and may also include: field sagewort (*Artemisia campestris*), tarragon (*Artemisia dracunculus*), white sagebrush (*Artemisia ludoviciana*), arrowleaf balsamroot (*Balsamorhiza sagittata*), Arizona thistle (*Cirsium arizonicum*), thicksepal cryptantha (*Cryptantha crassisepala*), fineleaf hymenopappus (*Hymenopappus filifolius*), hoary tansyaster (*Machaeranthera canescens*), scarlet globemallow, American vetch (*Vicia Americana*), and species of pussytoes (*Antennaria* spp.), milkvetch, buckwheat (*Eriogonum* spp.), and stickseeds (*Lappula* spp.). Scattered shrubs with less than 5 percent total cover are associated with mixed grasslands and have been observed within the region surrounding the project area including basin big sagebrush (*Artemisia tridentata* sp. *tridentata*), mountain big sagebrush, winterfat, antelope bitterbrush (*Purshia tridentata*), wax currant (*Ribes cereum*), and mountain snowberry (NatureServe, 2009; Lyon and Sovell, 2000). Cheatgrass is often widespread within this vegetation community as was observed within the Site, and contributes substantially to cover in disturbed areas. Other non-native species that may be present within the mixed grasslands include burning bush [*Bassia scoparia (Kochia scoparia)*], Kentucky bluegrass (*Poa pratensis*), tumblemustard (*Sisymbrium altissimum*), and yellow salsify (*Tragopogon dubius*) (NatureServe, 2009).

Overgrazing by livestock and plowing are the two greatest threats to mixed grasslands in western Colorado (Colorado Partners in Flight, 2008). Grazing has encouraged the increased growth of sod grasses on areas with deep soil and heavy to moderate rainfall. In areas with low precipitation, the bunchgrasses have been replaced by annual grasses, woody plants (i.e., sagebrush), and cacti (Paysen et al., 2000; Colorado Partners in Flight, 2008). Lack of fire and fragmentation are also threats. Fire plays a big role in this biome, preserving biodiversity and keeping trees from overtaking the grasses. These fires help certain plants by germinating seeds, clearing ground cover to allow rare plants a chance, and by nourishing the soil with freshly burnt vegetation (Colorado Partners in Flight, 2008).

3.5.1.4 Wetlands

On-Site Survey Methodology. Wetland delineation surveys were conducted by Kleinfelder on April 7 and April 8, 2008 (Kleinfelder, 2008c). The wetland delineation was conducted in accordance with the USACE Wetland delineation Manual (1987) and the Arid West Supplement (January 2006). The wetland delineation effort consisted of the Routine, Small Area Determination Method, as described in the Manual (1987), and by the evaluation of sample plots for wetland or non-wetland status. Visual observations were used to identify vegetation,

soil, and hydrological characteristics within the vicinity of the sample plots. Survey methodology is described in detail in the *Preliminary Delineation of Jurisdictional Water of the United States* (Kleinfelder, 2008c).

Wetland Features. No USACE jurisdictional wetlands were observed within the Site (Kleinfelder, 2008c). Only one non-jurisdictional wetland feature, a retention pond located on the Site historically used to water cattle, exhibited hydrologic criteria necessary for classification as a wetland. However, vegetation present at the retention pond sample plots did not meet the standards to be considered wetland vegetation (more than 50 percent of the dominant species must be hydrophytic). Most vegetation documented at the retention pond surveyed was upland vegetation similar to the surrounding dominant vegetation type (mixed grasslands and big sagebrush), although sunflowers (*Helianthus annuus*) and common cockleburs (*Xanthium strumarium*) – two species that can be associated with wetlands – were observed (Kleinfelder, 2008c).

No specific hydrophytic vegetation was associated with the ten ephemeral streams (nine discontinuous and one stream connected to East Paradox Creek) located on the Site. Kleinfelder (2008c) identified that one ephemeral stream with apparent connection to East Paradox Creek has potential to be a Waters of the United States (WoUS) and subject to USACE jurisdiction. Vegetation at each linear drainage consisted of vegetation within the dominant vegetation community it was located. Vegetation growth at the drainages was generally much greater as a result of increased available moisture, often three times the size of surrounding vegetation. These features were dominated by upland species such as four-winged saltbrush, big sagebrush, and Russian thistle (Kleinfelder, 2008c and 2009g). Vegetation associated with the wetland features were included in the totals for those dominant vegetation communities and discussed above.

In a letter dated June 5, 2008 from Kleinfelder to the USACE, Kleinfelder (on behalf of Energy Fuels) requested a review of their conclusions and verification of their findings that no USACE jurisdictional wetland resources or WoUS were observed within the Site. The USACE responded to Kleinfelder's request (September 15, 2008) stating that the Site is comprised entirely of uplands and accordingly, the proposed work would not require Department of Army Corps of Engineers authorization (USACE, 2008). The letter contains an approved jurisdictional determination for the subject site and the verification is valid for 5 years from the date of the letter unless new information warrants revision of the determination before the expiration date (USACE Identification Number: SPK-2008-1010).

3.5.1.5 Invasive, Non-Native Species

Noxious weeds are plants that are aggressive competitors non-native to an area, and are an increasingly serious problem in western Colorado. Most have come from Europe or Asia, either accidentally or as ornamentals that have escaped. Noxious weeds take advantage of any disturbance of the soil and are dispersed by wind, water, animals, people, and vehicles. Once established in a new environment they tend to spread quickly because insects, diseases, and animals that normally control them are absent.

Major weeds that are common in western Colorado are (Lyon and Sovell, 2000): Canada thistle (*Cirsium arvense*), Russian knapweed (*Acroptilon repens*), white top (*Cardaria* spp.), purple loosestrife (*Lythrum salicaria*), oxeye daisy (*Leucanthemum vulgare*), yellow toadflax (*Linaria vulgare*), tamarisk, Russian olive (*Eleagnus angustifolia*), houndstongue (*Cynoglossum officinale*), downy brome (cheatgrass), burdock (Family Asteraceae), cocklebur (*Xanthium strumarium*), Jim Hill mustard (*Sisymbrium altissimum*), Russian thistle, perennial pepperweed

(*Lepidium* spp.), cranesbill (*Erodium cicutarium*), and musk thistle (*Carduus nutans*). Canada thistle invades almost anywhere that contains disturbed soils and sufficient moisture. Russian knapweed is abundant in disturbed areas, along roads, and in Disappointment Valley in the greasewood flats. It was found in many locations, including along the Dolores River between Slick Rock and Bedrock, in Broad Canyon, Mailbox Park, Tuttle Draw, Dry Creek Basin, and Slick Rock. White top was also found in disturbed areas, such as hayfields and roadsides, and was noted near Mesa Creek, Maverick Draw, Atkinson Creek, and in the Redvale and Norwood areas. Purple loosestrife has been found in wet areas and can be a serious threat to wetlands and riparian areas. Oxeye daisy is a problem in mountain areas from the San Miguel River to Lizard Head Pass, is found along the South Fork, and in the Mountain Village area. Yellow toadflax is common along the San Miguel, on the mesas, and in the mountains. Tamarisk is found in riparian areas along the Dolores and San Miguel Rivers. Russian olive also occupies these same habitats. Houndstongue is widespread and abundant at higher elevations. Downy brome (cheatgrass) is found wherever there has been disturbance and is widespread. Once it has been established, cheatgrass is difficult to eliminate. Musk thistle tends to be found in moist areas in the middle elevations. Burdock is found throughout western Colorado in moist, disturbed sites. Cockleburs are abundant in drying stock ponds in the pinyon-juniper zone. Kentucky bluegrass is commonly planted for pasture or for erosion control and is abundant in moist areas, often replacing native grasses. The most common invader in the sagebrush shrublands, as well as in the pinyon-juniper woodlands is cheatgrass (Lyon and Sovell, 2000).

There are several lists of noxious weeds that have been identified under the Colorado Noxious Weed Act (Title 35, Article 5.5) that have been identified for various degrees of management within the state. The “A” list includes species that are not known to occur in Colorado or that have very limited distribution and that the Department of Agriculture Commissioner designates must be eradicated (18 species); “B” listed species include weeds with populations of varying distributions and densities and are designated by the Commissioner (in consultation with the state noxious weed advisory committee, local governments, and other interested parties) for inclusion in state noxious weed management plans designed to stop the continued spread of these species (40 species); “C” listed species are widespread and common in Colorado and can pose a threat to agricultural lands and may be required to be controlled (14 species) (Colorado Department of Agriculture, 2009a). The Montrose County Noxious Weed Management Plan (Colorado Department of Agriculture, 2009b) has designated 17 species (of the 72 species that occur on the Colorado State noxious weed lists) as noxious weeds that must be managed within the county. Table 3.5-6 provides a list of 21 noxious weeds that occur on the Colorado State noxious weed list and either occur on the Montrose County weed list and/or have been documented within the Site (Kleinfelder, 2009g and WestWater, 2009) or within the vicinity of the Site (Lyon and Sovell, 2000).

Noxious weeds are present throughout the Site due to disturbed habitat from present and historic agricultural activities, including cattle grazing. The observed noxious weeds are successional plants associated with the current land management practices. Observed noxious weeds at the Site include (Table 3.5-6): downy brome, Russian thistle, broom snakeweed, redstem filaree, and herb sophia (Kleinfelder, 2009g and WestWater, 2009), of which two occur on the Colorado State noxious weed list and require management (Table 3.5-2).

Table 3.5-6
Potential Occurrence and Observed Noxious Weed Locations in the Project Area [1]

Common Name Scientific Name	Montrose County Noxious Weed List	Location in Relation to Site
Colorado State A List		
Yellow Starthistle *Centaurea solstitalis*	X	Unknown
Purple Loosestrife *Lythrum salicaria*	X	In Vicinity
Colorado State B List		
Russian Knapweed *Acroptilon repens*	X	In Vicinity
Hoary cress *Cardaria draba*	X	Unknown
Plumeless Thistle *Carduus acanthoides*	X	Unknown
Musk thistle *Carduus nutans*	X	In Vicinity
Diffuse knapweed *Centaurea diffusa*	X	Unknown
Spotted knapweed *Centaurea maculosa*	X	Unknown
Oxeye Daisy *Chrysanthemum leucantheum*	X	In Vicinity
Canada Thistle *Cirsium arvense*	X	In Vicinity
Bull Thistle *Cirsium vulgare*	X	Unknown
Houndstongue *Cynoglossum officinale*	X	In Vicinity
Russian Olive *Elaeagnus angustifolia*		In Vicinity
Redstem filaree *Erodium cicutarium*		Within Site
Leafy Spurge *Euphorbia esula*	X	Unknown
Perennial pepperweed *Lepidium latifolium*		In Vicinity
Yellow Toadflax *Linaria vulgaris*	X	In Vicinity
Scotch Thistle *Onopordum acanthium, O. tauricum*	X	Unknown
Colorado State C List		
Jointed Goatgrass *Aegilops cylindrical*	X	Unknown
Common burdock *Arctium minus*	X	In Vicinity
Downy brome (cheatgrass) *Bromus tectorum*		Within Site

[1] Sources: Kleinfelder, 2009g; WestWater, 2009; Colorado Department of Agriculture, 2009a and 2009b; Lyon and Sovell, 2000.

3.5.2 Species of Special Status

The USFWS (2009a) has identified several fish and wildlife species and two plant species that are listed under the Endangered Species Act (ESA) that occur or could occur within Montrose County. As such, those species have been classified as “important” by the NRC in Regulatory Guide 3.8, Section 2.9 (NRC, 1982a). Each of these listed species is described below and is summarized in Table 3.5-7, which also includes two candidate species.

Table 3.5-7
Threatened, Endangered, and Candidate Species Potentially Occurring in Montrose County and in the Vicinity of the Site[1]

Listed Species	ESA Status[2]	Habitat[3]	Potential Occurrence within the Site
Mammals			
Canada Lynx *Lynx Canadensis*	Threatened with Critical Habitat	Coniferous forests interspersed with thickets of trees and shrubs, rocky outcrops, large woody debris; closely associated with snowshoe hares	Few occurrences of dispersed introduced lynx in Montrose County (Uncompahgre National Forest)
Black-footed Ferret *Mustela nigripes*	Endangered	Historically occupied areas ranging from short-grass and mid-grass prairie to semi-desert shrublands	Historic distribution in Colorado includes Montrose County, coincidental with Gunnison's prairie dog
Gunnison's Prairie Dog *Cynomys gunnisoni*	Candidate (in part of range)	Inhabit grasslands and semidesert1 to montane shrublands, elevations from 6,000-12,000 feet	Known to occur in Montrose County
Birds			
Mexican Spotted Owl *Strix occidentalis lucida*	Threatened with Critical Habitat	Steep rocky canyons with exposed cliffs and dense old growth conifer forest or canyons in pinyon-juniper with scattered patches of old Douglas-fir	Known to occur in Montrose County
Yellow-billed Cuckoo *Coccyzus americanus*	Candidate	Uncommon during summer in lowland riparian forested habitats and in urban areas with tall trees	Known to occur in Montrose County
Gunnison Sage-Grouse *Centrocercus minimus*	Former Candidate	Expansive sagebrush with grasses, forbs and healthy riparian ecosystems	Known to occur in Montrose County
Fish			
Bonytail *Gila elegans*	Endangered with Critical Habitat	Eddies, pools, and backwaters near swift current in large rivers of the Colorado River system	Main branches of the Colorado River including the Black Rocks area of the Colorado River downstream of Grand Junction
Humpback Chub *Gila cypha*	Endangered with Critical Habitat	Adults, in habitats ranging from deep turbid rapids often associated with large boulders and steep cliffs to flooded lowlands; young, in slow-moving backwaters	Main branches of the Yampa, Gunnison, Green, and Colorado rivers including the Black Rocks area of the Colorado River downstream of Grand Junction
Colorado Pikeminnow *Ptychocheilus lucius*	Endangered with Critical Habitat	Fast, deep, white-water rivers with backwater areas and eddy habitats 2 to 3 feet deep that support aquatic insects, small fish as prey species	Main branches of the Yampa, Gunnison, Green, and Colorado rivers including the Black Rocks area of the Colorado River downstream of Grand Junction
Razorback Sucker *Xyrauchen texanus*	Endangered with Critical Habitat	Slow backwater habitats or large rivers and impoundments, not small tributaries or headwaters, with mud, sand or gravel substrate	Main branches of the Yampa, Gunnison, Green, and Colorado rivers
Plants			
Colorado Hookless Cactus *Sclerocactus glaucus*	Threatened	Rocky hills, alluvial benches, and lower mesa slopes in desert shrub communities from 4,500 to 6,000 feet	Known to occur in northern Montrose County and/or Delta County
Clay-loving Wild Buckwheat *Eriogonum pelinophilum*	Endangered with Critical Habitat	Whitish, alkaline clay soils on Mancos shale, with sparse salt desert shrub community; elevations from 5,200 to 6,400 feet	Known to occur in eastern Montrose County in the vicinities of Montrose and Olathe

[1] Source: USFWS, 2009a.
[2] ESA Status = Endangered Species Act Status.
[3] Source: CDOW, 2009b; CNHP, 2009a and 2009b.

Candidate species are those for which the USFWS "has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened, but for which preparation and publication of a proposal is precluded by higher-priority listing actions" (USFWS, 2007a). Although candidate species have no legal protection under the ESA, candidate species may be proposed for listing in the future which could require consultation if construction of the Mill Facility would likely jeopardize the continued existence of such species (USFWS and National Marine Fisheries Service - NMFS, 1998). Consequently, the Services (USFWS and NMFS) encourage conservation of candidate species and their consideration in environmental planning (USFWS and NMFS, 1998). In this regard, candidate species may also be considered as "important" under the criterion, above, but also under an additional criterion that the species 1) affects the well-being of some ESA-listed species (Gunnison's prairie dog), and 2) the species is critical to the structure and function of the ecological system (Gunnison Sage-grouse) as described in Section 2.9 (NRC, 1982a).

Section 7 of the ESA, as amended, requires federal agencies to consult with the USFWS to ensure that any action the agency authorizes, funds, or implements is not likely to jeopardize the continued existence of a listed species, threaten a species, or result in the destruction or adverse modification of designated critical habitat (16 United States Code [USC] section 1536(a)(2)(1988)). If a listed species is found on private property, section 9 of the ESA requires the landowner to manage the species and habitat so that there will be no "take" of the species. Take includes "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt to engage in any such conduct". If use of the private property would potentially lead to a take, then the landowner could seek an incidental take permit under section 10 of the ESA. Incidental take (take that could occur while conducting otherwise lawful economic activities) would require the landowner to develop a habitat conservation plan (HCP) that would analyze likely impacts, identify measures to mitigate impacts, provide means of funding the measures, describe protocols for dealing with unexpected situations, and present alternatives to the activity that would minimize take with reasons why they would not be implemented. The USFWS could then issue an incidental take permit, possibly conditioned with other actions that would have to be implemented (Shogren, 1998).

Similar constraints apply to plants listed under the ESA for activities and projects under federal jurisdiction. On non-federal lands, the ESA prohibits the removal, cutting, digging up, or damaging or destroying of any ESA-listed plant species on any other area in knowing violation of any state law or regulation, or in the course of any violation of a state criminal trespass law. Colorado's Title 33, Article 2, Non-game and Endangered Species Conservation statute (CRS § 33-2-101 – 108) includes protections to nongame, endangered or threatened species of wildlife identified by the state but does not include protections to threatened or endangered plants.

Species Surveys. Surveys for wildlife, wildlife habitat, and migratory birds were conducted concurrently with surveys for vegetation during 2007 and 2008 (Kleinfelder, 2009h and 2009g). Similar to the vegetation survey, diurnal pedestrian surveys were conducted along transects and the presence of wildlife and/or their sign was documented. Night-time observation points were located at each corner of the Site and one in the middle of the Site. Nocturnal surveys were conducted during the Fall, Winter, and Spring seasons. A handheld spotlight with the capability to illuminate up to 1,000,000 foot candles was utilized. A spotter completed a 360-degree sweep with the handheld spotlight, while a second field worker documented the results behind the spotter, saving the documenters' night vision. A bird survey was conducted each season using point count survey techniques and a survey specifically to detect western burrowing owls was implemented during the Summer (2007) and Spring (2008) surveys (Kleinfelder, 2009). The

species' calls were broadcast from a portable player using a recommended protocol (CDOW, 2007).

The adjacent 80-acre parcel (well field) was examined by WestWater Engineering on August 24, 2009 (WestWater, 2009). Vegetation types were determined through field identification of plants, aerial photography, and on-the-ground assessments of plant abundance. Identification of plant species was aided by using pertinent published field guides (Anthony et al., 2007; Kershaw et al., 1998; Weber and Wittmann, 2001; and Whitson et al., 2004). Casual wildlife reconnaissance was also conducted at that time (WestWater, 2009).

In addition to on-site surveys, much of the following information about species and their potential occurrence on-site was obtained from databases that have been developed by CDOW, Natural Diversity Information Source (CDOW, 2009b) and the Colorado Natural Heritage Program - CNHP (2009a and 2009b), including spatial data provided in geographic information system (GIS) formats. In addition, relevant agency reports and published literature were reviewed, analyzed, and synthesized to develop the species' profiles provided in these sections to supplement results of on-site surveys with the goal of conducting appropriate and comprehensive impact analyses.

3.5.2.1 Federally Listed Threatened and Endangered Species

The Canada lynx is currently listed as threatened, although habitat in Colorado was not deemed as essential to the conservation of the species (USFWS, 2009a). Though unlikely, lynx could occur in Montrose County. Montrose County was within the historical range of endangered black-footed ferrets and their presence in the county has been judged as likely by CDOW (2009b). Mexican spotted owls, listed as threatened, are known to occur in Montrose County (CDOW, 2009b). Likewise, the Colorado hookless cactus and the clay loving buckwheat occur in Montrose County (CNHP, 2009a and 2009b). In addition, the western yellow-billed cuckoo is a candidate species under the ESA and may occur in Montrose County. The Gunnison's prairie dog is a candidate species under the ESA within part of its range, while Gunnison Sage-grouse is a former candidate species whose status is being reconsidered; both are known to occur in Montrose County (USFWS, 2009a; CDOW, 2009b).

Four species of Colorado River Basin fish (the bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker) are listed as endangered and critical habitat has been designated, although none has been designated in Montrose County for any of the four species.

To the extent that knowledge exists and data are available for the "important" species (defined in NRC Regulatory Guide 3.8, Section 2.9 (NRC, 1982a)) included in Table 3.5-7 the following sections provide discussions of the species' seasons of occurrence, estimates of abundance, local flight patterns, and critical habitats as well as spatial and temporal distributions, life histories, critical life stages, biologically significant activities, seasonal habitat requirements and population fluctuations, food chain, and other interspecific relationships as recommended in guidance provided by the NRC in Section 6.3.5 of NUREG-1748 (NRC, 2003a).

Canada Lynx. Canada lynx within the contiguous United States were listed as threatened on March 24, 2000 (USFWS, 2000a). The listing includes lynx within Colorado; 218 lynx captured in Alaska and Canada were introduced to Colorado between 1999 and 2007. Lynx are also listed by Colorado as endangered under the State's Non-game and Endangered Species Conservation statute (CRS § 33-2-101- 108).

In 2000, the USFWS (2000a) identified significant threats to the lynx including threats by destruction, modification, or curtailment of the species' habitat or range within the Northern Rockies/Cascades and Southern Rockies. Lynx habitats have been adversely affected by timber harvest, mostly within western boreal forests (subalpine fir/spruce forest). However, timber harvest levels on federal lands in the West have declined since the 1990's and reduction of early successional habitats with concomitant reductions of snowshoe hare habitats may have affected lynx in some areas (USFWS, 2000a). USFWS (2000a) concluded that lynx populations in the contiguous United States occur at naturally low densities, generally maintained by limited abundance of primary prey (snowshoe hare), which in turn results from patchy distribution of transitional boreal forest habitat. While lynx have been trapped, legally or otherwise, USFWS (2000a) recognized that overharvest (overutilization) of the species is not a factor that threatens lynx, especially since the 1980's when legal trapping became considerably restricted or eliminated by states.

Lynx inhabit coniferous forests interspersed with thickets of trees and shrubs, rocky outcrops, and large woody debris that are often used for den sites. Canada lynx are specialized predators that are highly dependent on snowshoe hare, although they may also prey opportunistically on squirrels, mice, beaver, muskrat, birds, young ungulates, and some carrion when hare populations decline. Breeding populations are not possible without an adequate snowshoe hare population (USFWS, 2003). They are highly mobile, and often explore outside their home ranges (USFWS, 2003). Historically, lynx occurred in the mountains of Colorado, probably the southern limit of the species' distribution. Records indicated they were present in the Park, Gore, San Juan, and La Plata mountains, as well as the White River Plateau (Fitzgerald et al., 1994).

The 218 Canada lynx that were introduced to the San Juan Mountains in southwestern Colorado (Shenk, 2005) are not designated as experimental under section 10(j) of the ESA. USFWS (2006a) recognized the reintroduction as important though not essential for recovery of lynx; the reintroduction program has been included in the recovery plan, but not the critical habitat designation (USFWS, 2006a). Lynx have dispersed from the San Juan Mountains into the Uncompahgre National Forest in central Montrose County. A few lynx have been located in San Miguel County, south of the Site and in San Juan County, Utah to the west of the Site (Shenk, 2005).

Recent compilations of lynx locations between 1999 and 2008, following reintroduction to southern Colorado, indicated they mostly used Engelmann spruce/subalpine fir forest cover types throughout the year, including mixtures of conifers with aspen (CDOW, 2009c). Lynx also utilized riparian cover types, primarily from July through December. Lynx were mostly located on gentle slopes, more so on slopes facing north, and were found at elevations averaging above 10,000 feet (CDOW, 2009c). Den sites also tended to be within Engelmann spruce/subalpine fir forests but on steeper north facing slopes at elevations averaging above 11,000 feet with considerable vegetative understory cover and coarse woody debris. Generally, reproducing female lynx have smaller home ranges (average of 29 square miles) than attending males (average of 39 square miles); non-reproductive females have the largest home ranges, averaging over 270 square miles (CDOW, 2009c). Diets of lynx released in Colorado appear similar to those of lynx elsewhere; snowshoe hares were the most common prey, followed by red squirrel (CDOW, 2009c). Snowshoe hares do occur within Montrose County but their elevational distribution ranges from 8,000 to 11,500 feet (CDOW, 2009b). The lowest elevation record is 6,500 feet from Gunnison County and the westernmost specimen of snowshoe hare is from Anvil Points, near Rifle, Garfield County (CDOW, 2009b). Consequently, the Site is not suitable habitat for lynx and a resident population of lynx in the project vicinity is highly unlikely.

Of the 218 lynx that were introduced to Colorado from 1999 through 2007, 115 have died from various causes including 16 that were known to be shot (five others were probably shot) and 14 more that were struck by vehicles (CDOW, 2009b). Others have died from starvation, disease, predation, or from unknown causes.

Critical habitat was initially designated for Canada lynx in 2006 (USFWS, 2006a) and areas of designated critical habitat were revised in 2009 (USFWS, 2009b). However, no critical habitat has been designated in Colorado. Although resident Canada lynx are highly unlikely to occur at the Site, transient lynx may occur as they disperse from population centers where they have become established following reintroductions.

Black-Footed Ferret. The black-footed ferret was included on the 1967 list of native fish and wildlife threatened with extinction under the Endangered Species Preservation Action of 1966 (USFWS, 1967) and included in Appendix D, the "United States List of Endangered Native Fish and Wildlife" (USFWS, 1970) prior to enactment of the ESA of 1973.

Black-footed ferrets are closely associated with prairie dogs, particularly black-tailed prairie dogs (*Cynomys ludovicianus*) and to a lesser extent, white-tailed prairie dogs (*C. leucurus*) and Gunnison's prairie dogs. Black-footed ferrets declined as prairie dog habitat declined because: 1) steady conversion of native prairie to cropland, which was unsuitable habitat for prairie dogs, 2) active control of prairie dogs through poisoning to reduce competition with livestock, and 3) introduction of exotic diseases, especially sylvatic plague, to which prairie dogs and ferrets are highly susceptible, and canine distemper (Lockhart et al., 2006). Similar threats to prairie dogs and ferrets are ongoing.

As of 2004, the black-footed ferret captive breeding program propagated more than 4,800 ferrets and reintroduced approximately 1,800 ferrets to nine sites in multiple states. However, only 600 ferrets were believed extant in the wild and only three reintroduction sites were judged as viable (Lockhart et al., 2006).

Black-footed ferrets' original distribution in North America closely corresponded to distributions of prairie dogs (Hall and Kelson, 1959; Fagerstone, 1987) and until 1985, a free-living population inhabited white-tailed prairie dog colonies located west of Meeteetse, Wyoming. This population was reduced by canine distemper in 1985 (Clark, 1985) and surviving ferrets were captured for captive breeding and eventual reintroduction to the wild. Black-footed ferrets depend on prairie dogs for food and prairie dog burrows for shelter (Hillman and Clark, 1980 and Fagerstone, 1987). They are mostly nocturnal and spend much of their time underground so their presence in an area is difficult to confirm. Black-footed ferrets breed from mid-March through early April (Clark and Stromberg, 1987) and young are born in prairie dog burrows. Young ferrets venture above ground during July but remain near the nest burrow (Fagerstone, 1987).

Black-footed ferrets were reintroduced to Rio Blanco and Moffat counties in northwest Colorado in 1999 at one site (Coyote Basin) on the Colorado-Utah border west of Rangely and in 2001 at a second site (Wolf Creek) south of Dinosaur National Monument. From 1999 to the present, a total of 255 ferrets have been released in Utah and 189 ferrets have been released in Colorado, both releases have been within white-tailed prairie dog colonies. Reproduction was confirmed in Coyote Basin in the fall of 2000 and in 2005 at the Wolf Creek site (BLM, 2009b). The Coyote Basin site is approximately 128 miles north and the Wolf Creek site is 135 miles north of the Site.

No critical habitat has been designated for black-footed ferrets. Black-footed ferrets are highly unlikely to occur in the Site and vicinity.

Mexican Spotted Owl. The Mexican spotted owl was listed as a threatened species in 1993 (USFWS, 1993). At the time they were listed, there were only 20 historic records (13 records accepted) of spotted owls in Colorado, mostly from the San Juan Mountains in southwestern Colorado.

At the time they were listed, the USFWS (1993) reported that significant portions of habitat had been lost or modified, primarily due to pressures from local and regional human population growth as well as natural causes, primarily fire. Timber harvest on NFS lands in the southwest, in particular, was held responsible for much loss of suitable spotted owl habitats. Timber harvest reduced the extent of uneven aged, multilayered timber stands and reduced the structural diversity that is characteristic of suitable habitats. Fragmentation of owl habitats has occurred during conversion of large contiguous tracts of forest to smaller areas, isolating stands from one another. Fragmentation has affected quality of owls' home ranges, reduced prey availability, and altered microclimatic conditions that are important to suitability of nest and roost sites (USFWS, 1993). Fragmentation was responsible for enhanced predation of spotted owls by avian predators, such as great horned owls and red-tailed hawks (USFWS, 1993). In addition, the USFWS identified less severe threats including land exchange, oil and gas leasing, mineral development, and grazing while noting that individual actions may generate low impact to the species but in combination, they may generate high cumulative impact because of synergistic interactions (USFWS, 1995).

To facilitate species' recovery, Mexican spotted owls' range within the United States was divided into six recovery units; the Site is within the Southern Rocky Mountains-Colorado Recovery Unit. Few spotted owls have been detected within the Southern Rocky Mountains-Colorado Recovery Unit; only 20 records of owls were reported prior to 1990 and 14 more were reported between 1990 and 1993, the fewest records for any of the Recovery Units within the United States (USFWS, 1995). In Colorado, Mexican spotted owls inhabit two types of habitats: 1) large canyons with steep, exposed cliffs and old-growth forests composed of Douglas-fir, white fir, and ponderosa pine, and 2) canyons in pinyon-juniper vegetation with small patches of late seral Douglas-fir (Andrews and Righter, 1992; USFWS, 1995). During summer, spotted owls roost in cool microclimatic sites in association with closed canopies and/or north-facing slopes (Andrews and Righter, 1992).

Roost and nest trees were found to be the oldest and largest within stands, whether stands were mixed-conifer dominated by Douglas-fir, ponderosa pine-Gambel oak, or riparian forests with diverse tree species (USFWS, 2004). Mexican spotted owl nests are either in trees with broken tops that provide platforms, trees with mistletoe brooms, trees with trunk cavities, on cliff ledges, or cliffs with potholes (Gutiérrez et al., 1995). One to four eggs hatch after 28 to 32 days. Eggs are incubated by the female, but both parents care for the young, which fledge 34 to 36 days after hatching. Pair formation begins in February to early March followed by nest construction through April. Only one clutch of eggs is generally laid per nesting season (Gutiérrez et al., 1995).

Prior to 1990 there were only 20 historical records of Mexican spotted owls in Colorado. Most historical records were along the Colorado Front Range, as far north as Fort Collins. Since 1990 there have be 14 additional records on NFS lands and BLM-administered lands (Ward et al., 1995). Records of spotted owls within the CNHP element database (2009b) are limited to San Miguel and Montezuma counties in southwestern Colorado. Owls observed in southwestern

Colorado were in canyon bottoms containing mixed-conifer or ponderosa pine-Gambel oak forests incised into mesas covered with pinyon-juniper vegetation (Ward et al., 1995). No suitable habitat for Mexican spotted owls is present within the Site or vicinity.

The USFWS (2004) designated over 8.6 million acres of critical habitat for the Mexican spotted owl over four western states, including Utah and Colorado. The closest designated critical habitat unit (CP-15) is on BLM-administered land within Carbon and Emery counties, Utah (USFWS, 2004) and is approximately 30 miles east of Price, Utah. It includes the West Tavaputs Plateau, primarily along the Desolation Canyon area of the Green River. There is no critical habitat near the Site. Mexican spotted owls are highly unlikely to occur at the Site and vicinity.

Bonytail Chub. The bonytail chub is an exceedingly rare minnow originally native to the Colorado River system of the western United States and northern Mexico (USFWS, 2002a). The bonytail was listed as endangered by the USFWS in 1980 because it had been nearly extirpated from its historical range. Recovery goals for the bonytail chub were released by the USFWS in 2002 as an amendment and supplement to the 1990 recovery plan. There are two recovery units; the upper Colorado River Basin, including the Green River and upper Colorado River subbasins; and the lower basin, including the mainstream and its tributaries from Lake Mead downstream to the southerly International Boundary with Mexico (USFWS, 2002a). The primary threats to bonytail are streamflow regulation, habitat modification, predation by non-native fish species, hybridization, and pesticides and pollutants (USFWS, 2002a).

The bonytail is endemic to the Colorado River Basin. The species experienced a significant decline in abundance, starting around 1950, although the decline was poorly documented. At the time it was listed, threats to the species included physical alterations (impoundments and diversions) and chemical changes to habitats and introductions of non-native fish (USFWS, 1980). There have been adverse effects to bonytails and other fish native to the Colorado River Basin by changes in river flow regimes, migratory barriers, changes in water temperature, competition and predation by exotic fish species, parasites, and altered food base (USFWS, 1987; USFWS, 2002a).

Bonytails that inhabit riverine habitats have not been observed to spawn. However, spawning appears to occur during late June and early July at water temperatures of about 18°C (Vanicek and Kramer, 1969). Apparently, spawning occurs over gravel bars in moderately deep water; eggs were deposited randomly, and no effort to safeguard the eggs was observed (Vanicek and Kramer, 1969).

Females produce between 1,000 and 17,000 eggs. Eggs begin hatching about 9 hours after fertilization and alevins remain in the gravel for 48 to120 hours before emerging. Survival rate of juveniles is 17 to 38 percent (USFWS, 2002a). Water temperatures between 68°F and 70°F appear to be optimal for reproduction, incubation, and survival of eggs and newly hatched fry (USFWS, 2002a). Water temperatures have decreased due to impoundments within the Colorado River Basin since colder water from the bottom of impoundments is released downstream (USFWS, 2002a).

The fish are considered big or mainstream river species, preferring pools and eddies of warm, often heavily silted, swift moving rivers; however, they do occur in reservoir habitats, as well (USFWS, 2008a). Viable populations are extremely rare within the Green River drainage in Utah and are not known within the State of Colorado (USFWS, 2002a; CDOW, 2009b). Apparently, there are no self-sustaining populations of bonytails in the Colorado River Basin. During the

1960s through the early 1980s, adult bonytail were captured in the Upper Colorado River Basin including the Yampa River, Green River, and Colorado River mainstream (USFWS, 2002a). Most recently, wild bonytails were captured in Lake Mohave, Nevada (in 2002) and Lake Havasu, Arizona (in 1990).

The USFWS has designated critical habitat for the bonytail chub in river channels and flooded, ponded, or inundated riverine habitats that would be suitable for adults and young. Critical habitat within Colorado has been designated on the Colorado River in Mesa County from Black Rocks (River Mile 137), downstream to Fish Ford River on the Utah-Colorado border (USFWS, 1994).

Recent information suggests that floodplain habitats may be more important to survival and recovery of the bonytail than originally thought; the last reported concentrations of the species in the upper Colorado River Basin occurred in or upstream of alluvial river reaches with substantial floodplain habitat (USFWS, 2002a). The USFWS has suggested that flooded bottomland habitats that are relatively free of predators may contribute to successful reproduction and recruitment, and support species' recovery (USFWS, 2002a); however, no critical habitat for the bonytail has been designated anywhere in the Dolores River.

Humpback Chub. The humpback chub was included on the 1967 list of native fish and wildlife threatened with extinction under the Endangered Species Preservation Act of 1966 (USFWS, 1967) and included in Appendix D, the "United States List of Endangered Native Fish and Wildlife" (USFWS, 1970) prior to enactment of the ESA of 1973. Humpback chubs are endangered under the ESA (USFWS, 2009a). The second revised Humpback Chub Recovery Plan was released in 1990. The goal of the plan is the protection or restoration of five viable, self-sustaining populations in the Colorado River Basin, as well as the protection of their habitat (USFWS, 1990a).

Similar to other endangered species such as the bonytail, humpback chubs have been adversely affected by stream alteration (dams, irrigation, dewatering, and channelization); competition with and predation by introduced, non-native fish species; and hybridization with other species of the genus Gila (USFWS, 1990a). Reduced water flows have also affected humpback chubs (Woodling, 1985; USFWS, 1990a; USFWS, 1994).

The humpback chub prefers waters that are deep, fast-moving, and turbid (Woodling, 1985), and they are often associated with large boulders and steep cliffs (CDOW, 2009b); however, they have been found in relatively quiet waters as well and may use diverse habitats (USFWS, 1990a). Evidence suggests that humpback chubs may spawn from April to June with water temperatures between 61°F to 68°F (USFWS, 1990a). Optimal temperature for egg hatch is in warmer (68°F) water. Similar to other species of Gila, humpback chubs feed on benthic invertebrates but will also feed on insects floating on the surface (USFWS, 1990a).

The known historic distribution includes portions of the mainstream Colorado River and four of its tributaries: the Green, Yampa, White, and Little Colorado (USFWS, 2002b). The distribution of humpback chub in 1990 included the Colorado River mainstream reaches in the vicinity of Westwater Canyon, Utah and Black Rocks, Colorado (USFWS, 1990a). In the Black Rocks and Westwater Canyon reaches, young humpback chubs appear to utilize shallow waters with depths averaging 2.1 feet but not exceeding 5.1 feet (Valdez et al., 1990). Alternatively, adults in the same areas were found in water averaging 50 feet (maximum depth of 92 feet) and were associated with in-stream large boulders where there were steep cliffs along the riverbanks

(Valdez et al., 1982; Wick et al., 1981). From its confluence with the San Miguel River, the Dolores River enters the Colorado River more than 65 miles downstream.

The USFWS has designated the same critical habitat for the humpback chub as for the bonytail chub on the Colorado River in Mesa County extending from Black Rocks near the Utah border to Fish Ford in Utah (USFWS, 1994). Designation of critical habitats for all listed fish in the Colorado River Basin, including the humpback chub, was based on presence of primary constituent elements – physical and biological features – needed for species' continued survival and identified above for the bonytail (USFWS, 1994). There is no critical habitat near the Site.

Colorado Pikeminnow. Historically, the Colorado pikeminnow occurred in great numbers throughout the Colorado River system from Green River, Wyoming to the Gulf of California in Mexico. The species was included on the 1967 list of native fish and wildlife threatened with extinction under the Endangered Species Preservation Act of 1966 (USFWS, 1967) and included in Appendix D, the "United States List of Endangered Native Fish and Wildlife" (USFWS, 1970) prior to enactment of the ESA of 1973. Colorado pikeminnows are endangered under the ESA (USFWS, 2009a).

In 1973, modification of habitat by construction of large reservoirs was cited as the primary threat to the species. Adverse conditions associated with cold temperatures in tailwaters below dams, reduced flows, and introduced fish species affected pikeminnow reproduction and survival (USFWS, 2002c). Additional threats identified in the species' Recovery Plan (USFWS, 1991a) were summarized as a combination of factors including direct loss of habitat, changes in flow and temperature, blockage of migration routes, and interaction (competition and predation) with introduced fish species. Pesticides and pollution also adversely affect the species (USFWS, 2002c).

Adult Colorado pikeminnows can be found in big, deep water (i.e., eddies, pools, and other areas adjacent to the main current flows), whereas young pikeminnow inhabit shallow, quiet backwaters (Woodling, 1985). Spawning occurs after high spring runoff flows with water temperatures ranging from 64°F to 73°F (USFWS, 2002c). After hatching, pikeminnow larvae drift downstream from spawning substrates and typically inhabit in-channel backwater sites, characterized by warm, deep, and turbid water that historically formed after spring peak runoff (USFWS, 2002c), generally during June, July, and August (USFWS, 1994).

Currently, wild populations are found only in the upper Colorado River Basin. In Colorado, they are found in the Green, Yampa, Little Snake, White, Colorado, Gunnison, San Juan, and Dolores rivers (Woodling, 1985; USFWS, 2002c). The Gunnison River is considered occupied habitat for 33.5 miles from the confluence with the Colorado River, and the Colorado River mainstream is occupied habitat from Palisade, Colorado downstream to Lake Powell (USFWS, 2002c). Spawning occurs in the upper Colorado and Gunnison rivers (USFWS, 2002c). The Dolores River is occupied by Colorado pikeminnow but only 2 km (1.2 miles) upstream from the confluence with the Colorado River (USFWS, 2002c). The Dolores River enters the Colorado River more than 65 miles downstream from its confluence with the San Miguel River in Montrose County.

The USFWS (1994) designated critical habitat in the Colorado River and its 100-year floodplain from the Colorado River Bridge at exit 90 north of Interstate-70 near Rifle in Garfield County, downstream to Lake Powell. The Gunnison River from the Uncompahgre River confluence downstream to the Colorado River is also designated as critical habitat (USFWS, 1994). Designation of critical habitats for all listed fish in the Colorado River Basin, including the

Colorado pikeminnow, was based on presence of primary constituent elements – physical and biological features – needed for species' continued survival and identified above for the bonytail (USFWS, 1994). There is no critical habitat near the Site.

Razorback Sucker. The razorback sucker was listed as endangered by the USFWS in 1991 because of limited numbers found throughout the Colorado River Basin and minimal evidence of natural recruitment (USFWS, 1991a). When razorback suckers were listed, the USFWS (1991a) noted there was not much indication of recruitment to populations and decreasing population trends for adult fish. Habitat alterations, including diversion and depletion of water, introduction of non-native fishes, and construction and operation of dams were cited as contributing to the observed downward trends. In addition, water development projects have depleted flows, altered flow regimes, changed water quality, and fragmented habitats. These effects combined with changes in fish communities due to introductions of many non-native fish species, predation by non-native fishes, loss of habitat, and pesticides and pollutions, have been cited as the causes for the species' endangered status (USFWS, 2002d).

The razorback is most often found in quiet, muddy backwaters along the river (USFWS, 1994; CDOW, 2009b). Spawning extends from April through June, and occurs in river bars with cobble, gravel, and sand substrates during high flows from spring runoff, when water temperatures are greater than 57°F (USFWS, 2002d). Juvenile rearing habitats are in quiet, warm, shallow water associated with various river and floodplain features (USFWS, 2002d). Reproduction has been adversely affected by lower water temperatures due to impoundments within the Colorado River Basin since colder water from the bottom is released downstream (USFWS, 2002d). Similar to habitats utilized by bonytail, young razorback suckers utilize warm shallow waters at tributary mouths and backwaters and inundated floodplains as nursery environments (USFWS, 2002d).

This species was once abundant through the Colorado River Basin, primarily in the mainstream and major tributaries and now is known within the Upper Colorado River Basin including the lower Yampa and Green rivers, mainstream Colorado River, and lower San Juan River (USFWS, 2002d). Within the Upper Colorado River Basin, naturally reproducing populations are only found in the middle Green River in Utah and in an off-channel pond in the Colorado River near Grand Junction (USFWS, 2002d). Razorback suckers have been reintroduced to the lower 34 miles of the Gunnison River from which wild populations had been previously extirpated (USFWS, 2002d).

The USFWS has designated 1,724 miles of critical habitat - 49 percent of historical habitat for the species – and includes the Gunnison River and its 100-year floodplain in Mesa County from the Redlands Diversion Dam to the confluence with the Colorado River (USFWS, 1994). There is no critical habitat near the Site.

Colorado Hookless Cactus. Colorado hookless cactus is a federally-listed threatened plant (USFWS, 1979) that occurs on river benches, valley slopes, and rolling hills in Delta, Garfield, Mesa, and Montrose counties, Colorado (USFWS, 1990b). In 1979, the species was listed as *Sclerocactus glaucus*, with the common name as Uinta Basin hookless cactus. Recently, USFWS (2007b) identified three separate species that were formerly included within the *Sclerocactus glaucus*-complex to include *Sclerocactus brevispinus* (*Pariette cactus*), *S. glaucus* (renamed the Colorado hookless cactus), and *S. wetlandicus* (currently with no common name but suggested to be named as the Uinta Basin hookless cactus due to its distribution in Utah). USFWS (2009c) revised the taxonomy of the 1990 listed *S. glaucus*, previously considered a complex (USFWS, 1990b), to recognize three distinct species: Pariette cactus (*S. brevispinus*),

Colorado hookless cactus (*S. glaucus*), and redefined Uinta Basin hookless cactus (*S. wetlandicus*). All three species remain listed as threatened until the USFWS can conduct a five-factor analysis for each species to reevaluate status and evaluate the necessary elements for critical habitat (USFWS, 2009c). This rule becomes effective on October 15, 2009.

S. glaucus is a perennial herb that produces pink flowers from April to late May. It is found in xeric, fine-textured soils overlain with cobbles and pebbles, growing in salt desert shrub and pinyon-juniper communities, at elevations ranging from 4,400 to 6,200 feet (CNHP, 2009a). Anthropogenic threats to this species include collecting, mineral and energy developments, off-road vehicle and recreation effects, road construction, water developments, and pesticide use (USFWS, 1990b).

Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs April to May and fruiting occurs May to June. Bees, flies, beetles, and ants have been observed visiting flowers. Many species of bees (bees in the family Halictadea are pollinators of other species of *Sclerocactus*) and long-tongued moths have been identified as pollinators, although reproduction (seed production) may be limited because of underpollination (Tepedino, 1999). Once seeds are released they are dispersed by gravity, water flow, or possibly insects and/or birds (USFWS, 1990b). Ants have been observed grazing on flowers and immature fruits, but significance to species survival is unknown (USFWS, 1990b).

There are two population centers of *S. glaucus* in Colorado (USFWS, 1990b): 1) on alluvial river terraces of the Gunnison River from near Delta, Colorado to southern Mesa County, Colorado (approximately 8,000 plants) and 2) on alluvial river terraces of the Colorado River and in the Plateau of Roan Creek drainages in the vicinity of DeBeque, Colorado (approximately 4,000 plants). An intensive survey of potential Colorado hookless cactus habitat present at the Site (pinyon-juniper woodland) was performed on August 24, 2009 but no hookless cactus were found (WestWater, 2009). Likewise, previous botanical surveys were conducted at the Site on multiple occasions from August 2007 through May 2008 but no *S. glaucus* plants were observed even though the surveys conducted in May 2009 coincided with the species' flowering period (Kleinfelder, 2009g). Colorado hookless cactus has not been found in the Paradox Valley area in previous survey efforts (USFWS, 1990b; Lyon and Sovell, 2000; Ferguson, 2009).

No critical habitat has been designated for the species. The Colorado hookless cactus is highly unlikely to occur at the Site and vicinity.

Clay-Loving Buckwheat. Clay-loving buckwheat was proposed for listing as an endangered species on June 22, 1983. The species was designated endangered on July 13, 1984, and the known range of the species at that time (119.8 acres) was designated as critical habitat USFWS, 1984). There is a current petition to revise critical habitat for this species and if the petition is found to be substantial, a 12-month finding will be submitted by September 21, 2009 (USFWS, 2009d).

At the time of listing, horse grazing was a major threat to the species and its habitat. There was also off-road vehicle use occurring in conjunction with management of the horses and pasture (USFWS, 1984). Rural residential housing tracts also pose a problem (USFWS, 1988), and this type of development is reported to have extirpated or degraded known occurrences (USFWS, 2009d). It is known to occur in the Mancos Shale hills within Delta and Montrose counties, Colorado. Much of the former habitat in the vicinity of Montrose, Colorado has been destroyed since the species was listed in 1984 (Flora of North America, 2008). Habitat associated with the clay-loving buckwheat in Delta County was largely destroyed in 2001 by off-road vehicle

activities in the designated critical habitat. A small population of clay-loving buckwheat is preserved at the Fairview Natural Area east of the City of Montrose (Flora of North America, 2008).

Clay loving buckwheat is a low-growing, rounded, densely branched subshrub in the buckwheat family. It is estimated to live between 20 and 50 years, with flowering usually occurring from late May to early September and individual flowers lasting fewer than 3 days. Reproduction requires a pollinator. This species is found in plant communities with low species diversity, low productivity, and minimal canopy cover (USFWS, 2009d).

The clay loving buckwheat is endemic to the adobe hills and flats immediately adjacent to the communities of Delta and Montrose, Colorado (USFWS, 2009d). The plants' northern range occurs near Lasear in Delta County and the southern range is the southeastern edge of the City of Montrose at elevations from 5,180 to 6,350 feet. The area in which the species occurs is dry, receiving an average of 8 to 9 inches of precipitation a year in the whitish, alkaline clay soils of the Mancos shale Formation. These soils are part of the Billings Series, with a fine texture and weak, unstable structure. Plants are generally found in swales or drainages where there is more moisture, and are located in low-lying areas with rolling topography and steeper, more barren slopes above them. Plants near Delta are located at lower elevations in small areas where snow lingers (USFWS, 2009d). Surveys were conducted at the Site on multiple occasions from August 2007 through May 2008, but no clay loving buckwheat plants were observed, even though the surveys conducted in August and September 2007 corresponded with the species' flowering period (Kleinfelder, 2009g). Clay loving buckwheat has not been found in the vicinity of the Site during previous survey efforts (Lyon and Sovell, 2000).

Critical habitat was designated on 120 acres of private land in Delta County, Colorado in 1984, which was the entire known area at the time (USFWS, 1984). The designated critical habitat is approximately 60 miles northeast of the Site. Soils within the Site are atypical of the critical habitat soils known to provide habitat for this species (Kleinfelder, 2009g). The clay-loving buckwheat is highly unlikely to occur at the Site and vicinity.

3.5.2.2 Candidate Species

Western Yellow-billed Cuckoo. The yellow-billed cuckoo is a federal candidate species that is being considered for listing due to loss of riparian habitat from agricultural use, water use, road development, and urban development (USFWS, 2007c). This species was petitioned for listing as threatened or endangered in 1998. Following a status review, the USFWS (2001) found that listing the western Distinct Population Segment (DPS) of yellow-billed cuckoos (including those in Colorado) as threatened was warranted but precluded and the species is currently a candidate species for listing (USFWS, 2009a).

Western yellow-billed cuckoos are considered a riparian obligate species and are usually found in large tracts of cottonwood/willow habitats with dense sub-canopies where they are known to breed. Yellow-billed cuckoos may also occur along narrow and patchy riparian corridors, which provide relatively suitable moist deciduous woodlands within otherwise unsuitable arid vegetation (USFWS, 2007c). The birds inhabit lowland riparian forests and urban areas with tall trees.

Yellow-billed cuckoos are brood parasites by which they occasionally lay eggs in nests of other yellow-billed cuckoos or nests of other bird species (USFWS, 2007c). Clutch size is usually two or three eggs, and development of the young is very rapid, with a breeding cycle of 17 days

from egg-laying to fledging of young. Rapid development of chicks allows them to out-compete other species' young in the parasitized nest.

The western DPS of yellow-billed cuckoos extends from the Continental Divide west including all states west of the Rocky Mountains and extends into southern British Columbia at the northern extent and into the northwestern states of Mexico at the southern limit (USFWS, 2007c). Currently, the range of the cuckoo is limited to disjunct fragments of riparian habitats from northern Utah, western Colorado, southwestern Wyoming, and southeastern Idaho southward into northwestern Mexico and westward into southern Nevada and California (USFWS, 2007c). North American populations of this species have been declining (Andrews and Righter, 1992).

Only one nesting observation was confirmed along the Yampa River near Hayden from 1987 to 1994. Other confirmed nesting attempts during the mid-1980s were associated with outbreaks of caterpillar infestations in box elders in the Four Corners Region/Durango area (USFWS, 2007c).

The bird is an uncommon local summer resident in western valleys, primarily from Mesa County southward. Numbers of this species fluctuate widely from year to year (CDOW, 2009b; Andrews and Righter, 1992). No known population of this species exist within the BLM Grand Junction Field Office or Uncompahgre Field Office areas although there have been a few sightings along the Colorado River corridor in the vicinity of Grand Junction (USFWS, 2007c) and in 1998, 242 miles of lowland river habitat were surveyed in west-central Colorado but only one cuckoo, believed to be one of a nesting pair, was found (USFWS, 2007c). CNHP (2009b) records indicate one occurrence of yellow-billed cuckoo in the state, within La Plata County. There is no suitable habitat for this species within the Site or vicinity, because there are no riparian forests dominated by cottonwoods.

Gunnison's Prairie Dog. Gunnison's prairie dog is a candidate species but only within a portion of their range. In 2004, the USFWS was petitioned to list Gunnison's prairie dog as threatened or endangered under the ESA and to designate critical habitat. The USFWS decided that there was insufficient information to warrant further review but was challenged in court and eventually conducted an additional review of the species' status. In 2008, the USFWS published their finding (USFWS, 2008b) that Gunnison's prairie dogs inhabiting central and south-central Colorado and north-central New Mexico were warranted for listing under ESA. The geographic area included in the finding does not coincide with the Site and Montrose County. Only Gunnison's prairie dogs inhabiting montane habitats - higher elevation, cooler, and moister plateaus, benches, and intermountain valleys - found in the northeastern portion of the species' range in central and southcentral Colorado and north-central New Mexico were included in the finding. However, while the USFWS determined that listing these populations under the ESA was warranted, they noted that listing was precluded by pending actions with higher priorities (USFWS, 2008b).

Gunnison's prairie dogs have inhabited the Site in the past; abandoned burrows (not occupied during the current year) were found within and adjacent to the 80-acre parcel in Section 7 (Township 46 North, Range 17 West). Gunnison's prairie dogs inhabit the Paradox Valley and were observed at two locations near the Site during surveys conducted in August, 2009. One active colony was observed approximately 1 mile east and another larger colony was found approximately 1.5 miles west of the Site (WestWater, 2009).

These populations of Gunnison's prairie dogs are not included in the USFWS' recent finding and would not be considered as candidate species because Gunnison's prairie dog was not found to be threatened or endangered throughout its entire range. Within approximately 60 percent of its range, including Gunnison's prairie dogs in the Paradox Valley, the available habitat and threats (primarily plague) were judged to currently not be sufficient to put the species in danger of extinction (endangered) or make it likely to become endangered within the foreseeable future (threatened) (USFWS, 2008b).

Gunnison's prairie dogs are colonial, similar to other species of prairie dogs and occur in small patchy colonies of fewer than 50 animals (Pizzimenti and Hoffmann, 1973). They have been described as a keystone species of the sagebrush ecosystem by creating habitat, providing food, and their burrowing helps to aerate the soil, add organic matter, and contributes to increased water penetration. Abandoned burrows are used by burrowing owls, weasels, snakes, badgers, and even foxes, and prairie dogs are important prey species for a variety of avian and mammalian predators (USFWS, 2009d).

Indiscriminate poisoning has reduced the species' numbers and range, and they are extremely susceptible to sylvatic plague. Plague has the potential to eradicate a colony within months. However, populations can recover from sylvatic plague epizootics rapidly, depending on females' reproductive and survival rates (Cully, 1997). Another threat to this species is habitat conversion to agriculture and urban developments (CDOW, 2009d). Recreational shooting of prairie dogs is less likely to be a major factor in controlling Gunnison's prairie dogs than black-tailed prairie dogs (*Cynomys ludovicianus*), which occur at much higher densities than Gunnison's prairie dog (Reeve and Vosburgh, 2006). CDOW (2009d) has developed a draft conservation plan to address managing principal threats to Gunnison's prairie dog which include plague, range condition, chemical control, shooting, and oil/gas developments.

Gunnison Sage-Grouse. Gunnison Sage-grouse has been a candidate species for listing under the ESA. In 2000, USFWS (2000b) designated the Gunnison Sage-grouse as a candidate species but in 2006, the USFWS removed the species as a candidate stating that listing was not warranted (USFWS, 2006b). Following the removal, a complaint was filed in District Court in 2006 declaring that the USFWS had violated the ESA in its finding on the Gunnison Sage-grouse. In August 2009, a settlement was reached in which the USFWS agreed to reconsider its 2006 finding and publish a new finding on or before June 30, 2010. Consequently, Gunnison Sage-grouse is discussed here as a former candidate (and potentially, a future candidate species); it has remained a species of special concern in Colorado where it has declined because of habitat loss due to housing and human development, livestock grazing, water diversion projects and increased deer and elk populations; the Colorado Wildlife Commission eliminated hunting in areas occupied by Gunnison Sage-grouse in 2000 (CDOW, 2009e).

Historically, Gunnison Sage-grouse ranged across 15 counties in western Colorado but are now restricted to one large, contiguous population in southern and central Gunnison and northeastern Saguache counties, as well as several much smaller populations sporadically located across Mesa, Montrose, Ouray, San Miguel, and Dolores counties (Braun et al*.,* 1994; Braun, 1995). Threats include habitat loss, fragmentation, and degradation of sagebrush habitats by development, agriculture, and grazing. Populations have declined in some areas due to treatments of sagebrush with herbicides and fire (Braun et al*.,* 1977). Indeed, some areas of sagebrush within the Site have been subject to similar eradication efforts in the past using mechanical control (brush-hogging).

There are seven separate populations of Gunnison Sage-grouse in Colorado and Utah. The Site coincides with San Miguel Basin population for which a conservation plan was finalized in 1998 (San Miguel Basin Sage Grouse Working Group, 1998). The sage grouse area closest to the Site is the Dry Creek Basin/Miramonte area. Results of studies conducted in the area indicate that wintering habitats used from November through March, nesting habitats utilized from April through June, early brood-rearing habitats used by hens with chicks during May and June, and escape cover adjacent to lek sites (used from March through May) were most important to birds in the Dry Creek Basin/Miramonte area (San Miguel Basin Sage Grouse Working Group, 1998). Wintering habitats used from November through March are not limiting in Dry Creek Basin. Leks sites in the area are associated with alkali flats and low sagebrush cover with taller sagebrush (>12 inches) escape cover within 200 yards. Nest sites are generally in taller, dense sagebrush 16 or more inches tall with more than 25 percent canopy cover, while early brood-rearing habitats tend to be in areas dominated by forbs and grasses with less sagebrush cover, associated with conditions often found in drainage channels (San Miguel Basin Sage Grouse Working Group, 1998).

CDOW (2009b) has mapped overall range utilized by the Dry Creek Basin/Miramonte population of Gunnison Sage-grouse. Overall range encompasses all mapped seasonal activity areas within the observed range of the population (CDOW, 2009b). Overall range is approximately 1.5 miles south of the Site. The closest lek, however, is farther than 11 miles south and wintering habitat is 12 miles south of the Site. According to CDOW (2008), the strip of pinyon-juniper vegetation associated with higher elevations south of the Site separates the occupied habitat in the Dry Creek Basin from potentially suitable habitat in the East Paradox Valley. Wintering Gunnison Sage-grouse were observed at the Site as recently as 2002 (CDOW, 2008). However, no sage-grouse or sign (feces, feathers, skeletal material) were observed at the Site during recent surveys conducted in August 2009 (WestWater, 2009) or during four seasonal on-site surveys from August 2007 through May 2008 (Kleinfelder, 2009h).

3.5.2.3 BLM Sensitive Species and State of Colorado Species of Special Concern

In addition to candidate species and species listed as threatened or endangered under the ESA, the BLM and the State of Colorado have identified sensitive animal species and BLM has identified certain plant species as sensitive. Species lists developed by BLM (2000) and Colorado (CNHP, 2009a) were used to determine both the BLM and State's sensitive species for animals and plants that may occur in Montrose or San Miguel counties and BLM's Uncompahgre Field Office (Montrose) and/or Grand Junction Field Office. Species' status, habitat descriptions and species' known distributions within Colorado that have been compiled by CDOW, Natural Diversity Information Source (CDOW, 2009b), and the CNHP (2009a and 2009b) were used to judge whether species' potentially occur at or near the Site, which is included in Table 3.5-8 and ultimately whether they could be potentially affected by construction of the Mill.

Table 3.5-8
Colorado and BLM Sensitive Wildlife Species Not Listed Under the ESA that Could Potentially Occur in the Vicinity of the Site in Montrose County

Common Name Scientific Name	Habitat [1]	Potential Occurrence [2]	Federal Sensitive[3]	State Status[4]	State Rank[5]
Mammals					
Townsend's Big-eared Bat *Corynorhinus townsendii pallescens*	Montane forests, pinyon-juniper woodlands, semi-desert shrublands	Possible	BLM GJ, UN	SC	S2
Spotted Bat *Euderma maculatum*	Ponderosa pine in montane forest, pinyon-juniper woodlands, aspen, semi-desert shrublands	Possible	BLM GJ, UN	S2	S2
Allen's (Mexican) Big-eared Bat *Idionycteris phyllotis*	Mountainous wooded areas; riparian woodland; near rocks	None	BLM UN		S2
Fringed Myotis *Myotis thysanodes*	Ponderosa pine, greasewood, oakbrush, saltbush shrublands	Possible	BLM GJ, UN	-	S3
Yuma Myotis *Myotis yumanensis*	Pinyon-juniper, riparian woodlands near water; roosts in caves, crevices, structures	Possible	BLM GJ, UN		none
Big Free-tailed Bat *Nyctinornops macrotis*	Rocky slopes, canyon lands, roosts in crevices	Unlikely	BLM GJ		S1
Wolverine *Gulo gulo*	Historical and recent sitings at higher elevations with heavy timber	None		SE	S1
Kit Fox *Vulpes macrotis*	Semidesert shrubland and margins of pinyon-juniper woodlands; saltbush, sagebrush, greasewood	Unlikely		SE	S1
Botta's Pocket Gopher *Thomomys bottae*	Agricultural land, grasslands, roadsides, open parklands, pinyon-juniper woodlands, open montane forest, montane shrublands, and semidesert shrublands	Possible		SC	S1
Northern Pocket Gopher *Thomomys talpoides*	Agricultural and pasture lands, semidesert shrublands, and grasslands at lower elevations upwards into alpine tundra	Unlikely		SC	S1
Northern River Otter *Lutra Canadensis*	Riparian habitats that traverse ecosystems ranging from semidesert shrublands to montane and subalpine forests	None		ST	
Birds					
Northern Goshawk *Accipter gentiles*	Forests of aspen, ponderosa pine, lodgepole pine	None	BLM GJ, UN		S3B,S2N
Barrow's Goldeneye *Bucephala islandica*	Winter – reservoirs, rivers Summer – mountain reservoirs, ponds in forests	None	BLM GJ	SC	S2B, SZN
Ferruginous Hawk *Buteo regalis*	Grassland, semidesert shrublands, rare in pinyon-juniper. Nest on isolated structures	Unlikely	BLM GJ, UN	SC	S3B,S4N
Gunnison Sage-Grouse *Centrocercus minimus*	Sagebrush grasslands and areas with herbaceous vegetation	Possible	BLM GJ, UN	SC	S1

Common Name Scientific Name	Habitat [1]	Potential Occurrence [2]	Federal Sensitive[3]	State Status[4]	State Rank[5]
Western Snowy Plover *Charadrius alexandrinus nivosus*	Beaches, dry mud or salt flats, sandy shores of rivers, lakes, and ponds	None	BLM GJ	SC	S1B,SZN
Black Tern *Chlidonias niger*	Reservoirs, lakes, breeding in cattail marshes by open water	None	BLM GJ		S3S4B,SZN
Long-billed Curlew *Numenius americanus*	Short-grass grasslands, wheatfields, dryland agriculture near water	None	BLM GJ, UN	SC	S2B,SZN
White-faced Ibis *Plegadis chihi*	Marsh edges, wet meadows, reservoir shorelines	None	BLM GJ, UN		S2B, SZN
American White Pelican *Pelecanus erythrorhynchos*	Larger reservoirs, breeding on islands in eastern Colorado	None	BLM GJ	SC	S1B,SZN
Columbian Sharp-tailed Grouse *Tympanuchus phasianellus columbianus*	Gambel oak, serviceberry shrublands, sagebrush shrublands, irrigated fields	None		SC	S2
Greater Sandhill Crane *Grus canadensis tabida*	Migrants – mudflats around reservoirs, agriculture, moist meadows, Breeding – parks with grassy hummocks, beaver ponds, natural ponds with willows or aspens	None		SC	S2B,S4N
Bald Eagle *Haliaeetus leucocephalus*	Reservoirs, rivers, wintering in semidesert and grasslands	Present		ST	S1B,S3N
American Peregrine Falcon *Falco peregrinus anatum*	Open conifer forests, riparian forests, and cliffs migrant in western Colorado	Possible		SC	S2B
Western Burrowing Owl *Athene cunicularia*	Grasslands in or near prairie dog towns	Present		ST	S4B
Reptiles					
Longnose Leopard Lizard *Gambelia wislizenii*	Flat or gently sloping, open ground shrublands	Unlikely	BLM GJ, UN	SC	S1
Milk Snake *Lampropeltis triangulum taylori*	Grasslands, sandhills, canyons, open woodlands ponderosa, pinyon-juniper	Unlikely	BLM GJ	SC	S2
Midget Faded Rattlesnake *Crotalus oreganus concolor*	Most terrestrial habitats in west-central Colorado	Possible	BLM GJ	SC	S3
Amphibians					
Boreal Toad *Bufo boreas* pop. 1	Pond margins, wet meadows, riparian areas in subalpine zones	None		SE	S1
Great Basin Spadefoot *Spea intermontana*	Pinyon-juniper woodlands, sagebrush, semidesert shrublands, stream floodplains, canyon bottoms	None	BLM GJ	SC	S3
Northern Cricket Frog *Acris crepitans*	Muddy, marshy edges of ponds, streams, other permanent water	None	BLM GJ	SC	SH
Canyon Treefrog *Hyla arenicolor*	Intermittent streams in deep rocky canyons with pinyon-juniper vegetation	Possible	BLM GJ, UN	SC	S2
Northern Leopard Frog	Margins, banks of marshes, ponds, streams,	Unlikely	BLM	SC	S3

Common Name Scientific Name	Habitat [1]	Potential Occurrence [2]	Federal Sensitive[3]	State Status[4]	State Rank[5]
Rana pipiens	other permanent water		GJ, UN		
Fish					
Colorado River Cutthroat Trout *Oncorhynchus clarkii pleuriticus*	Colorado River drainage, clear mountain streams	None	BLM GJ, UN	SC	S3
Roundtail Chub *Gila robusta*	Colorado River drainage, mostly large rivers, also streams and lakes	None	BLM GJ, UN	SC	S2
Bluehead Sucker *Catostomus discobolus*	Headwater streams to large rivers with moderate velocity, not in standing water	None	BLM GJ, UN	SC	S4
Flannelmouth Sucker *Catostomas latipinnis*	Larger streams and rivers with riffles, eddies, backwaters	None	BLM GJ, UN	SC	S3S4
Invertebrates					
Great Basin Silverspot (Nokomis Fritillary) Butterfly *Speyeria nokomis Nokomis*	Spring-fed meadows, seeps, marshes, boggy streamside meadows with flowing water; bog violets are larval food plants	Possible	BLM GJ, UN		S1
Vascular Plants					
Wideleaf bisquitroot (Canyonlands lomatium) *Aletes (Lomatium) latilobum*	Piñon-juniper, desert shrub, sandy soils from Entrada Formation, 5,000-7,000 feet	None	BLM GJ		S1
Jones Blue Star *Amsonia jonesii*	In runoff-fed draws on sandstone, desert-steppe	None	BLM GJ		S1
Debeque milkvetch *Astragalus debequaeus*	Varicolored, fine-textured, seleniferous, saline soils of Wasatch Formation-Shire Member; 5,100-6400 feet	None	BLM GJ		S2
Starvling milkvetch *Astragalus jejunus*	Rocky hills and ridges, barren hills	None	BLM GJ		S1
Grand Junction milkvetch *Astragalus linifolius*	Pinyon-juniper, sagebrush on Chinle, Morrison Formation. 4,800-6,200 feet	Possible	BLM GJ, UN		S3
Ferron milkvetch *Astragalus musiniensis*	Pinyon-juniper, desert shrub on shale, sandstone, or alluvium; 4,700-7,000 feet	None	BLM GJ		S1
Naturita milkvetch *Astragalus naturitensis*	Pinyon-juniper woodlands, sandstone mesas, ledges, crevices; 5,000-7,000 feet	Likely	BLM GJ, UN		S2S3
Fisher Tower's milkvetch *Astragalus piscator*	Sandy, gypsiferous soils in valley benches, gullied foot hills, 4,300-5,600 feet	None	BLM GJ		S1
San Rafeal milkvetch *Astragalus rafaelensis*	Gullied hills, washes, talus, seleniferous clay, silt, sand, 4,000-6,500 feet	None	BLM GJ		S1
Sandstone milkvetch *Astragalus sesquiflorus*	Banks of sandy clay gulches, in pockets at foot of sandstone outcrops, or among boulders along dry watercourses	Likely	BLM UN		S1
Rocky Mountain thistle *Cirsium perplexans*	Adobe hills derived from shale of Mancos or Wasatch Formation	None	BLM GJ, UN		S1
Osterhout cryptanth *Cryptantha osterhoutii*	Dry barren sites in reddish purple decomposed sandstone, or in dry, sandy soil	None	BLM GJ		S1S2
Kachina daisy	Saline soils in alcoves, seeps, 4,800-5,600 feet	None	BLM		S1

Common Name Scientific Name	Habitat [1]	Potential Occurrence [2]	Federal Sensitive[3]	State Status[4]	State Rank[5]
Erigeron kachinensis			GJ		
Grand buckwheat *Eriogonum contortum*	Mancos Shale badlands, shadscale saltbush, other salt desert shrubs; 4500-5100 feet	None	BLM GJ		S2
Tufted green gentian *Frasera paniculata*	Western Mesa County near Utah border, sandy soils	None	BLM GJ		S1
Narrowstem gilia *Gilia stenothysra*	Silt, loam, gravel soils from Green River/Uinta Formation, 5,000-6,000 feet	None	BLM GJ		S1
Piceance bladderpod *Lesquerella parviflora*	Shale in Green River Formation, ledges, canyon slopes; 6,200-8,600 feet	None	BLM GJ		S2S3
Montrose bladderpod (Good-neighbor bladderpod) *Lesquerella vicina*	Mancos shale between pinyon-juniper woodland and salt desert scrub; sandy soils from Jurassic sandstones; sagebrush steppe; disturbed areas	Unlikely	BLM UN		S1
Colorado Desert Parsley *Lomatium concinnum*	Barren adobe soils derived from shales of Mancos Formation in shrub-dominated communities	None	BLM UN		S1
Paradox Valley Lupine *Lupinus crassus*	Pinyon-juniper woodland; Mancos shale; quaternary alluvium derived from Chinle Formation; sparsely vegetated soil	Likely	BLM UN		S2
Dolores skeleton plant *Lygodesmia doloresensis*	Endemic on benches of Dolores River Valley	Unlikely	BLM GJ, UN		S1
Southwest stickleaf *Mentzelia argillosa*	Steeply sloping and constantly moving talus or scree slopes of the Green River Formation shale	None	BLM GJ		S2
Eastwood monkey-flower *Mimulus eastwoodiae*	Shallow caves, seeps, in canyon walls, 4,700-5,800 feet	None	BLM GJ, UN		S1S2
Paradox breadroot *Pediomelum aromaticum*	Open pinyon-juniper, sagebrush, shadscale zones, on sandy or clay soils, often on the sides of dry washes	Likely	BLM UN		S2

[1] Sources: CNHP, 2009a and 2009b, CDOW, 2009b, Weber and Wittmann, 2001; Andrews and Righter, Fitzgerald et al., 1994, 1992; Hammerson, 1986; Woodling, 1985.
[2] Potential Occurrence:
None: Does not occur within Montrose County and no suitable habitat is present.
Unlikely: May or may not occur in Montrose County but no suitable habitat is present.
Possible: Occurs in Montrose County, suitable habitat is present, but not observed at the Site.
Likely: Occurs In Montrose County, including the Site and/or immediate vicinity.
Present: Observed at or immediately adjacent to the Site and/or occupied habitat includes the Site.
[3] Federal Sensitive: BLM GJ, Grand Junction Field Office; BLM UN, Uncompahgre Field Office.
[4] State Status: SC = State Species of Special Concern, SE= State Endangered , ST = State Threatened.
[5] State Rank: S1= Critically Imperiled, S2= Imperiled, S3= Vulnerable, ranks with “B” indicate status of breeding occurrences.

Mammals. Four of the six species of bats that are included in Table 3.5-8 could occur at the Site. The Townsend's big eared bat (also called the pale lump-nosed bat) roosts in caves, tunnels, mines, and buildings, and can be found in lower elevation pinyon-juniper woodlands (Lyon and Sovell, 2000). In summer, male bats tend to roost as individuals in rock crevices and on walls, separate from the nursery colony (Fitzgerald et al*.* 1994), but in winter, non-migratory individuals roost in colonies. The species' distribution is strongly correlated with the availability of caves and cave-like roosting habitat, including abandoned mines. Population centers occur in areas dominated by exposed, cavity or caverniculous-forming rock and/or historic mining districts. Its habit of roosting pendant-like on open surfaces makes it readily detectable, and it can be the species most readily observed, when present (commonly in low numbers) in caves and abandoned mines throughout its range. There is suitable habitat in abandoned mines in the vicinity of the Site to the southwest. They have been documented by the CNHP (Lyon and Sovell, 2000) along the canyons of the San Miguel and Dolores rivers 7 to 8 miles north of the Site.

The spotted bat occurs in ponderosa pine woodlands, pinyon-juniper woodlands, and open semi-desert shrublands. Colorado is this species eastern-most range, although no breeding records exist in the state (Fitzgerald et al*.* 1994). It has been found roosting in crevices in cliff faces, but little is known about its winter status (Lyon and Sovell, 2000). The Yuma myotis is found in a variety of upland and lowland habitats, including riparian, desert scrub, moist woodlands, and forests, but generally near open water. Foraging is restricted to riparian corridors of the few major rivers. Nursery colonies are in buildings, caves, mines, and under bridges, and when disturbed, are either abandoned or reduced in numbers (Lyon, et al. 1996). CHNP have reported spotted bats and Yuma myotis in Coyote Wash, approximately 9 miles east of the Site (Lyon and Sovell, 2000).

Fringed myotis are known from western Montrose County, including the vicinity of the Site (Fitzgerald et al*.* 1994). The species commonly occupies oak and pinyon woodlands as well as Douglas-fir and ponderosa pine forests; mines, caves, and buildings provide roost sites (Adams, 2003). There are no records of fringed myotis in the vicinity of the project. Two unidentified bats were observed during spotlight surveys conducted at the Site during September 2007 (Kleinfelder, 2009h).

Suitable habitat does not exist at the Site for either the kit fox or for wolverines (Table 3.5-8). Both species are classified as endangered in Colorado. CNHP records indicate wolverines have been documented in eastern San Miguel County and kit fox have been observed in Mesa and Garfield counties, north of the Site. Likewise, northern river otters are classified as threatened in Colorado. They were present in most major drainages historically, but have been reintroduced from diverse geographic locations in North America since 1976 and have become established in the Dolores River and San Miguel River (Boyle, 2006). They are not expected to occur within the Site.

Botta's pocket gopher is a medium-sized rodent. The Botta's pocket gopher occurs in southern Colorado, where several local races have evolved (Fitzgerald et al*.,* 1994). This species can be found in a variety of vegetation types, including agricultural, grassland, along roadsides, parks, pinyon-juniper woodlands, open montane forest, montane shrublands, and semidesert shrublands. Northern pocket gophers are found in many different habitat types including agricultural and pasture lands, semidesert shrublands, and grasslands at lower elevations upwards into alpine tundra. Although there is suitable habitat at the Site for both species, neither was observed during surveys conducted in 2007 and 2008 (Kleinfelder, 2009h).

Birds. There are 14 bird species included in Table 3.5-8 that have been identified as sensitive species by the BLM GJFO or the BLM Uncompaghre Field Office, or are a protected species in Colorado. However, only four of the species are believed to possibly occur within the Site: Gunnison Sage-grouse, bald eagle, American peregrine falcon, and western burrowing owl. Gunnison Sage-grouse is a special status species that has been observed in the past in the project vicinity. Gunnison Sage-grouse was discussed above as a candidate species for listing under the ESA.

Two bird species that were removed from the list of threatened and endangered species may occur in the vicinity of the Site: the bald eagle and American peregrine falcon. Bald eagles are listed as threatened by the State of Colorado and as a sensitive species by the BLM. The USFWS proposed to remove the bald eagle from the list of endangered and threatened wildlife in 1999 because the bald eagle's population growth had exceeded most goals established in various recovery plans (USFWS, 1999a). The USFWS reopened the public comment period on February 16, 2006 (USFWS, 2006c), and on August 8, 2007, the bald eagle was delisted (USFWS, 2007d). Although no longer listed as threatened under the ESA, bald eagles remain protected under the Bald and Golden Eagle Protection Act (BGEPA) (16 USC 668-668d) and the Migratory Bird Treaty Act (MBTA) (16 USC 703-712). The BGEPA prohibits "take" of bald and golden eagles, which includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb (50 CFR § 22.3). The USFWS defines "disturb" as "to agitate or bother a bald or golden eagle to the degree that it interferes with or interrupts normal breeding, feeding, or sheltering habits, causing injury, death, or nest abandonment" (USFWS, 2006c).

Historically, fewer than four pairs of bald eagles nested in Colorado; nesting has increased steadily since the 1980's to 38 confirmed nests in 1995 (Winternitz, 1998), and bald eagles are commonly observed throughout the state during winter. The annual midwinter count shows a stable population of 600 to 800 eagles (Lyon and Sovell, 2000). The entire Site and wider area vicinity is identified as bald eagle winter range (CDOW, 2009b), areas where bald eagles have been observed between November 15 and April 1. A winter concentration area is present along the San Miguel River, approximately 6.5 miles east of the Site. Communal bald eagle winter roosts are also located along the San Miguel River 8 miles east of the Site and about 12 miles northwest of the Site on a tributary to West Paradox Creek near Paradox. Communal winter roosts are usually in groups of trees or individual trees that provide diurnal and/or nocturnal perches for less than 15 wintering bald eagles, and include a buffer zone extending 0.25-mile around these sites. These trees are usually the tallest available trees in the wintering area and are primarily located in riparian habitats (CDOW, 2009b). A bald eagle was observed passing through the Site along Highway 90 during the on-site survey in winter 2008, but no suitable habitat for foraging or nesting was observed (Kleinfelder, 2009h).

American peregrine falcons are a species of concern in Colorado. The peregrine falcon was classified as an endangered species under the Threatened and Endangered Species Act of 1973. With the banning of DDT and other chlorinated hydrocarbons and successful captive breeding, rearing, and release of over thousands of peregrines annually, USFWS (1999b) determined that the species had recovered and removed peregrine falcons from the list of Threatened and Endangered Species in 1999. Primary threats include environmental toxins, habitat loss, human disturbance, and illegal take. The recovery objectives established for the species when it was listed under ESA have been met in most areas, and the bird is widely distributed. In Colorado, through intensive reintroduction efforts over the past 17 years, more than 300 peregrines have been released in various locations throughout the state. Throughout the 1990's, Colorado has had approximately 24 breeding pairs, including nest sites in Paradox Valley and Slick Rock Canyon along the Dolores River that were active in 1999 (Lyon and Sovell, 2000). There are nine active peregrine falcon eyries within an approximate 20 mile

radius from the Site, primarily on cliffs in the Dolores River Canyons upstream and downstream from the project site. The closest eyrie is 4 miles away near the confluence of East Paradox Creek and the Dolores River.

Western burrowing owls are classified as threatened in Colorado. The western burrowing owl is one of the smallest species of owls. They typically inhabit open, dry grasslands and semidesert shrublands, usually near prairie dog colonies (Andrews and Righter, 1992) and occupy the abandoned underground burrows of other animals, such as ground squirrels, rabbits, or prairie dogs. They can dig their own burrows, but usually prefer the deserted excavations of other animals. The owls commonly perch on fence posts or on top of mounds outside their burrows. Western burrowing owls typically arrive on breeding grounds in Colorado in late March or early April, with nesting beginning a few weeks later.

Western burrowing owl surveys were performed by Kleinfelder (2009h) in 2007 in accordance with the CDOW's wildlife survey protocol (CDOW, 2007). Western burrowing owl surveys are conducted between March 15 and October 31. Active nesting and fledging has been recorded and may be expected from late March through early August (CDOW, 2007). Adults and young may remain at nesting grounds until migrating to wintering grounds in late summer or early autumn (CDOW, 2007). Western burrowing owl are active throughout the day; however, peaks in activity in the morning and evening make these the best times for conducting surveys (Conway and Simon, 2003).

Surveys for owls were conducted in the early morning (one half hour before sunrise until two hours after sunrise) and early evening (two hours before sunset until one half hour after sunset). To increase the likelihood of detecting western burrowing owl, if present, call-broadcast methods are used in western burrowing owl surveys. Conway and Simon (2003) detected 22 percent more western burrowing owls at point-count locations by broadcasting the primary male (*coo-coo*) and alarm (*quick-quick-quick*) calls during surveys. Although call-broadcast may increase the probability of detecting western burrowing owl, most owls will still be detected visually (CDOW, 2007).

Kleinfelder (2009h) reported that western burrowing owls were observed adjacent to the Site during Spring 2008. Three owls responded to call-broadcasts. They were apparently between one-eighth mile and one-half mile west to southwest of the observation point (call-broadcast point), off the Site but in the vicinity of the 80-acre parcel in Section 7 (Township 46 North, Range 17 West). No prairie dog burrows were observed on the Site in 2008 (Kleinfelder, 2009g). WestWater (2009) searched the 80-acre parcel in August 2008 and found abandoned burrows (not occupied during the current year) of Gunnison's prairie dog in the same vicinity as the burrowing owl locations reported the year before. No burrowing owls or sign of owls were seen in any of the burrows (WestWater, 2009) but, based on their response to call-broadcasts, they may have been present on the 80-acre parcel in 2008.

Gunnison's prairie dogs have inhabited the Site in the past; abandoned burrows (not occupied during the current year) were found within and adjacent to the 80-acre parcel in Section 7 (Township 46 North, Range 17 West) (WestWater, 2009). These abandoned burrows were apparently occupied by western burrowing owls; three western burrowing owls in the vicinity of the abandoned burrows were heard broadcasting in response to the CDOW call-broadcast compact disc during surveys in May 2008 (Kleinfelder, 2009h).

Reptiles. Based on their known distributions within the state (Hammerson, 1986; CDOW, 2009f), neither the longnose leopard lizard or milk snake are known within western Montrose County and there are no county records of either species in the CNHP (2009b) element

database. However, midget faded rattlesnakes have been documented in proximity to the Site. Midget faded rattlesnakes are primarily found on the ground, but will occasionally climb into trees and shrubs, and are often associated with upland pinyon-juniper woodlands. When inactive during cold weather, individuals occupy mammal burrows, crevices, or caves, where they sometime congregate in large numbers. This subspecies ranges from southern Wyoming and eastern Utah south to the Four Corners area (Stebbins, 1985). Colorado is at the eastern margin of the subspecies' range where it occurs in Mesa, Delta, Garfield, Montrose, and San Miguel counties. There are no rangewide estimates available; however, midget faded rattlesnakes are visibly common in much of west central Colorado (Lyon and Sovell, 2000). Although suitable habitat for the species is present within the Site, none were observed during surveys conducted in 2007 and 2008 (Kleinfelder, 2009h).

Amphibians. Four amphibian species are included in Table 3.5-8 as BLM-sensitive species and species of special concern in Colorado. A fifth species, the boreal (or western) toad, is classified as endangered in Colorado, but the species does not occur in southwestern Colorado, including Montrose County (Hammerson, 1986; CDOW, 2009f, CNHP, 2009b). The Great Basin spadefoot has been documented in Mesa County and sporadically observed in counties north of Mesa County. Northern cricket frogs (once present in northeastern Colorado) have not been seen in Colorado since 1979, and may be extirpated in the state (CDOW, 2009f).

Northern leopard frogs were locally common throughout most of Colorado, but are now rare or extirpated in many areas, particularly in the mountains (CDOW, 2009f). Reasons for population declines are not known but appear to be complex, related to habitat loss or degradation and interactions with non-native species, particularly bullfrogs (Lyon and Sovell, 2000). Mortality from bacterial infection such as red-leg disease (Brodkin, 1992) may be contributing to their decline. Most location records in Colorado are below 11,000 feet elevation and the population in the state is estimated to be between 3,000 and 10,000 individuals (Lyon and Sovell, 2000). They have been reported along the San Miguel River upstream from the confluence with the Dolores River and near Utah in the headwaters of West Paradox Creek (CDOW, 2009f). They could occur within East Paradox Creek and the small stock pond or retention pond located in the southeastern corner of the Site, but none were observed during any of the on-site surveys conducted during 2007 and 2008 (Kleinfelder, 2009h), or in 2009 (WestWater, 2009).

Canyon treefrogs are fairly common in restricted habitats of west-central and southwestern Colorado where they occur only along rocky stream courses in canyons. There are no quantitative data on population size or trends. They feed in pools along intermittently flowing streams, primarily from April to June, but may breed after heavy summer rains. Larvae metamorphose into small frogs as early as late July. Adults may be found basking on rocks and they may hide in rock crevices (CDOW, 2009f). Of 32 observations for the species, four are from western Montrose County in the Dolores River drainage and its side canyons (Lyon and Sovell, 2000), approximately 6 to 7.5 miles west of the Site. There is no suitable habitat for the species within or near the Site and none were observed during any of the on-site surveys conducted during 2007 and 2008 (Kleinfelder, 2009h), or in 2009 (WestWater, 2009).

Fish. None of the four fish species that are of special concern in Colorado and BLM-sensitive species (Grand Junction and Uncompaghre field offices) occur within the Site (Table 3.5-8); none of the drainages on-site provide habitat for any of the species. However, the flannelmouth sucker has been reported in the Dolores River near the confluence with East Paradox Creek and is found throughout the Dolores River from Slick Rock downstream to the Montrose-Mesa county line (Lyon and Sovell, 2000). The roundtail chub is similarly distributed in the Dolores River (Lyon and Sovell, 2000) and generally occurs in the Colorado River mainstream and its larger tributaries, including the White, Yampa, Dolores, San Juan, and Gunnison rivers

(Woodling, 1985). Bluehead suckers have not been reported from or sampled in Montrose County, although they are generally found throughout the middle and upper Colorado River Drainage in Colorado, New Mexico, Arizona, Utah, and Wyoming (CDOW, 2009b). Bluehead suckers inhabit a variety of habitats from headwater streams to large rivers. Within Montrose County, Colorado River cutthroat trout are present in Red Canyon, a tributary to Horsefly Creek, which is a tributary to the San Miguel River. The trout are also present in the Dry Creek drainage, a tributary to the Uncompaghre River in western Montrose County. The Colorado River cutthroat trout is also present in the Dolores River headwaters (hydrologic unit 1403000202), but not downstream at the Site and vicinity.

Invertebrates. One invertebrate species identified as sensitive by the BLM, the Great Basin silverspot butterfly (also called the Nokomis fritillary butterfly), occurs within Montrose County. It has been recorded at least 7 miles west of the Site, and colonies documented in the past have been verified in Montrose County (Selby, 2007). In western Colorado, Great Basin silverspot butterfly populations are associated with spring-fed and/or subirrigated wetlands below 7,500 feet, meadows interspersed with willows and other woody wetland species, and depend on northern bog violets (*Viola nephrophylla*) as the larval host (Selby, 2007). No suitable habitats are present within the Site but, given the proximity of the species, it could occur while in pursuit of adult food sources during the adult flight period. Adult Great Basin silverspot butterflies utilize a variety of plant species as nectar sources, but thistles are strongly favored; they apparently prefer blue- and yellow-flowered composites. Documented nectar sources include native and introduced thistles (including *Cirsium*, *Carduus*, and *Onopordon* spp), horsemint (*Agastache*), and joe pye weed (*Eupatorium maculatum*) (Selby, 2007). Several introduced thistles including Canada thistle (*Cirsium arvense*), plumeless thistle (*Carduus acanthoides*), and musk thistle (*Carduus nutans*) have been documented in the project vicinity (see Sections 3.5.1.2 and 3.5.1.3, Vegetation and Invasive Non-Native Species) and could be utilized as nectar sources.

It should be noted that another fritillary butterfly, the Uncompahgre fritillary, is listed under the ESA as endangered but only occurs in the San Juan Mountains and southern Sawatch Range at elevations above 13,200 feet in Gunnison, Hinsdale, and possibly Chaffee counties in southwestern Colorado (USFWS, 1991b).

Vascular Plants. There are 24 species of vascular plants included in Table 3.5-8 that have been identified by the BLM as sensitive by the GJFO and/or by the Uncompaghre Field Office. Reported distributions for 13 of the species do not include Montrose County and habitats for six other species are not found within or adjacent to the Site including Rocky Mountain thistle, Osterhout cryptanth, grand buckwheat, Montrose bladderpod (or Good-neighbor bladderpod), Colorado desert parsley, and Eastwood monkey-flower. The five remaining species in Table 3.5-8 have been judged as likely or possible to occur within the Site: Grand Junction milkvetch, naturita milkvetch, sandstone milkvetch, Paradox lupine (Payson lupine), and Paradox breadroot.

Grand Junction milkvetch is usually found associated with pinyon and juniper on sandy or clay soils derived from the Morrison Formation, between 4,800 and 6,200 feet. Associated species include Indian rice grass, hairy golden aster, low rabbitbrush, and broom snakeweed (Lyon and Sovell, 2000) some of which occur within the Site (Section 3.5.1.2, Vegetation). Grand Junction milkvetch is usually found on the eastern side of the Uncompahgre Plateau, but specimens were collected in the vicinity of Uravan (Lyon and Sovell, 2000) approximately 7 to 9 miles north of the Site. However, the specimens may be of another, closely related species (San Rafael milkvetch, *Astragalus rafaelensis*) and there is some debate whether the two species are one (Lyon and Sovell, 2000). No Grand Junction milkvetch were detected during any of the on-site surveys conducted during 2007 and 2008 (Kleinfelder, 2009g), or in 2009 (WestWater, 2009).

Naturita milkvetch has been found along the Dolores River Canyon and multiple other sites from 6 to 10 miles southwest of the Site (Lyon and Sovell, 2000). The species is found in pinyon-juniper woodlands and in areas with shallow soils over exposed bedrock, though usually it occurs in small soil pockets or rock crevices in sandstone pavement along canyon rims. Sometimes it is found nearby in deeper sandy soils with or without soil crusts. The milkvetch seems to tolerate and even thrive on some disturbance such as sites around power poles and in the compacted tracks of dirt roads (Lyon and Sovell, 2000). A third species of milkvetch, the sandstone milkvetch, has been documented historically in the Paradox area, and it has been found recently in the Dolores River Canyon downstream from Uravan and the confluence of the San Miguel River (Lyon and Sovell, 2000). Sandstone milkvetch grows on sandstone ledges and crevices of slickrock pavement. Associated species usually include pinyon, juniper, large-flowered breadroot (*Pediomelum megalanthum*), yucca, and prickly pear cactus (Lyon and Sovell, 2000). Although some of these species' associates are present within the Site, no Naturita milkvetch or sandstone milkvetch were detected during any of the on-site surveys conducted during 2007 and 2008 (Kleinfelder, 2009g), or in 2009 (WestWater, 2009).

Two species in Table 3.5-8 most likely to be present within the Site are Paradox lupine (also Payson lupine) and Paradox breadroot. Paradox lupines have been found in pinyon-juniper woodlands at the base of sandstone cliffs adjacent to East Paradox Creek north of the Site, and large populations of Paradox breadroot have been found there, as well as in the bottoms and sides of washes downstream from the lupine populations. Both species grow in soils derived from the Chinle Formation (Lyon and Sovell, 2000). Paradox lupine also occurs extensively on the opposite side (south side) of the East Paradox valley on the slopes of Davis Mesa, which are contiguous with the south slopes at the Site. Those slopes were designated a Potential Conservation Area (PCA) by CNHP (Lyon and Sovell, 2000) and begin approximately 0.7 mile northwest of the Site. The Davis Mesa Slopes PCA follows the distinct pinyon-juniper zone, but does not include the steep cliffs above the sagebrush flats on the valley floor, below (Lyon and Sovell, 2000). The following describes the PCA and locations where Paradox lupine have been found (Lyon and Sovell, 2000 page 124):

> "Davis Mesa Slopes PCA is located on the south side of Paradox Valley, at the base of the pinyon-juniper hillside. The area includes both private and BLM land. An unimproved road and a powerline run through the PCA. Thousands of individuals of Payson lupine were found in the pinyon-juniper woodland on soils derived from the Chinle Formation. The plants were particularly abundant in dry washes, and were even found in the middle of the dirt road. Adjacent sagebrush flats do not support the lupine."

Paradox breadroot were not noted within the Davis Mesa Slopes PCA (Lyon and Sovell, 2000), and neither species was reported from any of the on-site surveys conducted during 2007 and 2008 (Kleinfelder, 2009g), or in 2009 (WestWater, 2009).

3.5.3 Wildlife

3.5.3.1 Terrestrial Wildlife Species

Introduction. Numerous wildlife species are recreationally valuable to the public as game species and are known to occur or could occur within Montrose County and in the vicinity of the Site. As such, those species have been classified as "important" by the NRC in Regulatory Guide 3.8, Section 2.9 (NRC, 1982a). Categories of such species included Big Game, Small Game, Waterfowl, and Game Birds. In addition to game species, there are many species likely to affect the well-being of other "important species" through food chains and other interspecies relationships, and may contribute to predictions or evaluations of the impact of the facility on the regional biota. Those species include Neotropical migratory birds and a wide variety of

terrestrial non-game species. Non-game species are protected in Colorado under the Nongame, Endangered, or Threatened Species Conservation Act (CRS §33-2-101-108) and are included here under the designation of "important" species. To the extent that information is available, species that are known to occur or that could potentially occur, including their seasons of occurrence, estimates of abundance, local flight patterns, and critical habitats, are discussed to describe the ecological setting of the project area, as required by the NRC in NUREG-1748 (NRC, 2003a).

Species Surveys. On-site surveys were conducted on multiple dates during four seasons: 1) Summer (August 20, through August 24, 2007); 2) Fall (September 18 and 19, 2007); 3) Winter (January 16 and 17, 2008); and 4) Spring (May 19 and 20, 2008) by Kleinfelder (2009h). Surveys were confined to the 880-acre Site. An additional 80-acre parcel for the well field, was examined by WestWater on August 24, 2009 (WestWater, 2009).

Surveys for wildlife, wildlife habitat, and migratory birds were conducted during 2007 and 2008 (Kleinfelder, 2009h). Diurnal pedestrian surveys were conducted along transects and the presence of wildlife and/or their sign was documented. Night-time observation points were located at each corner of the Site and one in the middle of the Site. Nocturnal surveys were conducted during the Fall, Winter, and Spring seasons. A bird survey was conducted each season using point count survey techniques.

In addition to on-site surveys, much of the following information about species and their potential occurrence on-site was obtained from databases that have been developed by the Colorado Division of Wildlife Natural Diversity Information Source (CDOW, 2009f) and game species harvest reports and big game population estimates (CDOW, 2009g) including spatial data provided in GIS formats. In addition, relevant state and federal agency reports and published literature and databases were reviewed, compiled, analyzed, and synthesized to develop the species' profiles provided in these sections to supplement results of on-site surveys.

Big Game. The Site coincides with Game Management Unit (GMU) 70. Mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), black bear (*Ursus americanus*), and cougar (*Felis concolor*) are all big game species hunted within GMU 70. GMU 70 is part of a larger area, a Data Analysis Unit or DAU, which is a combination of one or more GMUs that represent a relatively discrete herd or population. Although the geographic area covered by a GMU is the same for each of the species, areas associated with DAUs are different for each big game species. A resident population of pronghorn (*Antilocapra americana*) also occurs within GMU 70, but no occupied pronghorn range coincides with the Site. The closest pronghorn range is over 4 miles south of the Property boundary, in the Dry Creek Basin. However, access routes from mines to the mill pass through pronghorn winter habitats.

The Site is entirely within mule deer overall range, mule deer winter range, and mule deer severe winter range. CDOW (see mule deer metadata in CDOW, 2009b) defines severe winter range as an area that supports 90 percent of the animals when annual snow depths are maximal and/or temperatures are minimal in two worst winters out of ten. Access to the Site on SH 90 from its junction with SH 141 west of Naturita is through a mule deer winter concentration area until 2.4 miles east of the Site. In addition, most of the access to the Site on SH 141 and SH 145 in Montrose County is through mule deer winter concentration areas, and all access routes, even those within Mesa and San Miguel counties, pass through extensive portions of mule deer winter range.

Winter concentration areas are parts of winter range where densities of animals are at least 200 percent greater than the surrounding winter range densities during an average of five winters out of ten. The CDOW has mapped approximate 4.6 miles of SH 90 where it passes through the winter concentration area, which corresponds to an area where mule deer traditionally cross the road (a mule deer road crossing area) presenting potential conflicts between mule deer and motorists (CDOW, 2009b). The Site does not coincide with mule deer summer range although much of the access to the Site along SH 141 west of Naturita passes through summer range. Mule deer tracks were observed in the project area during surveys conducted in January 2008 (Kleinfelder, 2009g).

GMU 70 is within Mule Deer DAU 24 along with two other, adjacent GMUs, 711 and 71, which both extend south into Montezuma County. CDOW (2009b) estimated the post-hunt mule deer population within DAU 24 in 2008 at 27,160 deer (Table 3.5-9). Population estimates by CDOW since 2004 appear to indicate a declining mule deer population within DAU 24, but the declining linear trend is not statistically significant (P>0.10).

Table 3.5-9
Population Estimates for Mule Deer and Elk
DAUs and Harvest in GMU 70 in the Vicinity of the Site, 2004 to 2008[1]

Big Game Year	Data Analysis Unit Post-Harvest Population Estimates	Big Game Harvest in Game Management Unit 70			
		Total Harvest	Total Hunters	Total Recreation Days	Average Days per Animal Harvested
Mule Deer	**Deer DAU 24**				
1999	no estimate	916	2,064	7941	8.7
2000	no estimate	1,077	2,107	8828	8.2
2001	no estimate	518	1,281	5394	10.4
2002	no estimate	593	1,053	4032	6.8
2003	no estimate	574	1,055	4,601	8.0
2004	32,560	721	1,129	4,513	6.3
2005	33,740	771	1,160	4,557	5.9
2006	36,710	842	1,230	6,121	7.3
2007	29,680	1,261	1,838	7,559	6.0
2008	27,160	1,373	2,016	9,351	6.8
Elk	**Elk DAU 24**				
1999	no estimate	702	3,162	17,519	25.0
2000	no estimate	1,155	3,927	18,485	16.0
2001	no estimate	872	2,916	13,548	15.5
2002	no estimate	1,074	2,942	13,603	12.7
2003	no estimate	1,262	3,275	15,349	12.2
2004	18,270	1,194	3,389	15,957	13.4
2005	15,160	1,378	4,013	19,382	14.1
2006	18,460	1,458	4,517	23,218	15.9
2007	19,760	1,306	4,193	21,378	16.4
2008	19,530	1,267	4,475	23,348	18.4

[1] Source: CDOW, 2009g.

There are no population estimates over time for mule deer in GMU 70. However, CDOW has provided harvest estimates for mule deer in the GMU since 1999. Among the many statistics available are estimates of total mule deer harvested per year and the total recreation days spent by hunters each year. The two data sets combined were used to derive an estimate of the average number of days hunters spent to harvest a mule deer each year since 1999 (Table 3.5-9). The estimate is an index, similar to a catch-per-unit-effort (CPUE) index often used in fisheries to track population change over time (Ricker, 1975; Malvestuto, 1983); with the assumption that many variables remain constant from year to year, the less time it takes to harvest a deer indicates a higher deer density and larger the population. Though there is

considerable year-to-year variation, the average number of days required to harvest a mule deer within GMU 70 appears to have been decreasing since 1999 (Figure 3.5-3), which may be interpreted as an increasing number of mule deer during that time in GMU 70, but perhaps not within the more-encompassing DAU 24.

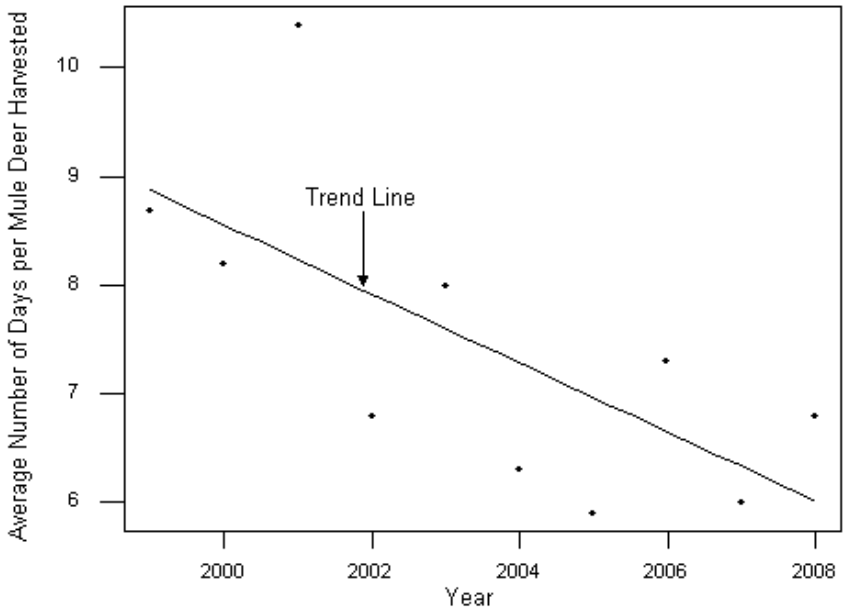


Figure 3.5-3
Trend for Harvest of Mule Deer per Unit Effort (Days per Deer Harvested) in GMU 70 Since 1999 (r^2 = 0.467, P = 0.029)
Source: CDOW, 2009b

In 2008, 1,373 male mule deer were harvested in GMU 70 (Table 3.5-9); 2,016 hunters spent 9,351 recreational days to harvest the 1,373 bucks, averaging 6.8 days per deer harvested in 2008. In 1999, hunters spent an average of 8.7 days per mule deer harvested (7,941 recreational days to harvest 916 mule deer) in GMU 70. The shorter amount of time required to harvest each deer in 2008 is consistent with an increasing population since 1999 (Table 3.5-9).

Similar to mule deer, elk in the vicinity of the Site utilize the entire Site as winter range and as severe winter range. In addition, a small area (1,341 acres) of elk winter concentration range coincides with most of the Site. As with mule deer, elk winter concentration areas are parts of winter ranges where densities of animals are at least 200 percent greater than the surrounding winter range densities during an average of five winters out of ten. All of the access routes in Montrose County and most of the access to the Site through Mesa and San Miguel counties on SHs 90, 141, and 145, pass through elk winter range and elk severe winter ranges. No elk summer range is in the project vicinity, although a small resident herd of elk utilizes an area about 5.5 miles northwest of the Site, in the vicinity of Bedrock. Elk tracks were observed in the project area during January 2008 surveys and one cow elk was seen during the May 20, 2008 survey (Kleinfelder, 2009h).

Elk are also harvested within GMU 70; however, elk in GMU 70 are within Elk DAU 24, which encompasses five GMUs and extends from Montrose County south, to Montezuma County and the borders with Utah and New Mexico, a much larger geographic area than Mule Deer DAU 24. The post-hunt elk population in DAU 24 was 19,530 in 2008, an increase from 18,270 elk in 2004 (Table 3.5-9). However, there is no statistically significant trend in the elk population over time (P>0.10). Likewise, there is no apparent trend in the average number of days spent by

hunters to harvest an elk in GMU 70 since 1999 (Table 3.5-9). In 2008, a total of 1,267 elk (666 bulls, 563 cows, and 38 calves) were harvested by all means in GMU 70. A total of 4,475 hunters spent 23,348 recreation days to harvest that many elk for an average of 18.4 days per elk harvested (Table 3.5-9).

The entire Site coincides with habitats utilized by black bears (black bear overall range). An area coinciding with most of Naturita (approximately 10 miles from the Site) is one of recurrent human conflicts with black bears, where two or more confirmed black bear complaints per season were received resulting in CDOW investigations, damage to persons or property (cabins, tents, vehicles, etc), and/or the removal of the problem bear(s) (CDOW, 2009b). The Site is within cougar (mountain lion) overall range, but no conflict areas with cougars have been delineated in Naturita, although scattered incidences of conflicts have occurred in the vicinity of the Site, including near the town of Paradox. No observations of black bear or cougar or their sign were reported during on-site wildlife surveys (Kleinfelder, 2009h; WestWater, 2009).

Harvest of black bears within GMU 70 has been variable since 2000, ranging from 23 in 2002 to 5 in 2004. Fourteen boars and four sows were harvested in GMU 70 in 2008, while nine boars and five sows were harvested in 2007. Likewise, harvest of cougars in the GMU ranged from 13 in 2008 to 5 in 2002 (CDOW, 2009g).

Small Game. Small game includes a variety of mammal and bird species. Harvest is compiled by county rather than by GMU. Furbearers are classified as small game and include bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and raccoon (*Procyon lotor*), all of which have been harvested within Montrose County. Other mammals harvested as small game within Montrose County include desert cottontail and mountain cottontail (*Sylvilagus audubonii* and *S. nuttallii*, respectively), jackrabbits (*Lepus californicus* and/or *Lepus townsendii*), snowshoe hares (*Lepus americanus*), squirrels (pine squirrel – *Tamiasciurus hudsonicus*, and Abert's squirrel – *Sciurus abertii*), marmots (*Marmota flaviventris*), and prairie dogs (*Cynomys* sp.). Numerous bird species are harvested as small game in Montrose County, including ring-necked pheasants (*Phasianus colchicus*), chukar (*Alectoris chukar*), Gambel's quail (*Callipepla gambelii*), bobwhite quail (*Colinus virginianus*), blue (dusky) grouse, (*Dendragapus obscurus)* and mourning doves (*Zenaida macroura*), but only those included in Table 3.5-10 were identified as harvested in Montrose County during the 2007-2008 harvest year and, based on their distributions, are likely to occur in or near the Site to provide a comparison of harvest effort among the various species.

Table 3.5-10
Comparative Harvest of Small Game Species
within Montrose County during the 2007-2008 Harvest Year[1]

Small Game	Total Harvest	Total Hunters	Total Recreation Days	Average Days per Animal Harvested
Mammals				
Cottontail	2,235	362	2,291	1.0
Coyote	777	404	2,616	3.4
Birds				
Blue Grouse	738	332	1,409	1.9
Mourning dove	2,535	167	725	0.3
Pheasant	179	120	374	2.1
Bobwhite Quail	30	15	15	0.5

[1] Source: CDOW, 2009g.

Cottontail rabbits were the most hunted small game mammals, although more recreational days were spent harvesting coyotes in 2007-2008. Harvest of other small game mammals was not

reported. Coyotes, cottontails, and black-tailed jackrabbits were seen on-site during summer 2007 and spring 2008 surveys, and cottontails and jackrabbits were present on-site during fall 2007 and winter 2008 surveys, as well (Kleinfelder, 2009h). Coyote and bobcat tracks were observed in damp soil in the vicinity of a recent well drilling site on the property during August, 2009. Bobcats have been harvested in Montrose County but harvest data has not been reported since 2002-2003. Desert cottontail and black-tailed jackrabbit were also observed during the August 2009 survey (WestWater, 2009).

Mourning doves were by far the most harvested game bird species in Montrose County in 2007-2008. Mourning doves occur within the project area; however, other harvested bird species in Table 3.5-10 are not expected; two mourning doves were observed on-site during summer 2007 and four were reported during spring 2008 surveys (Kleinfelder, 2009h). Mourning doves were also seen on-site in August 2009 (WestWater, 2009).

Waterfowl and Turkeys. Ducks, geese, and swans are classified as waterfowl rather than small game. Western Colorado and the Site are within the Pacific Flyway, though there may be some intermingling with waterfowl migrations along the Central Flyway (Bellrose, 1980 and Flyways, 2009). Harvest data for light geese are compiled on a statewide basis by CDOW. In 2008, 5,228 light geese were harvested south of Interstate-70 and 8,508 were harvested north of Interstate-70; all harvest reports in the state were for areas east of Interstate-25 (CDOW, 2009g). No waterfowl harvest specifically within western Colorado has been reported. Suitable habitat for most waterfowl is limited to the Dolores River and possibly the small impoundment at the Site. CDOW (2009g) has defined riparian zones along the San Miguel and Dolores rivers as snow goose (*Chen caerulescens*) production areas in which nesting and brooding geese occur, and as snow goose winter range used by geese from November 1 through March 1 for winter loafing, resting, and foraging (see geese metadata in CDOW, 2009b). The northern Paradox Valley, approximately 8.5 miles northwest of the Site, which includes multiple tributaries to West Paradox Creek, is mapped as winter range, production areas, and snow goose foraging habitat.

Merriam's turkey (*Meleagris gallopavo*) is in its own harvest category. CDOW (2009b) has mapped seasonal habitats occupied by Merriam's turkey but the Site does not coincide with any. Overall range occupied by turkeys is found along the Dolores River corridor downstream from the confluence with the San Miguel River. Access to the Site on SHs 141 and 145 passes through turkey overall range. No observations of waterfowl or turkeys or their sign were reported during on-site wildlife surveys (Kleinfelder, 2009h).

Migratory Birds. The Migratory Bird Treaty Act (MBTA) of 1918, as amended, implements treaties for the protection of migratory birds. The Act prohibits hunting, taking, capturing, killing, possessing, selling, purchasing, shipping, transporting, or exporting migratory birds, parts, nests, and eggs, covered by the Act. Non-native birds are not covered by the MBTA.

Executive Order (EO) 13186 issued in 2001 directs actions that would further implement the MBTA. This includes requiring federal agencies to develop a Memoradum of Understanding (MOU) with the USFWS through which each agency would promote the conservation of migratory bird species. As of late 2007, the BLM had not established a national MOU with the USFWS but had developed interim guidelines to consistently address migratory bird populations and habitats until a MOU is in place (BLM, 2007). BLM requires analysis of project effects to migratory birds in every National Environmental Policy Act (NEPA) analysis. Focus should be on effects to migratory bird species of concern that are within local Bird Conservation Areas (U.S. North American Bird Conservation Initiative - NABCI Committee, 2000). BLM guidance includes consideration of goals and objectives set out in various existing bird conservation strategies including those provided by Partners in Flight (PIF) Bird Conservation Plans. In EO 13186,

federal agencies are instructed to identify when unintentional take may have a negative effect on migratory bird populations in order to develop methods that may lessen take, focusing on species of concern, priority habitats, and key risk factors. The requirements of EO 13186 are included in this ER to be consistent with the EO implementation by federal agencies.

Colorado Partners in Flight (CPIF) developed a conservation plan for the various physiographic regions that coincide with the state, including the Colorado Plateau region (with which the Site coincides) and the adjacent Southern Rockies region, and specified strategies to implement the plan in habitats that support priority focal species (Beidleman, 2000). There are two habitats that are within the Site or adjacent to it, pinyon-juniper and sagebrush shrubland. Both habitats are included in CPIF's plan that identifies priority species and habitats, and establishes objectives for preserving or conserving bird populations and their habitats in Colorado. Mixed grassland habitat that is also found within the Site is not included in conservation plans for either the Colorado Plateau or the Southern Rockies regions (Beidleman, 2000). Focal land bird species associated with each of the two habitats and recent population trends (1993-2007) at the local level (based on 14 Breeding Bird Survey - BBS routes) and the regional level are provided in Table 3.5-11 (Sauer et al., 2008).

Table 3.5-11
Focal Land Bird Species Associated with Habitats within the Site with Regional and Local Population Trends (with levels of significance)

Habitat	Focal Land Bird Species	Population Trend Estimates, Past 15 Years		
		Pinyon-Juniper Woodlands[1]	Southern Rockies[1]	Local [2]
Pinyon-Juniper Woodland	Black-chinned Hummingbird *Archilochus alexandri*	Decreasing (P<0.10)	No trend (P>0.10)	Insufficient Data
	Gray Flycatcher *Empidonax wrightii*	Increasing (P<0.10)	Increasing (P<0.10)	Insufficient Data
	Cassin's Kingbird *Tyrannus vociferans*	No trend (P>0.10)	Increasing (P<0.05)	Insufficient Data
	Gray Vireo *Vireo vicinior*	Increasing (P<0.05)	No estimate	Insufficient Data
	Pinyon Jay *Gymnorhinus cyanocephalus*	Decreasing (P<0.10)	No trend (P>0.10)	No trend (P>0.10)
	Juniper Titmouse *Baeolophus griseus*	No trend (P>0.10)	No trend (P>0.10)	Insufficient Data
	Black-throated Gray Warbler *Dendroica striata*	No trend (P>0.10)	No trend (P>0.10)	Increasing (P<0.01)
	Scott's Oriole *Icterus parisorum*	No trend (P>0.10)	No estimate	Insufficient Data
Sagebrush Shrubland	Northern Sage Grouse *Centrocercus urophasianus*	No estimate	No estimate	No Data
	Gunnison Sage-Grouse *Centrocercus minimus*	No estimate	No estimate	Insufficient Data
	Brewer's Sparrow *Spizella breweri*	Decreasing (P<0.001)	No trend (P>0.10)	Decreasing (P<0.01)
	Sage Sparrow *Amphispiza belli*	No trend (P>0.10)	Decreasing (P<0.005)	Insufficient Data

[1] Regional trend analysis from USGS, Patuxent Wildlife Research Center (Sauer et al., 2008).
[2] Local trend analysis from National Biological Survey BBS routes in Rio Blanco, Garfield, Mesa, and Delta counties.

On a regional scale, three focal land bird species within habitats coinciding with the Pinyon-Juniper Woodlands region have statistically significant decreasing population trends since 1993 (two in pinyon-juniper habitat, and one in sagebrush shrubland habitat). Data compiled for the Southern Rockies region indicates that only one species (Brewer's sparrow in sagebrush shrubland habitat) has a statistically significant declining trend (Table 3.5-11);Brewer's sparrow

populations appear to be statistically significantly decreasing (P<0.01) on a local level, including the Site.

Data compiled for 14 National Biological Survey BBS routes in the project area vicinity [Mesa (2 routes), Montrose (3 routes), Delta (1 route), and San Miguel (2 routes) counties in Colorado, and San Juan (3 routes) and Grand (3 routes) counties in Utah] reveal 176 bird species have been observed on one or more routes since 1980 (Sauer et al., 2008). Of those, 124 species are listed as Neotropical migratory birds by the USFWS, Division of Bird Habitat Conservation, pursuant to the Neotropical Migratory Bird Conservation Act. Based on data from the 14 BBS routes, 18 species of Neotropical migratory birds have statistically significant declining (P<0.1) population trends (numbers observed per BBS route each year) during the past 15 years in the region surrounding the Site. Alternatively, four species of Neotropical migratory birds have statistically significant increasing (P<0.1) trends in the region during that period.

Species identified as Birds of Management Concern (BMC – a subset of all species protected under MBTA) include species listed under ESA, species with declining populations that were identified by USFWS (2008) as Birds of Conservation Concern (BCC), and various other species for which focused management was judged to be necessary. BCC within Bird Conservation Region 16 (Southern Rockies/Colorado Plateau region) include species identified as BCC that have been observed on BBS routes in the region surrounding the Site. Those species include Gunnison Sage-grouse, bald eagle, golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), long-billed curlew (*Numenius americanus*), burrowing owl, Lewis' woodpecker (*Melanerpes lewis*), willow flycatcher (*Empidonax traillii*), pinyon jay, juniper titmouse, veery (*Catharus fuscescens*), Brewer's sparrow, and Cassin's finch (*Carpodacus cassinii*). However, based on species' known distributions and habitats present, long-billed curlew, veery, Cassin's finch, and willow flycatcher are not expected to occur within any portions of the project area. One BCC species was observed during the August 2009 survey. A pair of juniper titmice was observed in the woodlands on the southeast side of the 80-acre parcel and suitable habitat for the species coincides with pinyon-juniper woodlands in the project area (WestWater, 2009).

Non-game Wildlife. CDOW (2009b) compiled a list of wildlife species that are expected to occur in Montrose County. For each species, the associated habitat types that occur within the project area were identified from species-habitat linkages developed by the CDOW (2009b) in their NDIS database with species' life-history profiles and distributions within the state (CDOW, 2009b). A total of 357 terrestrial vertebrate species are listed in NDIS for Montrose County of which 322 are known to occur (6 amphibian species, 18 reptiles, 223 birds, and 75 mammal species).

There are three habitat types within the project area: pinyon-juniper woodland, sagebrush shrubland, and mixed grassland. Open water is also present at a small retention pond located within the Site. However, no wildlife species have been reported at or in the pond (Kleinfelder, 2008c, 2009h; WestWater, 2009), and it is not included here as wildlife habitat for non-game species that otherwise might occur in the project area.

Based on the three habitat types present and the distribution of non-game species within Montrose County (not counting various game species discussed above and the sensitive species included in Table 3.5-8 in Section 3.5.2.3, above), there could be 23 species of reptiles, 65 species of birds, and 23 species of non-game mammals within the project area and vicinity (CDOW, 2009b).

Some non-game wildlife species potentially occur only in one habitat present while others are ubiquitous and potentially could occur in every habitat defined in the project area and vicinity. Most non-game species occur within the pinyon-juniper habitat on-site (Table 3.5-12), though not every species that could potentially occur in these and other habitats is expected to actually occur in the project area.

Table 3.5-12
Number of Nongame Wildlife Species Occurring within Montrose County that are Associated with Habitats[1] in the Project Area

Habitat	Amphibians	Reptiles	Birds	Mammals	Species Total
Pinyon-Juniper Woodland	0	5	32	10	47
Sagebrush Shrubland	0	3	18	9	30
Mixed Grasslands	0	3	15	4	22

[1] NDIS data from CDOW, 2009b.

Several of the wildlife species included in the totals of Table 3.5-12 have been observed in the project area during surveys conducted in 2007 and 2008 (Kleinfelder, 2009h) and in August 2009 (WestWater, 2009). Those species are included in Table 3.5-13, though several species reported in one cited report (Kleinfelder, 2009h) have been omitted because their distributions do not include Montrose County and/or Colorado.

Table 3.5-13
Non-game Wildlife Species Observed within the Project Area During On-Site Surveys

Common Name	Scientific Name	Season(s) Observed [1]
Reptiles		
Collared Lizard	*Crotaphytus collaris*	Summer 2009
Fence Lizard	*Sceloporus undulates*	Summer 2007, Spring 2008
Sagebrush Lizard	*Sceloporus graciosus*	Summer 2009
Short-horned Lizard	*Phrynosoma hernandesi*	Summer 2007
Western Whiptail	*Cnemidophorus tigris*	Summer 2009
Birds		
American Crow	*Corvus brachyrhynchos*	Spring 2008
Broad-tailed Hummingbird	*Selasphorus platycercus*	Summer 2009
Cliff Swallow	*Petrochelidon pyrrhonota*	Summer, Fall 2007
Common Raven	*Corvus corax*	Summer 2009
Dark-eyed Junco	*Junco hyemalis*	Winter 2008, Summer 2009
Dusky Flycatcher	*Empidonax oberholseri*	Summer 2007
European Starling	*Sturnus vulgaris*	Spring 2008
Golden Eagle	*Aquila chrysaetos*	Summer 2009
Juniper Titmouse	*Baeolophus griseus*	Summer 2009
Lark Sparrow	*Chondestes grammacus*	Summer, Fall 2007, Spring 2008
Loggerhead Shrike	*Lanius ludovicianus*	Summer 2007, Summer 2009
Mountain Bluebird	*Sialia currucoides*	Summer 2009
Rock Wren	*Salpinctes obsoletus*	Summer 2009
Sharp-shinned Hawk	*Accipiter striatus*	Summer 2007
Western Meadowlark	*Sturnella neglecta*	Summer 2007, Spring 2008
Western Scrub Jay	*Aphelocoma californica*	Summer 2007
Mammals		
Kangaroo Rat	*Dipodomys ordii*	Spring 2008
Mice	*Peromyscus* sp.	Spring 2008
Bats	Unknown	Fall 2007

[1] Sources: Summer, Fall 2007 and Winter, Spring 2008 - Kleinfelder, 2009h; Summer 2009- WestWater, 2009.

Bird surveys were conducted each season in 2007 and 2008 by means of point count surveys that allow determinations of bird species diversity. The four-season point count bird survey

observed 196 individual birds at 30 sample point locations. In a total of 77 point count surveys, the species observed were lark sparrows, dusky flycatchers, cliff swallows, western scrub-jays, a ruby-throated hummingbird, western meadowlarks, a loggerhead shrike, mourning doves, dark-eyed juncos, American crows, and a European starling (Table 3.5-13; and Appendix A in Kleinfelder, 2009h). The Simpson's Diversity Reciprocal Index yielded a value of 3.05 for the combined observations during the four seasonal surveys. The spring survey yielded an index value of 2.91 on a scale that ranges from zero to eleven. This result suggests that the diversity of birds on-site is higher in the spring than in the summer, fall, and winter seasons, because observations during those seasons yielded diversity index values of 2.12, 1.99, and 1.0, respectively (Kleinfelder, 2009h).

3.5.3.2 Aquatic Species

There are no permanently flowing waterbodies within the Site. Nine ephemeral drainages on-site have been described as discontinuous; however, the ephemeral drainage crossing the northwest portion of the Site appears to have connections to East Paradox Creek (Kleinfelder, 2008c). No Aquatic Species or habitats occur within the Site.

Several species of native non-game fish are possible within East Paradox Creek if flows are sufficient to provide habitat, and downstream in the Dolores River. Speckled dace (*Rhinichthys osculus*) likely inhabit riffles and gravel substrates, longnose suckers (*Catostomus catostomus*) inhabit pools and riffles, and mottled sculpins (*Cottus bairdii*) are associated with cobbles and rubble bottoms of cool clear streams (Woodling, 1985). Native flannelmouth suckers and roundtail chubs may be present but are more typical inhabitants of larger streams, including the Dolores River. Flannelmouth suckers and roundtail chubs are BLM-sensitive species and Colorado species of concern (see Table 3.5-8 in Section 3.5.2.3). Other species including fathead minnows (*Pimephales promelas*) and white suckers (*Catostomus commersoni*) may also be present. They are native to Colorado, but were originally restricted to eastslope streams. Over time, they and many other fish species have been introduced to the upper Colorado River Basin.

3.6 METEOROLOGY, CLIMATOLOGY, AND AIR QUALITY

Kleinfelder prepared a *Work Plan for Ambient Air Monitoring Energy Fuels Resources Corporation Uranium Mill Licensing Support Piñon Ridge Mill* – Work Plan (Kleinfelder, 2008d). The Work Plan was submitted to CDPHE for review and comment and formed the basis for baseline data collection at the Site.

Three air monitoring stations and two meteorology towers on the Site and two additional off-site air monitoring stations were installed and monitored starting in March 2008. The baseline analysis presented here is based on the first four quarters of baseline data collected at the Site (April 2008 through March 2009). The monitoring sites for the project were chosen according to NRC and EPA guidance (NRC, 1988 and EPA, 2000).

Selection of monitoring station locations is based on both pre-operational and operational air monitoring criteria set forth in NRC RG 4.14 (NRC, 1980a). Three monitoring locations were located near the Property Boundary. A fourth location was selected as a background location and was located to the northwest and a fifth location was selected at the nearest residence located to the southeast.

Monitoring sites 1 and 2 are equipped with meteorological, particulate matter less than 10 microns (PM_{10}), and radionuclide monitoring instrumentation, while sites 3, 4, and 5 only support radionuclide monitoring. Site 1 is located near the Property Boundary on the north, and has a

10-meter tower with meteorological sensors, and precipitation and evaporation gauges. Site 2 is near the eastern edge of the Property Boundary and has meteorological sensors on a 30-meter tower. Site 3 is near the western edge of the Property Boundary. Site 4 is located upwind in accordance with NRC guidance and is approximately 2 miles northwest of the Site near SH 90. Site 5 is located at the nearest residence in accordance with NRC guidance and is in a downwind location approximately 3 miles southeast of the Site. The locations of the air and meteorological monitoring sites are provided in Figure 3.6-1 and mapping coordinates are provided in Table 3.6-1.

Table 3.6-1
Monitor Site Locations[1]

Site ID	UTM Zone 12 (NAD 83)	
	Easting	**Northing**
Site #1 (North Site) – 10m Tower	695211.43	4237487.24
Site #2 (East Site) – 30m Tower	695930.42	4235452.56
Site #3 (West Site)	694443.09	4235724.28
Site #4 (Cooper Site) – Upwind (Background)	691782.99	4239297.89
Site #5 (Carver Site) – Downwind Resident	700135.95	4232939.27

[1] Source: Kleinfelder, 2009i.

Data from the monitoring sites were summarized in quarterly reports (Kleinfelder, 2008e-g and Energy Fuels, 2009g). The quarterly reports include data recovery statistics, analysis of the data, details about station operations, and audit and calibration reports. The results from the quarterly reports are combined in the *Meteorology, Air Quality, and Climatology Report* (Kleinfelder, 2009i).

3.6.1 Meteorology

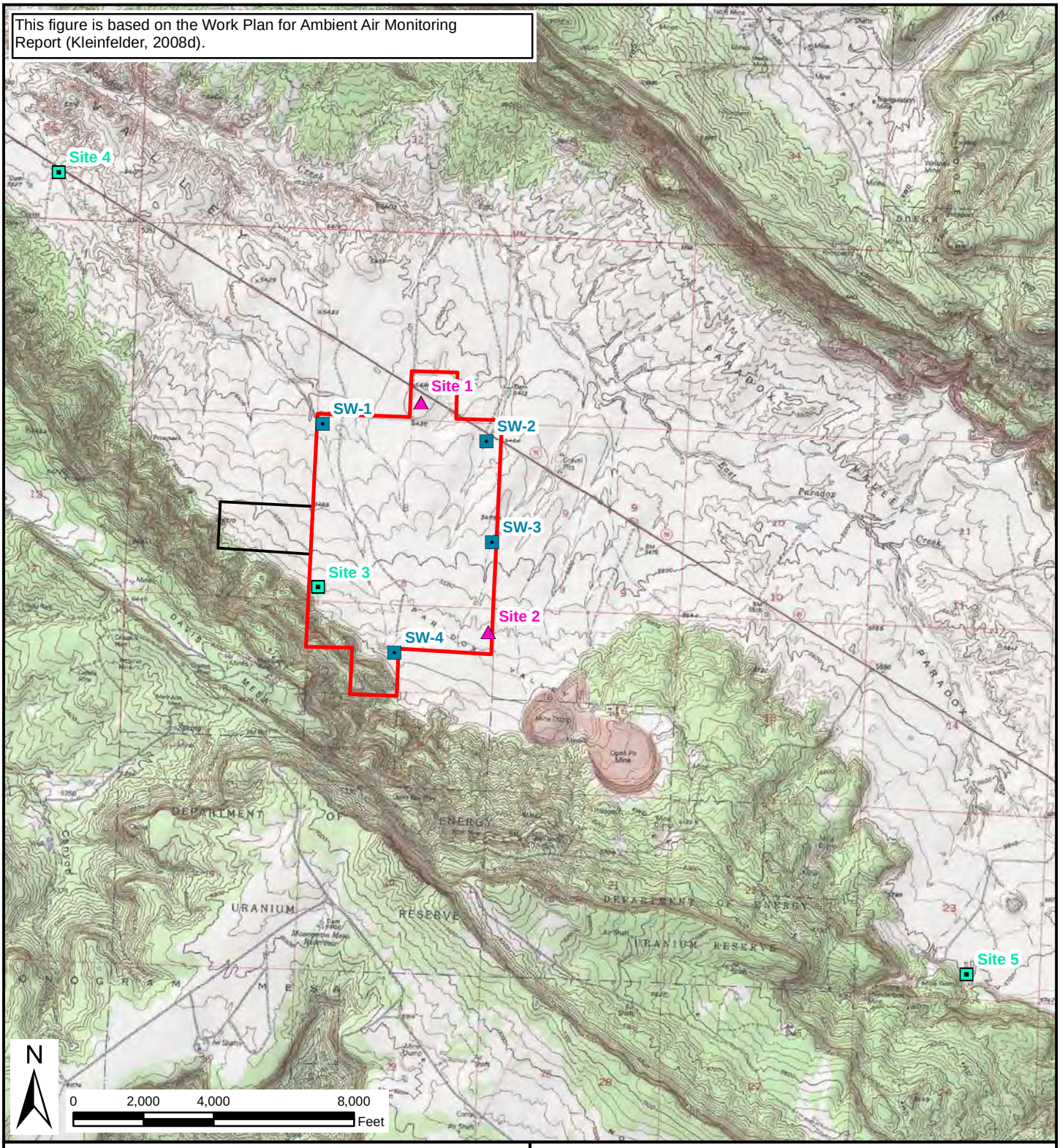
The meteorological sensors were operated based on EPA guidance (EPA, 2000). A summary of the monitoring guidelines and the specifications for the instruments are outlined in the Work Plan (Kleinfelder, 2008d). The parameters monitored by the sensors are provided in Table 3.6-2.

Table 3.6-2[1]
Parameters Monitored by EFR Meteorological Sensors

Site #1 (10-meter tower)	Site #2 (30-meter tower)
Wind Speed	Wind Speed
Wind Direction	Wind Direction
Temperature (2 meters and 10 meters)	Temperature (2 meters and 10 meters)
Delta Temperature	Delta Temperature
Relative Humidity	Relative Humidity
Solar Radiation	Solar Radiation
Barometric Pressure	Barometric Pressure
Precipitation	----
Evaporation	----

[1] Source: Kleinfelder, 2009i.

Site Data Summary. Monthly summaries of the 2-meter temperature, relative humidity, solar radiation, wind speed, and maximum wind gust collected at sites 1 and are shown in Table 3.6-3.



Meterological Tower, PM10 Samplers, & Radionuclide Monitoring

Radionuclide Monitoring Only

Surface Water Sampler Location and ID (Includes Manual Rain Gauge)

Property Boundary

Well Field Boundary

Figure 3.6-1

Air and Meteorological Monitoring Sites

Table 3.6-3
Monthly Meteorology Data from Sites 1 and 2[1]

Monitoring Quarter	Month	Site	Temp[2] 2m °F	Relative Humidity %	Solar Radiation W/m²	Solar Radiation Kwh/m²	Wind Speed mph	Max Wind Gust Mph
Q2 2008 (Q1 baseline)	Apr 2008	Site 1	48.3	29.6	285.23	205.4	8.5	55.3
		Site 2	49.0	28.1	282.88	203.7	8.1	57.6
	May 2008	Site 1	57.1	34.9	297.36	221.2	8.1	61.7
		Site 2	57.7	33.0	300.51	223.6	8.0	51.2
	June 2008	Site 1	70.1	21.6	342.03	246.3	7.6	55.7
		Site 2	70.8	20.3	338.39	243.6	7.2	57.9
Q3 2008 (Q2 baseline)	Jul 2008	Site 1	76.2	32.9	291.75	217.1	6.5	42.0
		Site 2	76.7	31.5	288.03	214.3	6.5	47.6
	Aug 2008	Site 1	74.1	34.0	279.35	207.8	6.4	49.2
		Site 2	74.7	32.4	277.98	206.8	6.2	43.0
	Sep 2008	Site 1	64.0	34.8	241.30	173.7	5.9	45.6
		Site 2	65.1	32.1	240.61	173.2	5.5	50.1
Q4 2008 (Q3 baseline)	Oct 2008	Site 1	51.4	37.2	173.97	129.4	6.0	54.4
		Site 2	52.6	34.7	175.46	130.5	5.4	59.7
	Nov 2008	Site 1	40.2	50.5	125.49	90.4	4.3	48.0
		Site 2	41.7	47.7	121.73	87.6	3.7	49.9
	Dec 2008	Site 1	27.7	70.5	96.53	71.8	5.2	50.8
		Site 2	28.6	67.3	91.25	67.9	5.0	53.1
Q1 2009 (Q4 baseline)	Jan 2008	Site 1	27.5	69.5	120.56	89.7	4.0	45.5
		Site 2	28.2	66.3	114.86	85.5	3.2	43.8
	Feb 2008	Site 1	35.8	54.1	160.59	107.9	5.6	47.0
		Site 2	36.5	51.1	155.01	104.2	5.2	43.8
	Mar 2008	Site 1	43.5	39.0	215.22	160.1	7.8	57.3
		Site 2	44.0	37.3	212.23	157.9	7.3	63.5

[1] Source: Kleinfelder, 2009i.
[2] Temperature from the 2-meter instruments at both site 1 and 2.

Evaporation. Monthly total pan evaporation data collected at Site 1 between April and October 2008 are presented in Table 3.6-4. Pan evaporation measurements were not taken during the months when freezing conditions interfered with the measurements. The total pan evaporation for the 7-month period is 55.26 inches.

Table 3.6-4
Summary of Evaporation Data[1,2]

Monitoring Period	2008 Apr	May	Jun	Jul	Aug	Sep	Oct
Inches	6.64	7.40	10.84	10.12	10.06	6.31	3.89

[1] Source: Kleinfelder, 2009i.
[2] The evaporation instrument was taken offline to avoid freezing, thus, measurements were not collected for November through March 2009.

Precipitation. Monthly and annual total precipitation data from the sources at the Site (recording gauge at Site 1 and the surface water gauges) are shown in Table 3.6-5 for the 12-month period from May 2008 through April 2009. The precipitation data includes the data collected from the surface water network gauges from May through October 2008 and from the Site 1 precipitation gauge from November 2008 through April 2009. The table also contains precipitation totals from two National Weather Service (NWS) Cooperative Observer Network (COOP) stations and one Remote Automated Weather Station (RAWS) operated by the BLM. These stations include the Uravan and Paradox 2N COOP Stations and the Nucla RAWS station. The COOP and BLM RAWS stations were active during the monitoring program. Other nearby COOP stations in the Paradox Valley were not operating during the monitoring program, but historic data from these stations is discussed in Section 4.6.2, Climatology.

The total precipitation measured at the Site for the 12-month period was 10.01 inches, with monthly totals ranging from 0.20 inches in July to 2.62 inches in December. The total for the 4-month period from September through December 2008 is 6.05 inches, which is 60 percent of the annual total. The annual precipitation totals at the nearby COOP stations during this baseline period were 9.52 and 9.53 inches. These totals are approximately 5 percent less than the annual total measured at the Piñon Ridge Site. With the exception of the winter months, monthly precipitation totals at the Nucla RAWS station were similar to totals from the other stations. The lower values shown at the Nucla RAWS station during December through March may be due to the Nucla gauge being unheated or to natural differences due to terrain exposure and location.

Table 3.6-5
Summary of Precipitation Data[1]

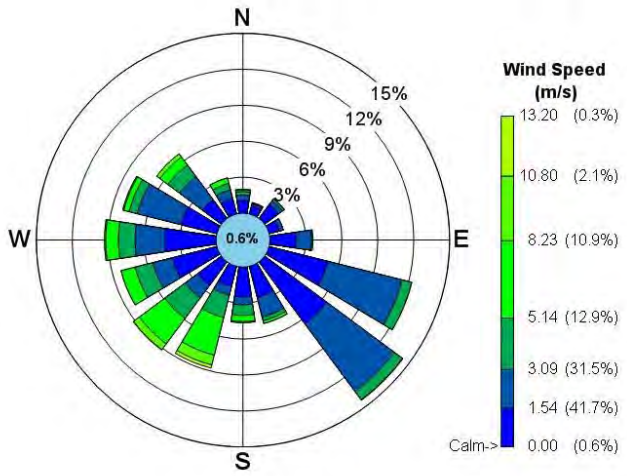
Totals in inches	**Data Sources**			
Period 2008-09	**Mill Site (combined)[2]**	**Uravan**	**Paradox 2N**	**Nucla**
May	0.61	0.73	0.62	0.98
June	0.45	0.42	0.48	0.37
July	0.20	0.13	0.48	0.60
August	0.84	1.79	1.78	1.37
September	1.08	0.38	0.49	0.17
October	1.16	0.69	0.68	0.51
November	1.19	0.89	0.89	0.89
December	2.62	2.72	2.40	0.83
January	0.46	0.27	0.45	0.07
February	0.32	0.36	0.73	0.20
March	0.61	0.59	0.17	0.39
April	0.47	0.55	0.36	0.91
Annual Total	10.01	9.52	9.53	7.29
Difference[3]	----	-4.9%	-4.8%	-27.2%

[1] Source: Kleinfelder, 2009i.
[2] Precipitation data was collected from the surface water network from May to October 2008 and from the Site 1 gauge from November 2008 to April 2009.
[3] The differences of the annual totals relative to the combined data.

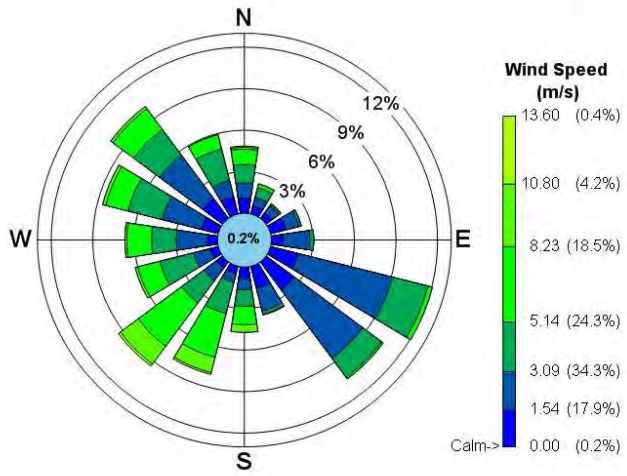
Because the surface water network did not monitor precipitation on an hourly schedule, annual hourly precipitation results are not available for the entire monitoring period. However, a summary of the results from the precipitation gauge at Site 1 has been completed. From November 1, 2008 through April 1, 2009 the precipitation gauge at Site 1 recorded 155 hours with greater than 0.01 inches of precipitation for a total of 5.22 inches. The hourly average precipitation rate for this period was 0.03 inches per hour.

Wind Summary. Wind direction and wind speed are summarized in the “wind rose” presentations which are included in the *Meteorology, Air Quality, and Climatology Report* (Kleinfelder, 2009i). In the wind rose, each hourly measurement of wind direction is assigned to a sixteen-point sector of the compass, and the frequency of occurrence of wind from a direction is proportional to the length of the solid line beginning in the central circle and extending outward. The color bars within each compass direction indicate the frequency of specific wind speeds within each wind direction. Figures 3.6-2 and 3.6-3 show quarterly wind roses for Sites 1 and 2. The quarterly wind roses for Site 1 in Figure 3.6-2 show the nighttime southeast valley flow through each quarter. In Figure 3.6-3, the wind roses for Site 2 indicate that the various westerly winds persist through the entire year. Both sites recorded more measurements with higher wind speeds in the second quarter of 2008 than in the other quarters.

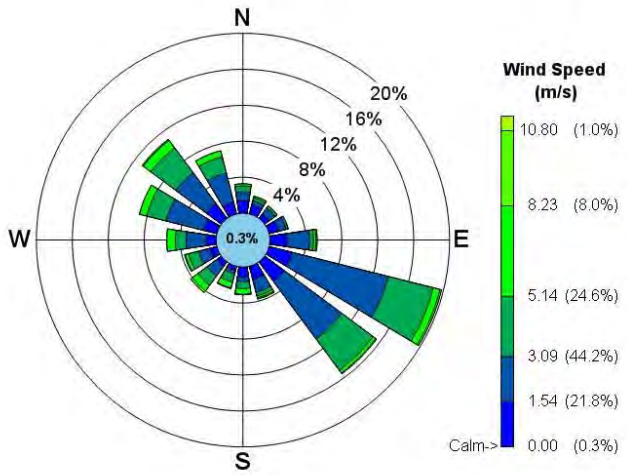
This figure is based on the Meteorology, Air Quality and Climatology Report (Kleinfelder, 2009i).



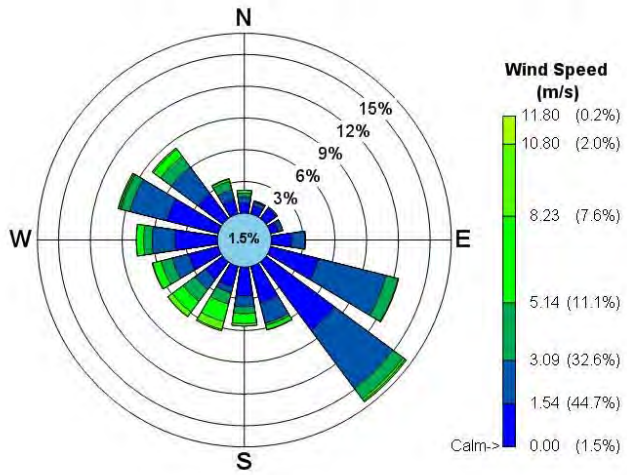
Q2 2008: April 1, 2008 - June 30, 2008 (Q1 baseline)



Q3 2008: July 1, 2008 - September 30, 2008 (Q2 baseline)



Q4 2008: October 1, 2008 - December 31, 2008 (Q3 baseline)

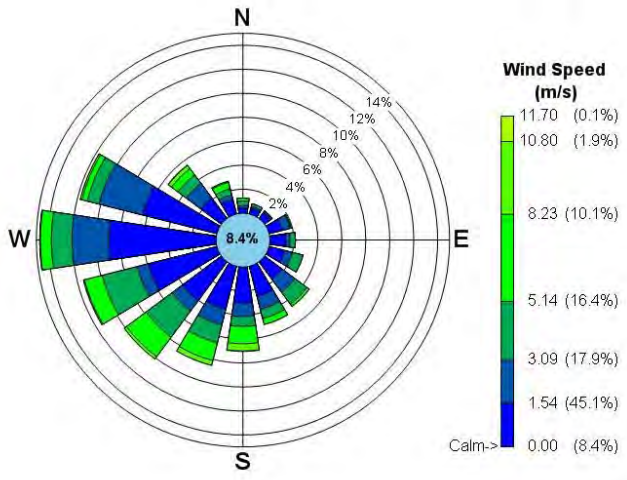


Q1 2009: January 1, 2009 - March 31, 2009 (Q4 baseline)

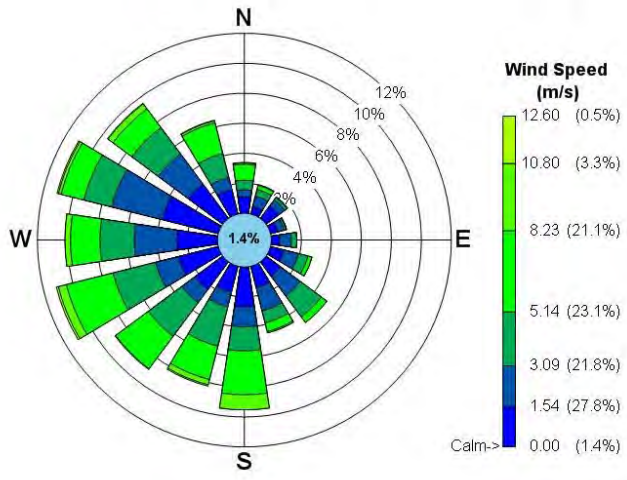
Figure 3.6-2

Site 1 Quarterly Wind Roses
10-m Level, April 2008 through March 2009

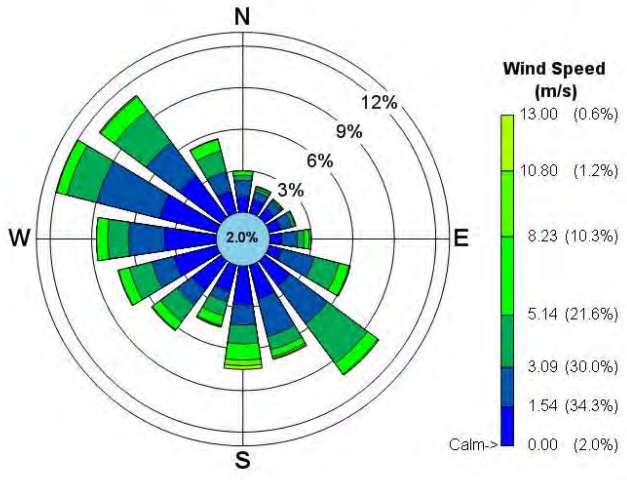
This figure is based on the Meteorology, Air Quality and Climatology Report (Kleinfelder, 2009i).



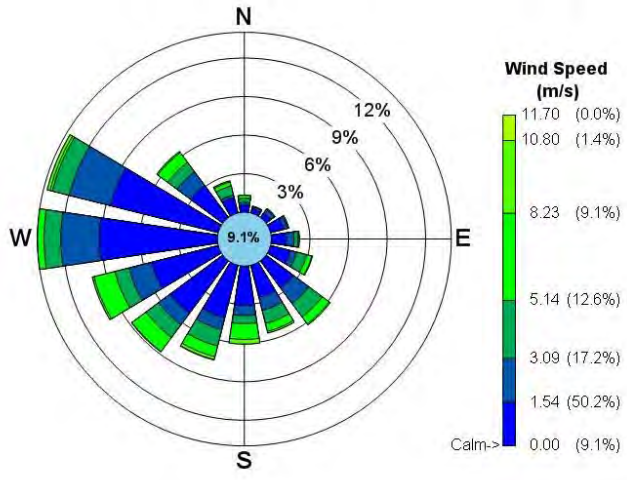
Q2 2008: April 1, 2008 - June 30, 2008 (Q1 baseline)



Q3 2008: July 1, 2008 - September 30, 2008 (Q2 baseline)



Q4 2008: October 1, 2008 - December 31, 2008 (Q3 baseline)



Q1 2009: January 1, 2009 - March 31, 2009 (Q4 baseline)

Figure 3.6-3

Site 2 Quarterly Wind Roses
30-m Level, April 2008 through March 2009

Wind roses are presented in Kleinfelder (2009i) for the annual 10-m winds at Site 1, which is located in the northwest corner of the Site towards the middle of the Paradox Valley and for the annual 30-m winds at Site 2, which is located at the southeast corner of the Site closer to mesas along the southwestern edge of the valley. The various westerly winds with many speed groups are associated with the daytime hours. The wind rose for Site 1 shows two dominant directions (ESE and SE) with very light wind speeds. These are associated with nighttime, stable, drainage breezes that flow parallel along the axis of the Paradox Valley. Site 2 experiences westerly and southwesterly winds during both day and nighttime hours, and the wind patterns do not resemble the persistent nighttime valley flow observed at Site 1. The calm winds at Site 2 are most likely the result of local canyon drainage flows from the mesa located west and southwest of Site 2.

Wind roses for the months in each quarter for Sites 1 and 2 are also presented in Kleinfelder (2009i) and represent a more detailed wind summary for each site. At Site 1, westerly winds with higher speeds were observed in April, May, and June of 2008. March of 2009 recorded similar patterns. The southeasterly breezes were observed in all months, but the calmest conditions were recorded in the months of November, December, January, and February. Similar to Site 1, Site 2 exhibited westerly winds with higher speeds in April, May, and June of 2008, and March of 2009. Calm, nighttime westerly breezes were observed in all months, but the calmest conditions were recorded in November, December, and January.

Atmospheric Stability. Atmospheric stability is typically used for assessing dispersion of emissions, because the stability describes the potential for vertical motion in the atmosphere. Unstable conditions encourage positive vertical motion or movement toward the sky, and stable conditions encourage negative vertical motion or movement toward the ground. Atmospheric stability conditions for Sites 1 and 2 were estimated by Kleinfelder (2009i) using the Solar Radiation/Delta T (SRDT) Method as outlined by EPA (2000). The SRDT method assigns a Pasquill-Gifford Stability Class (P-G Class) to each hourly measurement based on specific conditions of solar radiation, vertical temperature differences, and wind measurements. The P-G Classes range from A through F with A being unstable and F being the most stable.

For daytime hours, P-G Classes are assigned based on solar radiation and wind speed. Lower wind speeds and higher solar radiation result in more unstable conditions while higher wind speeds and lower radiation result in more stable conditions. For nighttime hours, P-G Classes are assigned based on the vertical temperature gradient (Delta T) and the wind speed. At night, only stable conditions (D, E, F) are assigned, but positive vertical temperature conditions and low wind speeds result in very stable conditions. The specific criteria for daytime and nighttime conditions are provided in Table 3.6-6.

The atmospheric stability summary for Sites 1 and 2 is provided in Figure 3.6-4. The data from both sites exhibit similar patterns with neutral to stable conditions being the most frequent. Site 2 does have a larger percentage of hours with very stable conditions than recorded at Site 1. These very stable conditions at Site 2 are most likely a result of the calmer nighttime, canyon winds.

Annual joint frequency tables with wind speed, wind direction, and stability class were produced to describe the wind patterns at Sites 1 and 2. The tables list the occurrence of 16 wind directions as measured in each stability class with specific wind speeds. The joint frequency tables quantitatively summarize the trends described above. The tables are provided in Appendix C in the *Meteorology, Air Quality, and Climatology Report* (Kleinfelder, 2009i).

This figure is based on the Meteorology, Air Quality and Climatology Report (Kleinfelder, 2009i).

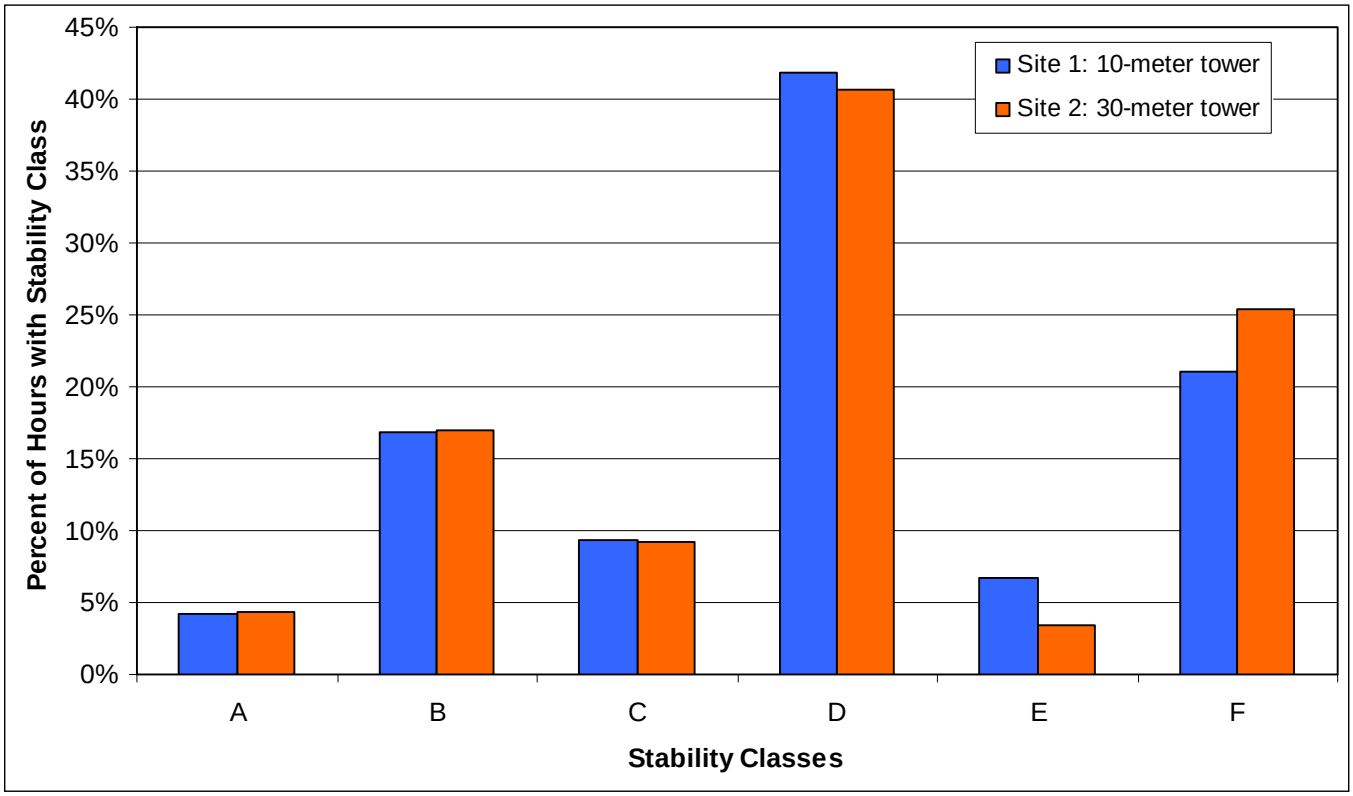


Figure 3.6-4

Summary of Stability Conditions at Sites 1 and 2

Table 3.6-6
SRDT Method Criteria for P-G Stability Classes[1]

Daytime				
Wind Speed (m/s)	**Solar Radiation (W/m^2)**			
	.≥925	925-675	675-135	<175
<2	A	A	B	D
2-3	A	B	C	D
3-5	B	B	C	D
5-6	C	C	D	D
.≥6	C	D	D	D
Nighttime				
Wind Speed (m/s)	**Vertical Temperature Gradient**			
	<0		.≥0	
<2.0	E		F	
2.0 – 2.5	D		E	
.≥2.5	D		D	

[1] Source: Kleinfelder, 2009i.

3.6.2 Climatology

3.6.2.1 Regional Climate Data Sources

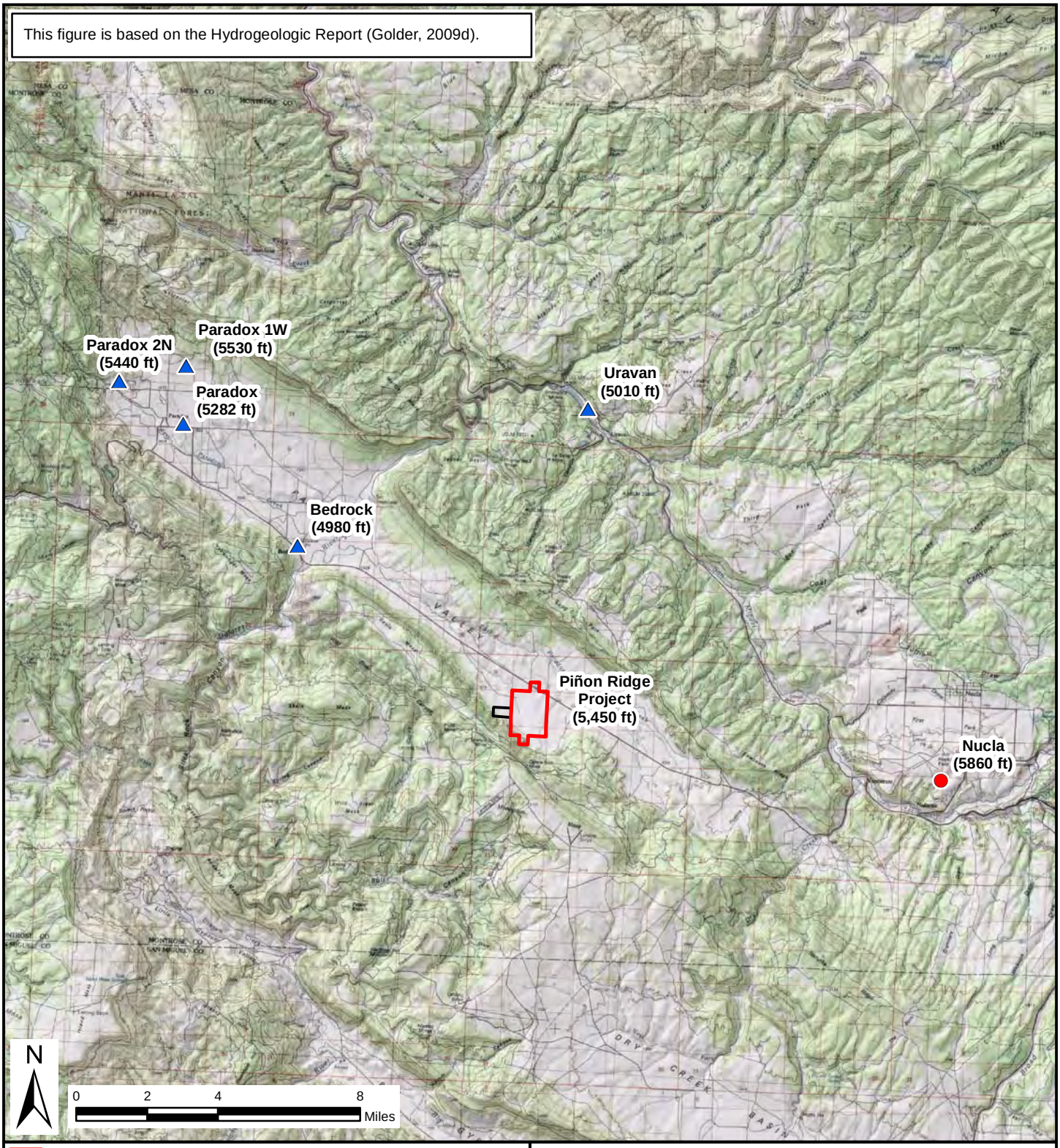
Climate descriptions involve averaging meteorological records over a period of time. The National Oceanic and Atmospheric Administration's National Climatic Data Center uses 30 years of data to calculate the classical "normal" values often used to describe long-term climate conditions. In some cases, climate can be adequately described with shorter or longer periods of records, depending on the purpose of the data. Sources of meteorology data in the region of the Site were evaluated by Kleinfelder (2009i) based on data availability, location, and topography to assess if the station was representative of the Site conditions. The stations chosen as representative of climate conditions at the Site are summarized in Table 3.6-7.

The La Sal, Utah and the La Sal 2 SE, Utah COOP stations, the Big Indian RAWS station, and the evaporation station in Moab, Utah were not considered to be as representative as other sites and were therefore excluded as a basis of climate data because elevation differences can have a large influence on temperatures and precipitation totals. The evaporation station in Moab, Utah was also not used in the analysis due to distance from the Site and elevation.

The locations of the COOP and RAWS sites listed in Table 3.6-7 are shown with the Paradox Valley topography in Figure 3.6-5. The summary tables of the climate data discussed in this section are provided in Appendix D of the *Meteorology, Air Quality and Climatology Report* (Kleinfelder, 2009i).

Data from the COOP sites were obtained from the Western Region Climate Center and are included in the *Meteorology, Climatology, and Air Quality Report* (Kleinfelder, 2009i). The Uravan COOP station was identified as the long-term continuous data source for temperature and precipitation trends at the Site and vicinity. The Nucla RAWS station is the primary source of long-term data for temperature, wind speed, humidity, and solar radiation; however wind direction data from the Nucla RAWS station is not representative of long-term wind directions at the Site. Kleinfelder (2009i) provides discussion and justification for use of data from various COOP sties.

This figure is based on the Hydrogeologic Report (Golder, 2009d).



Property Boundary
Well Field Boundary
Approximate NWS Coop Observers Sites
Approximate BLM RAWS Site

Figure 3.6-5

Climate Data Site Locations

Table 3.6-7
Summary of Meteorology Stations Used for Climate Analysis[1]

Station Type	Site Locations	Elevation (feet)[5]	Period of Record	Available Parameters for Climate Analysis
COOP[2]	Paradox, CO (Pdox1E)	5,282	1948 – 1977	Precipitation[8] Temperature[8]
	Paradox, CO (Pdox1W)	5,530	1977 – 1995	
	Paradox, CO (Pdox2N)	5,440	2005 – 2008	
	Bedrock, CO	4,980	1997 – 2005	
	Uravan, CO	5,010	1960 – 2008	
RAWS[3]	Nucla, CO	5,860	1999 – 2008	Precipitation Temperature[8] Dew Point Temp[8] Relative Humidity[8] Wind Speed[8] Wind Direction Solar Radiation[8] Barometric Pressure
NWS[4]	Grand Junction, CO[6]	4,859	1962-2005	Evaporation[8]
	Montrose-1, CO[7]	5,758	1948-1982	

[1] Source: Kleinfelder, 2009i.
[2] COOP Stations refer to National Weather Service (NWS) Cooperative Observer Network.
[3] RAWS stations refer to the BLM Remote Automatic Weather Station.
[4] NWS stations are official stations operated by NWS offices.
[5]. The Site elevation is approximately 5,450 ft.
[6] NWS at Grand Junction includes information shown for Nucla, CO; only evaporation data were used
[7] NWS evaporation stations Montrose-1 is also a COOP station
[8] Parameters are used in the Site climate analysis.

3.6.2.2 Long Term Statistics and 30-year Normal Values

Climate data from nearby stations relevant to characterizing the Site area are presented in this section, with a focus on precipitation data. In addition to the 30-year normal values often used in climate analyses, data from other time periods are presented when available.

Precipitation Averages and Extremes. The full period of record precipitation data taken at the five COOP stations and the Nucla RAWS station are summarized in Appendix D of the *Meteorology, Climatology, and Air Quality Report* (Kleinfelder, 2009i). The COOP summary tables include the following information:

- Monthly, seasonal and annual mean and extreme totals, and the year the extreme event occurred;
- One-day maximum amounts, with the date it occurred;
- Average number of days that the precipitation total exceeded 0.01, 0.10, 0.50 and 1.00 inches, and
- Average and maximum snowfall accumulation, with the year the monthly maximum occurred.

The data for Uravan (Kleinfelder, 2009i) show the annual average precipitation for the period from 1960 through 2008 is 12.63 inches. Note that the Uravan annual total of 9.52 inches over the baseline monitoring period (Table 3.6-5) was 24.6 percent less than the long-term annual average of 12.63 inches. The extreme annual values range from 7.13 inches in 1989 to 21.40 inches in 1965. The monthly averages range from 0.48 inches in June to 1.51 inches in September. The extreme one-day total was 1.90 inches, which occurred on August 21, 1971. The annual average number of days with measurable precipitation, that is at least 0.01 inch, is 76. The average occurrences of days with precipitation at least 0.10 and 0.50 inch are 39 and 6, respectively. The average annual snowfall is 10.0 inches; the maximum year was 1979, when 40.9 inches of snowfall was measured.

Thirty year normal values for the period 1971-2000 for Uravan, the station identified as the most representative of the Site area, are presented in Appendix D in Kleinfelder (2009i). The precipitation data include monthly and annual mean and extreme totals. The 30-year normal values for the preceding statistics were very similar to the long-term results.

During the baseline year of onsite monitoring, 10.01 inches of precipitation were recorded as representative of the Site area as presented in Section 4.6.1. During the same period, Uravan recorded 9.52, which is 4.9 percent less than the monitored total. Applying the difference observed between the monitored and Uravan annual totals during the monitoring year, -4.9 percent, to the long-term average annual total for Uravan, 12.63 inches, the expected average annual total precipitation for the Site area is 13.28 inches.

Wind and Local Airflow Patterns. Data of the average annual wind speed and maximum wind gusts for the Nucla RAWS station is provided in Appendix C in the *Meteorology, Climatology, and Air Quality Report (*Kleinfelder, 2009i). The average annual wind speed from 1999 through 2008 at the Nucla RAWS station is 5.2 miles per hour (mph). The ten-year monthly averages range from 3.6 mph in December and January to 6.7 mph in April and June.

Extreme values of wind gusts are less likely to show regular patterns than the monthly average and total values that are typically presented. The monthly average wind gusts for the 1999 through 2008 period ranged from 40.3 mph to 54.0 mph, with a tendency for the higher speeds to occur during April through June. The overall maximum gust speed recorded was 76 mph in June 2005. The next highest maximum gust speed was 60 mph in May 2004.

The Nucla RAWS station wind sensor is located approximately 3 meters above ground surface while the Site 1 and 2 wind sensors were installed at 10 meters and 30 meters for Sites 1 and 2, respectively. Average wind speeds typically increase with height. Accordingly, the monthly wind speed averages from Sites 1 and 2 are higher than the Nucla RAWS long-term averages, however, both data sets exhibit similar annual patterns. Both the RAWS station and the data from Sites 1 and 2 record the highest monthly wind speed averages in the months of March, April, May, and June, and the lowest wind speeds are collected during the winter months.

Humidity. Long-term dew-point temperature monthly summaries for the Nucla RAWS station are provided in Appendix D in the *Meteorology, Climatology, and Air Quality Report* (Kleinfelder, 2009i). The overall annual average dew-point temperature at Nucla is 24.8ºF. The monthly mean values range from 16.1ºF in January to 42.8ºF in August.

The average annual relative humidity for the period from 1999 through 2008 at the Nucla RAWS station is 41.9 percent. The monthly averages are provided in Appendix C in Kleinfelder (2009i). June has the lowest monthly average relative humidity, with 22.7 percent. The highest monthly

average is December, with 58.4 percent. This opposite cycle (summer minimum) to the temperature data is, in part, due to the opposite relation between relative humidity and temperature.

For the monitoring period, April 2008 through March 2009, the monthly average relative humidity values at Sites 1 and 2 are very similar to the data from the Nucla RAWS station. The overall average of monthly differences for the Piñon Ridge Sites 1 and 2 compared to the Nucla RAWS Station are 2.4 percent and -0.2 percent, respectively.

Solar Radiation. The monthly total incoming solar radiation values on a flat surface, in langleys (cal/cm^2), were obtained for the Nucla RAWS station. The average monthly values ranged from 6,727 langleys in December to 20,350 langleys in June. To facilitate using this information in the metric form, the values in langleys were calculated in kilowatt-hours per square meter (kwh/m^2) by a multiplication factor of 0.01163. The corresponding average monthly values for the 10-year period in kwh/m^2 were 78.2 in December and 236.7 in June. The monthly totals for each year, and the overall monthly averages of the totals, are summarized in Appendix D in Kleinfelder (2009i).

The comparisons between the Nucla RAWS station and Piñon Ridge Sites 1 and 2 show that measured solar radiation from Sites 1 and 2 occurred within the range of values measured at the Nucla RAWS station.

Evaporation. Kleinfelder (2009i) obtained summaries of pan evaporation data from the two NWS stations to estimate pan evaporation in the region. The Grand Junction data were taken from 1962 through 2005; and Montrose data were taken from 1948 through 1982. A summary of the monthly and annual totals is provided in Appendix D in Kleinfelder (2009i).

The long-term pan evaporation rate for the Site was estimated by taking an average of the available monthly values from Grand Junction and Montrose. The calculated values for the Site are averages of the two sites, except the Montrose data were taken from the months when the Grand Junction data were not provided. The calculated results for the Site are provided in Appendix D in Kleinfelder (2009i). The estimated long-term monthly average pan evaporation rates ranged from 1.30 inches (33.0 mm) during December to 10.7 inches (270.5) mm) in June. The annual total estimated pan evaporation is 64.75 inches (1,644.7 mm). An accepted pan evaporation coefficient to calculate lake (free water) evaporation is 0.77 (Linacre, 1994). According to this method, the corresponding lake evaporation would be 49.9 inches (1,266 mm) per year.

Evaporation data were collected at Site 1 during the non-freezing months and resulted in a seven-month total of 55.26 inches. The total for the same seven months for the calculated average of Montrose and Grand Junction is 55.1 inches, which is very nearly identical to the measured value of 55.26 inches. Evaporation at the Site during the winter period was also estimated based on the data available from Montrose because winter evaporation measurements were taken at Montrose. Accordingly, the evaporation from April through June accounts for 84 percent of the evaporation at Montrose. Kleinfelder (2009i) applied this factor to the evaporation data collected at Site 1and estimated that the total annual Site evaporation as 65.8 inches (55.26/0.84). This is only a 1.5 percent difference from the average annual pan evaporation from Grand Junction and Montrose of 64.8 inches. A graph of the long-term monthly averages from the two NWS stations, the seven-month results from the Piñon Ridge Site 1 data, and the estimated Site evaporation rate based on the NWS data are shown in Figure 3.6-6.

This figure is based on the Meteorology, Air Quality and Climatology Report (Kleinfelder, 2009i).

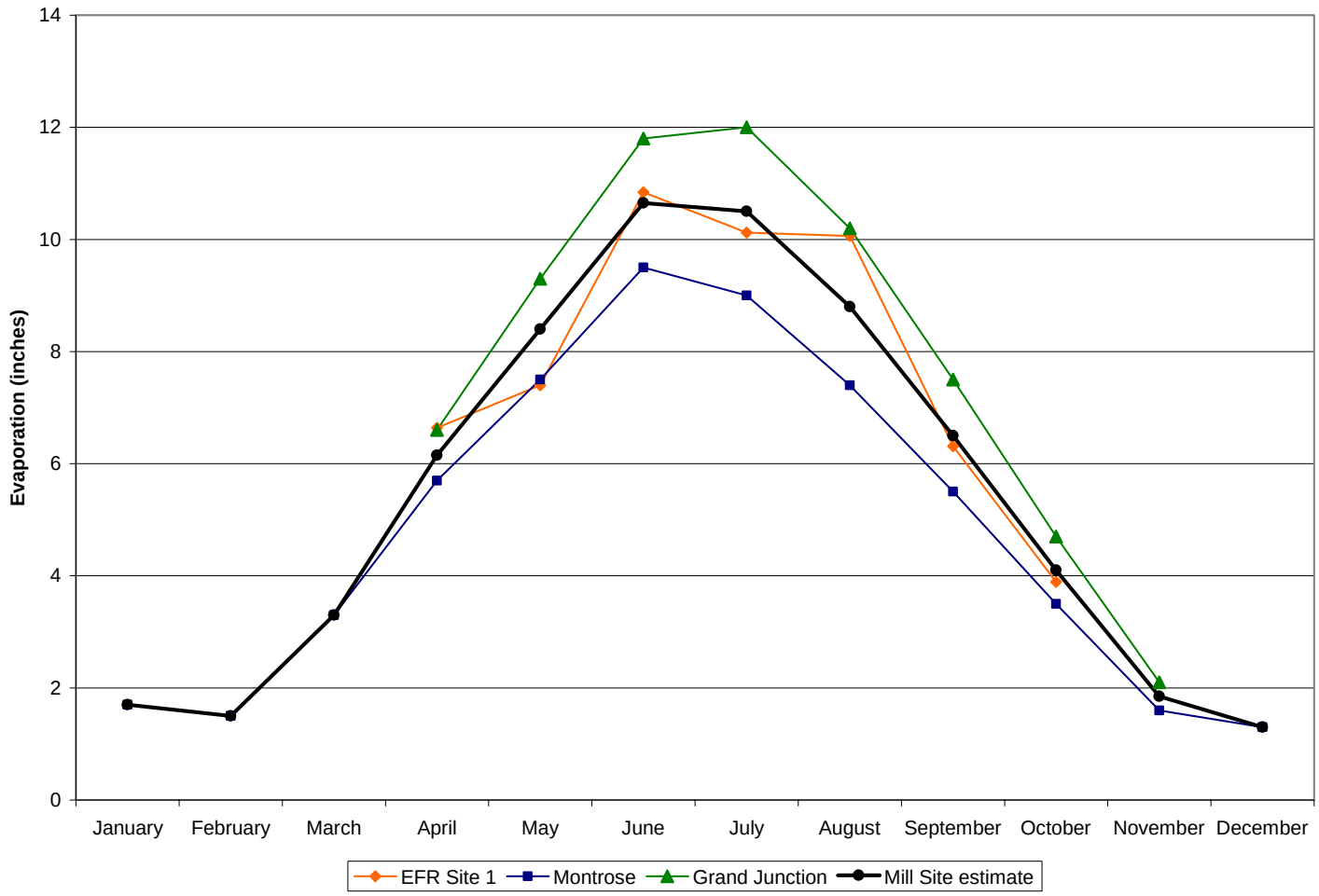


Figure 3.6-6

Summary of Evaporation Data

Severe Weather Phenomena. Kleinfelder (2009i) reports excerpts from Doesken et al. (2003) as follows:

> *Thunderstorms are quite prevalent in the eastern plains and along the eastern slopes of the mountains during the spring and summer. No specific mention is made of these occurrences in southwestern Colorado. Tornadoes are relatively rare in the mountains and western valleys but do occur. Lightning has emerged as one of the greatest weather hazards in Colorado. Each year there are typically several fatalities and injuries. Unlike tornadoes that are most common in selected areas of the state, lightning occurs everywhere.*
>
> *Heavy snows in the high mountains are common. Avalanches pose a serious problem to residents, road maintenance crews and back country travelers. Considerable effort is made each year to predict and manage avalanches.*
>
> *A spring flood potential results from the melting of the snow pack at the higher elevations. In a year of near-normal snow accumulations in the mountains and normal spring temperatures, river stages become high, but there is no general flooding. In years when snow cover is heavy, or when there is widespread lower elevation snow accumulation and a sudden warming in the spring, there may be extensive flooding.*

Avalanches could not occur at the Site due to its relatively low elevation (i.e., as compared to high mountains); however, the other severe weather phenomena discussed above could occur at or in the vicinity of the Site.

Climate Change. Most of the data presented in the preceding sections and in Kleinfelder (2009i) describe conditions occurring during the last 10-year period, 1999 through 2008. Data from longer periods of time are available from more distant sites and could have been included. However, the issue of how well data from more distant sites with differing geography represent conditions in the Paradox Valley resulted in using data from closer sites that have data availability over a shorter period of time. Trends in climate change are not clearly evident in the data evaluated. Therefore, in addition to that data, information from a recent report on climate change in Colorado was evaluated to assist with projecting the climatic conditions that could occur during the lifetime of the Site, a period of approximately 40 years.

As reported in Kleinfelder (2009i), the Western Water Assessment (WWA) group associated with the University of Colorado prepared a report for the Colorado Water Conservation Board in 2008, *Climate Change in Colorado* (WWA, 2008). The report acknowledges the difficulty in projecting regional changes in response to global-scale changes in climate conditions and weather system occurrences, though temperature and precipitation trends on a regional basis are shown. Montrose, Colorado, is one of the stations depicted in the WWA report, which is located approximately 50 miles north northeast of the Site.

The primary points from this report relevant to the Site are:

- Temperature: climate models project Colorado will warm by 4ºF by 2050, relative to the 1950-99 baseline values.
- Precipitation: climate models do not agree on changes in annual mean precipitation, though seasonal shifts may occur, including a lower snowpack occurring by 2050.

The WWA report shows that since 1970 10-year average observed temperatures have increased across the state. The increase from 1977 through 2006 for the southwestern regional corner of the State is reported as 2ºF. The Montrose data in the WWA report are representative of trends at other regional stations in the report. Year-to-year variations of average temperature have exceeded 1ºF, including during the most recent period. The warming trend could include shorter periods during the year of freezing temperature occurrences. Although not documented in the WWA report, evaporation rates are expected to increase associated with warmer temperatures.

In the WWA report, no apparent precipitation trends in the water-year (October through September) were presented for the regional stations. This lack of trend is also found in the climate model projections. The WWA report also discusses that annual values can range from one-half to twice the long-term average values. The annual variation in annual precipitation at the Uravan COOP station was nearly a factor of three, demonstrating the large year-to-year variability that occurs in the Site area. In another section of the WWA report, the regional drought during 2000 through 2007 is seen to be consistent with natural variability observed in the long-term and paleoclimatic records covering thousands of years.

Because of complex interactions between climatic elements and factors affecting water use, the lack of apparent trend and projected changes in total precipitation do not carry through to future water resource expectations. The WWA report concludes that a reduction in total water supply will occur during the projection period. Drought severity could be increased due to higher temperatures alone. Runoff in the Upper Basin of the Colorado River is expected to decline by 6 to 20 percent by the year 2050 (WWA, 2008).

3.6.3 Air Quality

Attainment Status. The EPA sets National Ambient Air Quality Standards (NAAQS) and CDPHE sets Colorado Ambient Air Quality Standards (CAAQS) which are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access. According to the Colorado Air Quality Control Commission's *Annual Report to the Public 2008-2009*, all of Montrose County is designated as "attainment" for all criteria pollutants (CDPHE, 2009a). Criteria pollutants for which CAAQS and NAAQS exist include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb).

Nearby Sources. Most of the Paradox Valley including the land surrounding the Site is considered unincorporated. Most of the valley is utilized for open ranching, but some agricultural sources exist near Bedrock and Nucla, Colorado. There are several minor sources throughout the valley including aggregate processing operations, concrete batch plants, and uranium/vanadium ore mining. These operations are primarily sources of particulate matter, but can also utilize processes and/or equipment that emit nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and some Hazardous Air Pollutants (HAPs). Tri-State Generation and Transmission also operates a coal strip mine and a coal-fired power plant in Nucla. The mining activities are another source of particulate matter, while the power plant is a major source for NO_x, SO_2, CO, particulate matter, and HAPs.

Air Quality Data Summary. The Energy Fuels air monitoring program collected data to examine both PM_{10} and radionuclide trends at the Site. Radionuclide trends are discussed in Section 3.11, Public and Occupational Health. The PM_{10} data collected at Sites 1 and 2 are presented in Appendix E in the *Meteorology, Climatology, and Air Quality Report* (Kleinfelder, 2009i). Also in Kleinfelder (2009i), the PM_{10} concentrations are summarized in Appendix E and the PM_{10} concentrations are plotted as a function of time in Figure 3.6-7. The monthly and annual PM_{10} averages are presented in Table 3.6-8. Site area concentrations for PM_{10} were calculated from the data and the results were below the NAAQS and the CAAQS.

Table 3.6-8
PM_{10} Monthly and Annual Averages[1]

Year	2008									2009			ANNUAL
Month	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	
Location	Concentration in ug/m^3												
Site 1	19	13	10	10	8	7	9	7	3	4	4	6	9
Site 2	22	14	10	9	8	7	8	7	3	3	4	6	8

[1] Source: Kleinfelder, 2009i.

The Site area air quality is required to meet both the NAAQS and the CAAQS. The EPA monitors PM_{10} attainment status with a 24-hour standard. During the course of one year, PM_{10} concentrations may only exceed 150 microgram per cubic meter (ug/m^3) one time. If the PM_{10} concentrations exceed the 150 ug/m^3 more than once during the year, the area is designated as nonattainment for PM_{10}. The CDPHE enforces the 24-hour standard, but also requires areas to comply with an annual PM_{10} standard. To attain this standard, the 3-year average of the weighted annual mean PM_{10} concentrations from one or several monitors must not exceed 50.0 ug/m^3. In comparison with the Piñon Ridge PM_{10} results, both Site 1 and 2 had 24-hour and annual PM_{10} concentrations less that the NAAQS and the CAAQS.

During the monitoring program, the annual averages for Sites 1 and 2 were 9 ug/m^3 and 8 ug/m^3, respectively, both well below the CAAQS of 50 ug/m^3. April 2008 had the highest monthly average PM_{10} concentration, 22 ug/m^3, and December 2008 had the lowest average PM_{10} concentration of 3 ug/m^3. The maximum 24-hour concentration recorded was 66 ug/m^3 recorded on April 30, 2008, at both Site 1 and 2 which is considerably less than the NAAQS 24-hour standard of 150 ug/m^3.

3.7 NOISE

Noise measurements are not available for the vicinity of the Site. Local conditions such as traffic, topography, and winds characteristic of the region can alter background noise conditions. In general, sound levels (decibels – dB) at outdoor rural residential locations are about 40 dBA - decibels on the A-weighted scale - averaged for day and night periods (EPA, 1974). The A-weighted decibel scale is frequency-weighted to approximate human hearing of noise propagated through air. The A scale begins at zero, the faintest noise that humans can hear. Decibels are measured on a logarithmic scale, so a noise level of 70 dBA is twice as loud to the listener as a noise of 60 dBA. The existing average ambient noise levels at the Site are expected to be in the range of 35 to 45 dBA and probably near an average of 40 dBA for day and night conditions.

This figure is based on the Meteorology, Air Quality and Climatology Report (Kleinfelder, 2009i).

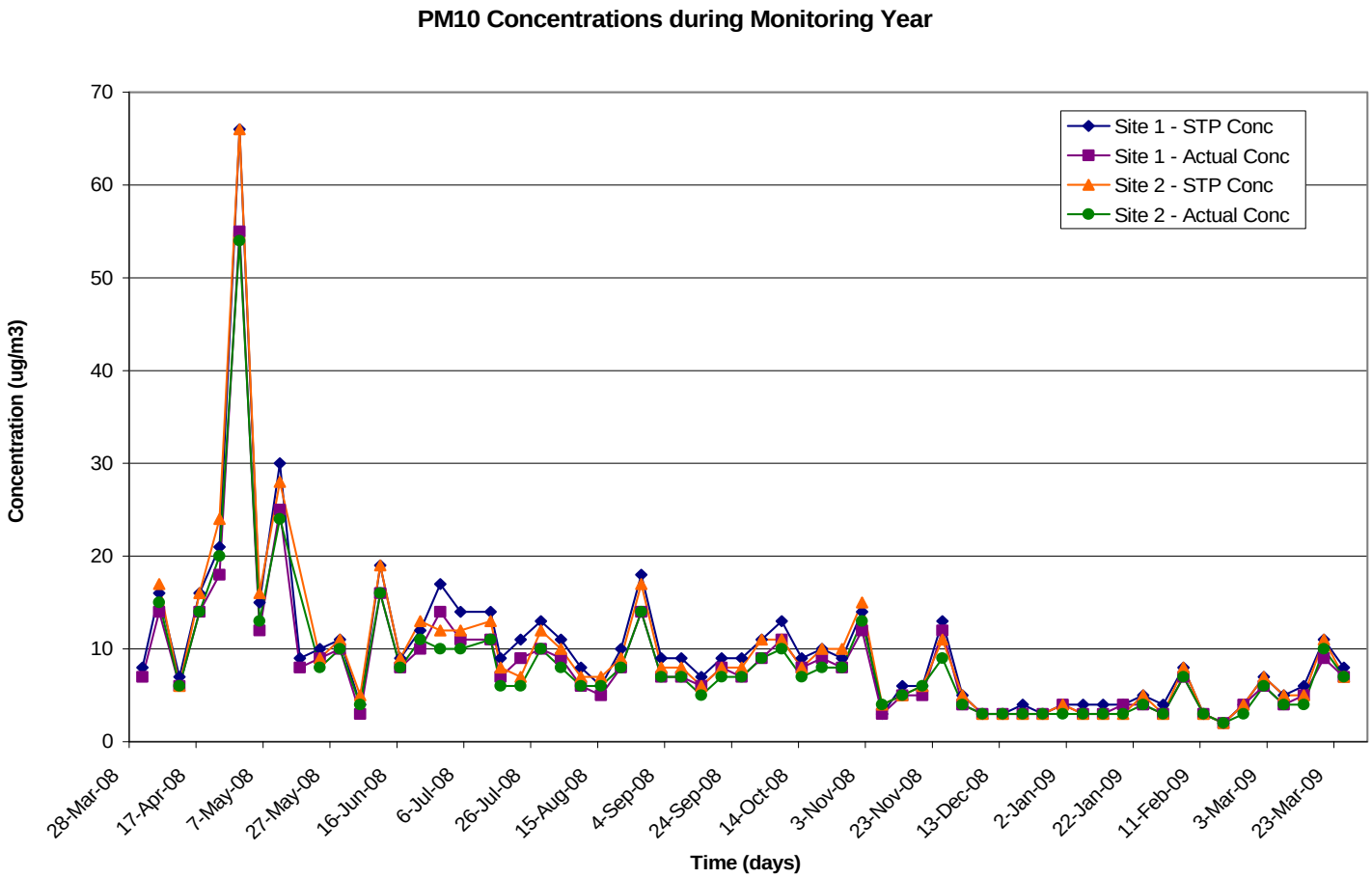


Figure 3.6-7

PM_{10} Concentrations at Sites 1 and 2

The existing ambient noise in the vicinity of the Site is dominated by the traffic noise from SH 90. SH 90 provides access to the local residences in the communities of Paradox and Bedrock from La Sal, Utah and Naturita, Colorado, for natural resource development, ranching activities, and recreational users, and for connecting traffic to SH 141 at Vancorum, east of Naturita.

Existing levels of vehicular traffic on SH 90, between Bedrock and Vancorum are reported as 530 vehicles per day, including 82 trucks per day (CDOT, 2009d). An estimate of existing hourly traffic on SH 90 would be approximately 10 percent of the daily traffic volume (Washington State Department of Transportation-WSDOT, 2008) or 53 vehicles per hour.

For traffic at an approximate volume of 125 vehicles per hour (the lowest traffic volume tabulated) and traveling at speeds of 65 miles per hour WSDOT (2008, see Table 7-3) estimated noise levels at 63.8 dBA from 50 feet away from the highway. Using the progressive relationship between traffic volume and associated noise provided in WSDOT's Table 7-3, an hourly traffic volume of 53 vehicles per hour, traveling at 65 miles per hour, would produce an estimated noise level of 60.7 dBA at 50 feet from the roadway.

For analytical purposes, traffic is considered a line source of noise rather than as a point source. Noise from a line source spreads out cylindrically along the length of a line. The standard reduction for line source noise is 3 dB per doubling of distance from the source - compared to 6 dB for a point source of noise (WSDOT, 2008). With a reduction rate of 3 dB per doubling of distance ("hard site reduction" rate), noise generated by traffic on SH 90 would be expected to attenuate to the background average of 40 dBA at 6,460 feet (1.2 miles) away if traffic volume was 53 vehicles per hour. Ground cover or normal unpacked earth present between the source and receptor will be a "soft site"; the ground becomes absorptive of noise energy and will reduce the attenuation from line sources by 1.5 dB in addition to the to 3.0 dB reduction per doubling of distance. Under soft site conditions (reduction of 4.5 dB per doubling of distance), estimated traffic noise associated with 53 vehicles per hour would attenuate to 40 dBA at 1,267 feet (0.24 mile) away, which is the estimated distance away from SH 90 that existing traffic noise would be louder than average estimated background noise at the Site.

3.8 HISTORIC AND CULTURAL RESOURCES

According to guidance provided in the NRC's NUREG-1748 (NRC, 2003a), Section 106 of the National Historic Preservation Act (NHPA) requires staff to consider the impacts on cultural resources associated with a Proposed Action. If there is potential for impacts to cultural resources, consultation with the State Historic Preservation Officer (SHPO) is required.

Cultural resources are definite locations of past human activity. These resources encompass archaeological, historic, traditional, religious, and built environment locales of importance. Qualified cultural resources professionals, consulting with their peers, Native Americans, or review authorities, conduct studies of those resources having potential to possess significance and which could be affected by development projects. In most cases, cultural resources are evaluated based on eligibility criteria for listing in the National Register of Historic Places (NRHP). NRHP significance criteria are codified under 36 CFR 60.4 and are summarized below:

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

b) that are associated with the lives of persons significant in the past; or
c) that embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction; or
d) that have yielded, or are likely to yield, information important in prehistory or history.

In local and regional contexts, research questions posed in Reed and Metcalf's *Colorado Prehistory: A Context for the Northern Colorado River Basin* (1999) are often used as an additional guide for resource analyses. The book provides more specific guidance for the application of NRHP criteria and was used in the Piñon Ridge project reconnaissance inventories described in the section below.

Energy Fuels contracted with ERO Resources Corporation (ERO) to conduct archeological investigations at the Site. ERO conducted a file and literature review with the Colorado Office of Archaeology and Historic Preservation (OAHP) in Denver. The review indicated that three previous cultural resource inventories were conducted within 0.5-mile of the Site. No previously documented cultural resources occur within the 880-acre portion of the Site (ERO, 2007).

A survey conducted by Lone Mountain Archaeological Services in 1999 is the only project that resulted in the location of cultural resources - two isolated finds - within 0.5 mile of the Site. The other two previous inventories include a 6,000-acre survey by Fort Lewis College in 1975 in Montrose and San Miguel counties that resulted in the location of 22 archaeological sites, none within 0.5 mile of the Site (ERO, 2007).

ERO conducted Class III cultural resource inventories and evaluative testing for the site (ERO, 2007 and 2009a).The Site contains 880 acres located on the floor and southern edge of the Paradox Valley between Sawtooth Ridge and Davis Mesa and an additional 80 acres to the west of the Site (see Figure 1.1-1). The purpose of the inventories was to comply with Section 106 of the NHPA, as amended. The full report and its addendum provide detailed descriptions of methodology, regional temporal frameworks, and area prehistoric and historic contexts (ERO, 2007 and 2009a). ERO submitted the full report and its addendum to the SHPO and SHPO concurred with ERO's finding of "no historic properties affected". Copies of SHPO's letters to ERO indicated their concurrence is included in ERO (2007, 2009a and 2009b). On behalf of CDPHE, ERO also notified Native American tribal affiliates (ERO, 2007, 2009a and 2009b).

The 2007 ERO inventory covered the Site (all on privately owned lands) and resulted in documentation of 20 new archaeological sites and 14 isolated finds. Table 3.8-1 summarizes the newly documented sites. The sites consisted of 16 prehistoric open artifact scatters, one sheltered artifact scatter, and three historic habitation sites. Of the 20 sites documented, four are recommended eligible for listing on the NRHP and 16 are recommended not eligible. The isolated finds are not sites, buildings, structures, objects, or districts and do not meet the minimum requirements for consideration for eligibility to the NRHP. Thirteen of the prehistoric sites were located in the sagebrush flats of Paradox Valley. Four prehistoric sites were located in the pinyon-juniper woodlands of Davis Mesa. Controlled collection took place at eight sites, and six archaeological sites were trenched in order to evaluate their potential for subsurface cultural deposits (ERO, 2007).

Table 3.8-1
Cultural Resource Sites Documented at the Site[1]

Smithsonian Number	Site Type	Temporal Period	NRHP Eligibility	Status	Management Recommendation
5MN8269	Open Camp	Early Archaic to Late Prehistoric	Eligible	Collected/Excavated/Mitigated	Avoid and Monitor
5MN8270	Sheltered Camp	Late Formative	Eligible	Fully Collected	No further work
5MN8271	Open Lithic Scatter	Late Archaic/Early Formative to Late Formative	Not Eligible	Partially Collected	No further work
5MN8272	Open Lithic Scatter	Late Archaic or Early Formative	Not Eligible	Baseline Documentation	No further work
5MN8273	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Collected/Trenched	No further work
5MN8274	Open Camp	Early to Late Archaic/ Protohistoric Ute	Not Eligible	Collected/Trenched	No further work
5MN8275	Historic Habitation	EuroAmerican	Not Eligible	Baseline Documentation	No further work
5MN8276	Open Artifact Scatter	Late Paleoindian – Jimmy Allen	Not Eligible	Collected	No further work
5MN8277	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Collected/Trenched	No further work
5MN8278	Historic Habitation	EuroAmerican	Not Eligible	Baseline Documentation	No further work
5MN8279	Open Artifact Scatter	Middle Archaic – Humboldt	Not Eligible	Collected/Trenched	No further work
5MN8280	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Baseline Documentation	No further work
5MN8281	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Baseline Documentation	No further work
5MN8282	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Baseline Documentation	No further work
5MN8283	Open Camp	Basketmaker II	Not Eligible	Collected/Scraped	No further work
5MN8284	Open Lithic Scatter	Late Archaic or Terminal – Elko Series	Eligible	Baseline Documentation	Avoid and protect
5MN8285	Open Lithic Scatter	Unknown Prehistoric	Not Eligible	Baseline Documentation	No further work
5MN8286	Open Artifact Scatter	Unknown Prehistoric	Eligible	Baseline Documentation	Avoid and protect
5MN8287	Historic Habitation	EuroAmerican	Not Eligible	Baseline Documentation	No further work
5MN8288	Open Artifact Scatter	Unknown Prehistoric	Not Eligible	Baseline Documentation	No further work

[1] Source: ERO, 2007.

The 2009 ERO inventory resulted in documentation of four new archaeological sites and two isolated finds (see Table 3.8-2). Most sites are open lithic scatters. Two sites include a historic component – one consists of a historic can scatter and the other is the remains of a homestead. All but one site are recommended not eligible for listing on the NRHP due to their limited research potential beyond current documentation. A portion of site 5MN9206 is recommended eligible for the NRHP based on the potential for a buried thermal feature (ERO, 2009a).

Table 3.8-2
Cultural Resource Sites Documented at the 80-acre Well Field[1]

Smithsonian Number	Resource Type	NRHP Eligibility	Management Recommendation
5MN9206	Prehistoric	Eligible	Protect and avoid
5MN9207	Prehistoric	Not Eligible	No future work
5MN9208	Prehistoric/Historic	Not Eligible	No future work
5MN9209	Prehistoric/Historic	Not Eligible	No future work

[1] Source: ERO, 2009a.

3.9 VISUAL/SCENIC RESOURCES

Visual resources are the visible physical features of a landscape that convey scenic value and are often the dominant resource value involved in providing recreational opportunities. In bulletin NUREG-1748 the NRC environmental review guidance for licensing requests that ratings for visual resources at proposed sites follow the BLM's Visual Resource Management (VRM) System, where applicable (NRC, 2003a). An earlier guide adopted by CDPHE, USNRC Regulatory Guide 3.8 Preparation of Environmental Reports for Uranium Mills, provides no direct guidance for visual resources (NRC, 1982a).

The BLM VRM system consists of two stages – inventory and analysis. The inventory stage involves identifying the visual resources of an area and assigning them to inventory classes using BLM's visual resource inventory process. Visual quality, sensitivity, and public visibility are considered, resulting in VRM classifications. This process results in assigning VRM classes to visual resources within a BLM district and becomes an important component of an area's Resource Management Plan (RMP). For the analysis stage, the BLM uses its Manual 8431: Visual Resource Contrast Rating as a guide to analyze and mitigate potential visual impacts from proposed developments. The rating system was devised to ensure that an earnest attempt is made to minimize potential visual impacts (BLM, 1986).

The BLM lands surrounding the Site (which is located on private lands) are currently managed under the San Juan/San Miguel Planning Area RMP (BLM, 1985). According to this document, none of the BLM lands within immediate vicinity of the Site have designated VRM classifications. In most cases, proposed development activities on these lands would require site-specific visual quality objectives and design guidelines (BLM, 1985). BLM's Dolores River Canyon Wilderness Study Area, the eastern-most edge of which lies approximately 2 miles west of the Site, is managed as VRM Class I area, the most sensitive class (BLM, 1985). Here, the objective is to preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention (BLM, 1984). Some other BLM lands in the region are managed as VRM Class II areas. The objective in Class II areas is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape (BLM, 1984).

The Site is located in the relatively isolated and unaltered landscape near the center of the Paradox Valley, in an area known locally as East Paradox Valley. The valley lies on the eastern edge of Montrose County near the Utah border. Paradox Valley is atypical for the area in that it is a wide plane sharply defined by the steep mesa cliffs and bluffs that bound it – an area known as Carpenter Ridge on the north and Davis Mesa on the south. A huge trough-like feature, the valley was formed when a salt dome collapsed (USDI, 2009). Elsewhere in the vicinity, landscapes more common to the Colorado Plateau are found, including the rugged, tight-twisting canyonlands carved out by the Dolores and San Miguel river drainages.

Most visitors to the valley use Colorado SH 90 to access nearby small towns, recreation sites in the Manti La Sal National Forest and area BLM lands, and sites along the scenic gorges of the Dolores and San Miguel rivers. Figures 3.9-1 and 3.9-2 show two key observation points (KOPs) from which observers might be exposed to the Site from SH 90. Other visitors to the valley include recreationists on the Dolores River. The Dolores River bisects Paradox Valley near the unincorporated settlement of Bedrock, Colorado, about 7.2 miles northwest of the Site. The nearby Dolores River Canyon Wilderness Study Area is on BLM-administered lands adjacent to the Paradox Valley. Hunters also utilize both the valley bottom lands and adjacent mesa and ridge forest lands (see Section 3.1.2.3 for more information on hunter use). Figure 3.9-3 represents a view of the Site and Paradox Valley hunters or other recreationists might encounter from near the top of Davis Mesa. Remnants of past mining activity can be seen in the foreground.

Figure 3.9-1
KOP 1: Northbound State Highway 90 Viewpoint Showing Visual Resources and Site

Figure 3.9-2
KOP 2: Southbound State Highway 90 Viewpoint Showing Visual Resources and Site

Figure 3.9-3
View from Davis Mesa to the Piñon Ridge Site and Paradox Valley

At an average width of about 2 miles, the Paradox Valley provides dynamic background vistas of the La Sal Mountains to the northwest, a grand focal feature for travelers heading northwest on SH 90. Observers traveling southbound toward Naturita can find panoramic views that include Davis Mesa and the snow-capped peaks of Mount Wilson in the distance. Foreground views for SH 90 observers are comprised of flat to gently rolling planes covered with sagebrush dominated vegetation commonly used by elk and mule deer in the winter. Middleground landscapes are dominated by the red, beige, and brown striated cliff faces of Carpenter Ridge, and the coarse greenish flanks of Davis Mesa, shrouded in pinyon-juniper vegetation cut with jagged horizontal rock formations. Figures 3.9-4 and 3.9-5 show some landscapes encountered by observers traveling on SH 90. Near Bedrock, irrigated agricultural land is a common foreground landscape feature. Occasional scattered piles of multi-colored badlands round out the diverse landscape characteristics of the Paradox Valley.

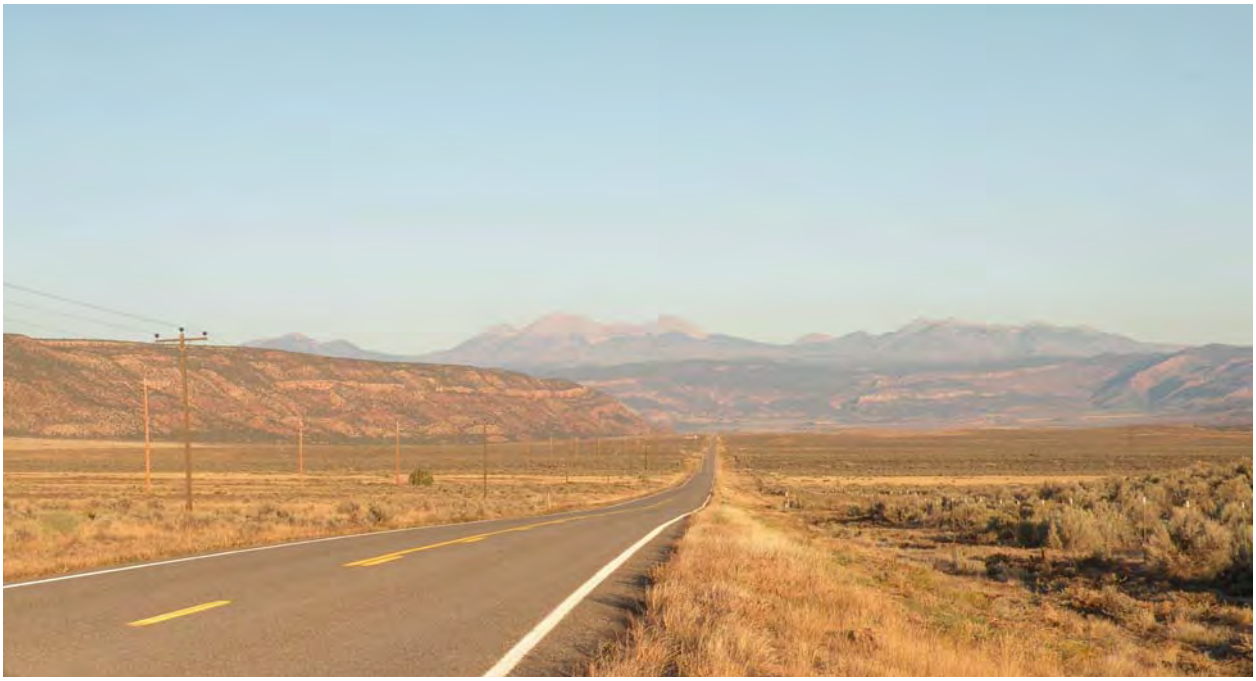


Figure 3.9-4
La Sal Mountains and the Paradox Valley from Northbound State Highway 90

Figure 3.9-5
Davis Mesa, Open Pit Mine, and Distant Mt. Wilson from Southbound State Highway 90

Currently, a straight dirt road paralleled by a timber-poled powerline and primitive cattle fence run south from SH 90 along the Site's eastern boundary. Sagebrush has been removed in some portions of the Site creating swaths of mixed grasslands along the west and southern portions of the Site. Southeast of the Site, the topsoil from the nearby surface mine was spread over approximately 80 acres and seeded with grass. These activities have created bands of sagebrush alternating with bands of grasses. Adjacent to the Site's southeastern boundary is an open pit mine and overburden pile (material stripped during mining operations), both of which cover approximately 190 acres total. The overburden pile (see Figure 3.9-6) is about 0.45 miles wide and over 200 feet high, and is most visible to SH 90 observers traveling south through the Paradox Valley. The landscape feature's form blends in with the existing natural contours of surrounding Davis Mesa, but the pile's light color and lack of congruent vegetation signal a marked contrast. The vegetation band pattern, overburden pile, waste rock dumps, mine buildings, and the circuitous mesh of access roads in the nearby forested bluffs are among the few existing human developments in the Paradox Valley that attract attention of the casual observer.

Figure 3.9-6
Overburden Pile from Open Pit Mine Adjacent to the Site

Most of the land in the vicinity of the Site is zoned as general agricultural districts. However, through a comprehensive public process, the Montrose County Commissioners recently approved a Special Use Permit for Energy Fuels to construct and operate the Mill in the Paradox Valley (Montrose County, 2009a).

3.10 SOCIOECONOMICS

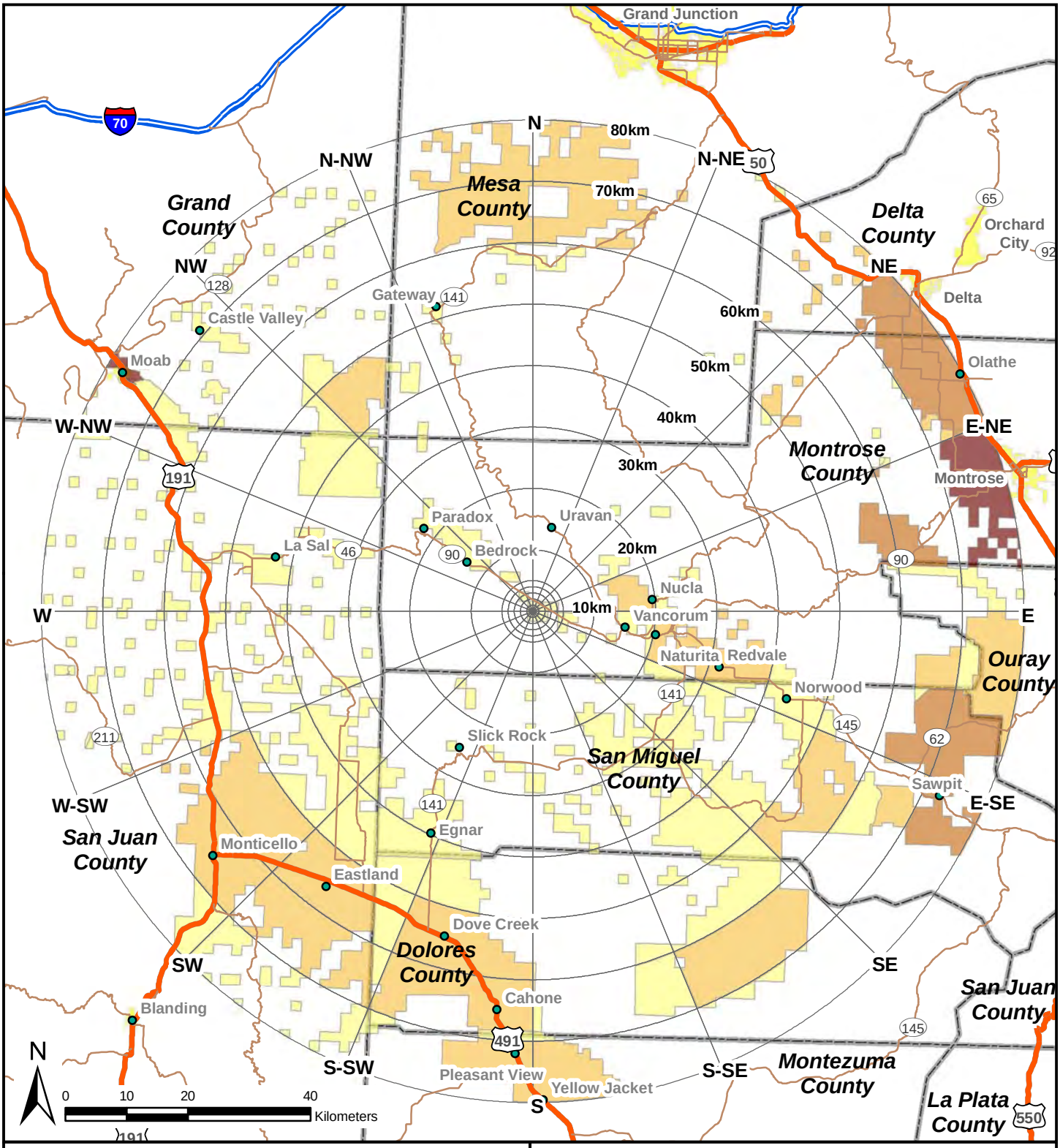
Information presented in this section addresses the demographic and social characteristics of the counties and communities that may be affected by the Proposed Action. The Site is located in a sparsely populated, rural region of western Colorado/eastern Utah that has been characterized historically by ranching and mining activities. Most of the region experienced substantial population growth during the 1990s, which has decreased since 2000. The economy of western Montrose County, where the Site is located, has contracted since uranium mining and milling activities slowed in the 1980s.

3.10.1 Regional Population

NRC Guidance for Environmental Reports for Uranium Mills requires that a proposed project's impacts on population distribution be evaluated for all areas within 50 miles (80 km) of the Site (NRC, 1982a). A 50 mile (80 km) radius around the Site includes portions of Delta, Dolores, Mesa, Montezuma, Montrose, Ouray, and San Miguel counties in Colorado, and Grand and San Juan counties in Utah. Figure 3.10-1, which is based on population estimates compiled by the Colorado State Demography Office and Utah Governor's Office of Planning and Budget, illustrates current population distributions within 50 miles (80 km) of the Site (Colorado Department of Local Affairs - CDOLA, 2009a; Utah Governor's Office of Planning and Budget, 2009).

Tables B1 through B4 in Appendix B show the expected residential population in each segment shown on Figure 3.10-1 for the expected first year of mill operation (year 2012) and census years through the anticipated life of the Mill Facility (2020 and 2030). Appendix B also discusses the methodology used to estimate future populations within each segment. Although the Mill Facility has an anticipated operational life of 40 years, the Colorado State Demography Office forecasts population through 2035 only. Therefore, within this analysis, 2035 is the final year of estimated population within each sector.

Table 3.10-1 shows the populations of all counties included in the 50 mile (80 km) radius around the Site. This discussion of regional population trends addresses county-wide populations for all counties that are partially included within a 50 mile (80 km) radius of the Site, and not the populations contained within the 50 mile (80 km) radius. As the center of commercial activity in western Colorado, Mesa County is the most populated county in the region. Montrose and Delta counties follow as the second and third most populous counties, respectively. Ouray and Dolores counties are the least populated counties in the area. During the 1980s, population growth in western Colorado was checkered. The populations of Delta and Dolores counties decreased, while population growth in Montrose County was stagnant (see Table 3.10-2). The populations of Mesa, Montezuma, Ouray, and San Miguel counties increased. Although Ouray and San Miguel counties had the highest growth rates (due in large part to their low populations), Mesa and Montezuma counties gained the most people. During this time, growth in eastern Utah was below the Utah state average. Grand County, Utah had the greatest population losses across the nine-county region, both in absolute and percentage terms. Overall, the region's population increased by 7.6 percent (0.8 percent per year) between 1980 and 1990.



Population

- 0 - 200
- 201 - 1000
- 1001 - 2500
- 2501 - UP

Figure 3.10-1

Population Distribution within 50 miles (80 km) of the Site 2009

Table 3.10-1
Population Estimates and Projections for Counties within 50 miles (80 km) of the Site[1,2]

Area	1980	1990	2000	2008	2010	2020	2030	2035
State of Colorado	2,907,856	3,304,042	4,301,261	4,939,456	5,218,144	6,287,021	7,331,876	7,819,775
Delta, CO	21,225	20,980	27,834	30,923	33,372	44,518	56,486	60,809
Dolores, CO	1,658	1,504	1,844	1,986	1,998	2,391	2,841	3,069
Mesa, CO	81,530	93,145	116,255	143,171	153,457	188,396	230,087	249,963
Montezuma, CO	16,510	18,672	23,830	25,384	26,645	32,293	38,556	41,455
Montrose, CO	24,352	24,423	33,432	40,539	44,675	59,813	74,439	80,444
Ouray, CO	1,925	2,295	3,742	4,560	4,864	6,420	6,876	7,020
San Miguel, CO	3,192	3,653	6,594	7,552	8,471	11,324	14,284	15,625
State of Utah	1,461,037	1,722,850	2,233,169	2,736,424	2,927,643	3,652,547	4,387,831	4,772,204
Grand, UT	8,241	6,620	8,485	9,589	9,693	11,007	11,827	12,141
San Juan, UT	12,253	12,621	14,413	14,969	15,053	15,319	16,653	17,333

[1] Sources: CDOLA, 2009a and Utah Governor's Office of Planning and Budget, 2009.
[2] Includes all counties that are partially within a 50 mile (80 km) radius of the Site.

Table 3.10-2
Historic and Projected Population Growth in Counties within an 50 mile (80 km) Radius of the Site, 1980 - 2035[1]

Area	1980 – 1990 (percent)	1990 – 2000 (percent)	2000 – 2010 (percent)	2010 – 2020 (percent)	2020 – 2035 (percent)
State of Colorado	13.6	30.2	21.3	20.5	24.4
Delta County	-1.2	32.7	19.9	33.4	36.6
Dolores County	-9.3	22.6	8.4	19.7	28.4
Mesa County	14.2	24.8	32.0	22.8	32.7
Montezuma County	13.1	27.6	11.8	21.2	28.4
Montrose County	0.3	36.9	33.6	33.9	34.5
Ouray County	19.2	63.1	30.0	32.0	9.3
San Miguel County	14.4	80.5	28.5	33.7	38.0
State of Utah	17.9	29.6	31.1	24.8	30.7
Grand County	-19.7	28.2	14.2	13.6	10.3
San Juan County	3.0	14.2	4.4	1.8	13.1
Nine-county region	7.6	28.6	26.1	24.6	31.3

[1] Includes all counties that are partially within a 50 mile (80 km) radius of the Site.

The 1990s were a growth period for all counties across the region. Counties regained population losses from the 1980s, and population growth rates in all counties exceeded those of the previous decade. Mesa, Montrose, and Delta counties gained the most people, and Dolores County gained the fewest. Overall, the region's population increased by 28.6 percent (2.9 percent per year) between 1990 and 2000.

Between 2000 and 2010, population growth in western Colorado is expected to outpace the statewide average growth rate. Population growth in eastern Utah is expected to remain below the (Utah) statewide average. Mesa, Montrose, and Delta counties continue to gain the most people, while Dolores and San Juan counties have gained the fewest. Overall, the region's population is expected to increase 26.1 percent (2.6 percent per year) between 2000 and 2010.

The Colorado State Demography Office and Utah Governor's Office of Planning and Budget forecast populations for their respective states. According to these agencies' forecasts, Mesa, Montrose, and Delta counties will gain the most people between 2010 and 2020, and Dolores and San Juan counties will gain the fewest (CDOLA, 2009a, Utah Governor's Office of Planning and Budget, 2009). Overall, the region's population is projected to increase 24.6 percent

between 2010 and 2020. Relative population trends within the nine-county region are expected to remain generally consistent between 2020 and 2035 (a projected decline in Ouray County's growth rate and a projected increase in San Juan County's growth rate are the exceptions). Overall, the region's population is expected to increase 31.3 percent (2.1 percent per year) between 2020 and 2035.

3.10.1.1 Age Distribution of the Regional Population

The 2008 population by age for counties within 50 miles (80 km) of the Site is shown in Table 3.10-3. Overall, 39.5 percent of the population within the nine-county region was within the prime working years of 20 to 49. As a portion of county-wide population, this age group ranged from a low of 35.8 percent in Delta County to a high of 51 percent in San Miguel County, Colorado. Persons under the age of 20, who will be entering the workforce in the next 10 to 20 years, comprised 27 percent of the region's population. This age group ranged from a low of 21.1 percent in San Miguel County to a high of 34.8 percent in San Juan County, Utah.

Table 3.10-3
Population by Age for Counties within a 50 mile (80-km) Radius of the Site, 2008[1,2]

Area	Under 5 Years	5 to 19 Years	20 to 34 Years	35 to 49 Years	50 to 64 Years	65 Years and Older
Number of people						
Delta County, CO	1,788	6,000	5,278	5,905	6,329	5,977
Dolores County, CO	116	341	304	398	454	324
Mesa County, CO	10,010	29,277	30,610	28,464	26,517	20,793
Montezuma County, CO	1,613	5,486	4,264	5,057	5,388	3,953
Montrose County, CO	2,795	8,725	7,605	8,286	7,778	6,370
Ouray County, CO	211	842	741	976	1,183	673
San Miguel County, CO	451	1,219	1,565	2,480	1,877	340
Grand County, UT	522	1,892	1,925	1,807	1,941	1,236
San Juan County, CO	959	4,251	3,588	2,522	2,049	1,600
Percent of county population						
Delta County, CO	5.7%	19.2%	16.9%	18.9%	20.2%	19.1%
Dolores County, CO	6.0%	17.6%	15.7%	20.5%	23.4%	16.7%
Mesa County, CO	6.9%	20.1%	21.0%	19.5%	18.2%	14.3%
Montezuma County, CO	6.3%	21.3%	16.6%	19.6%	20.9%	15.3%
Montrose County, CO	6.7%	21.0%	18.3%	19.9%	18.7%	15.3%
Ouray County, CO	4.6%	18.2%	16.0%	21.1%	25.6%	14.5%
San Miguel County, CO	5.7%	15.4%	19.7%	31.3%	23.7%	4.3%
Grand County, UT	5.6%	20.3%	20.6%	19.4%	20.8%	13.3%
San Juan County, CO	6.4%	28.4%	24.0%	16.8%	13.7%	10.7%

[1] Sources: CDOLA, 2009a and Utah Governor's Office of Planning and Budget, 2009.
[2] Includes all counties that are partially within a 50 mile (80 km) radius of the Site.

The portion of the region's population that is within retirement years (age 65 and older), comprised 14.6 percent of the region's population. This age group ranged from a low of 4.3 percent in San Miguel County to a high of 19.1 percent in Delta County.

3.10.1.2 Minority and Low Income Populations within the Regional Population

In 2008, 80.4 percent of the total population of the nine counties within a 50 mile (80 km) radius of the Site was classified as white. Indians and persons of Hispanic origin comprised 5.3 percent and 12 percent, respectively. The populations of all other racial categories accounted for less than 1 percent of the population across all nine counties (U.S. Census Bureau, 2009a).

With the exception of lower proportions of African-American populations, the racial characteristics of Delta, Dolores, Mesa, Montrose, Ouray, and San Miguel counties are similar to the racial characteristics of the State of Colorado. Similarly, the racial characteristics of Grand

County, Utah are comparable to the racial characteristics of the state of Utah (see Table 3.10-4). American Indians account for 13.8 percent of the population of Montezuma County, Colorado, and 54.3 percent of the population of San Juan County, Utah. These are larger proportions than the share of American Indian populations within the statewide populations. American Indians comprise 1.2 percent of Colorado's population and 1.4 percent of Utah's population. This is because Montezuma County contains the Ute Mountain Indian Reservation and San Juan County contains Navajo Nation tribal lands. Both reservations are outside the 50 mile (80 km) region that is centered on the Site.

Table 3.10-4
Percent of Minorities in Counties within a 50 mile (80 km) Radius of the Site, 2008[1]

Area	African American (percent)	American Indian (percent)	Asian or Pacific Islander (percent)	Hispanic, any Race[3] (percent)	Total Minority (percent)
State of Colorado	4.3	1.2	2.8	20.2	28.5
Delta County	0.7	0.9	0.6	13.4	15.5
Dolores County	0.1	2.7	0.5	5.3	8.5
Mesa County	1.0	1.1	0.8	12.1	15.0
Montezuma County	0.5	13.8	0.5	9.7	24.4
Montrose County	0.7	1.4	0.7	17.6	20.4
Ouray County	0.1	0.9	0.3	5.6	6.9
San Miguel County	0.3	0.9	1.0	9.0	11.1
State of Utah	1.3	1.4	2.7	12.0	17.4
Grand County	0.4	5.3	0.3	6.6	12.6
San Juan County	1.4	54.3	0.8	5.2	61.9

[1] U.S. Census Bureau, 2009a.
[2] Includes all counties that are within a 50 mile (80 km) radius of the Site.
[3] Hispanic origin is considered an ethnicity, not a race. Hispanics may be of any race.

In 2000 (the most recent year for which household poverty data are available from the U.S. Census Bureau), persons in poverty comprised 9.3 percent of the population in Colorado and 9.4 percent of the population in Utah (U.S. Census Bureau, 2000a). In that year, 12.8 percent of the total population of the nine counties within an 80 km radius of the Site had incomes below the poverty level. San Juan County, Utah, and Montezuma County, Colorado had the highest portions of low-income households; 31.4 percent of the households in San Juan County and 16.4 percent of the households in Montezuma County had incomes below the poverty level (see Table 3.10-5).

Table 3.10-5
Percent of Persons in Poverty in Counties within a 50 mile (80 km) Radius of the Site, 2000[1,2]

Area	Median Household Income	Percent of Households with Incomes Below Poverty Level
State of Colorado	$47,203	9.3
Delta County	$32,785	12.1
Dolores County	$32,196	13.1
Mesa County	$35,864	10.2
Montezuma County	$32,083	16.4
Montrose County	$35,234	12.6
Ouray County	$42,019	7.2
San Miguel County	$48,514	10.4
State of Utah	$45,726	9.4
Grand County	$32,387	14.8
San Juan County	$28,137	31.4

[1] Source: U.S. Census Bureau, 2000a.
[2] Includes all counties that are partially within a 50 mile (80 km) radius of the Site.

3.10.2 Local Population

Communities in western Montrose County are most likely to experience the socioeconomic impacts from the Proposed Action. The towns of Naturita and Nucla, and the unincorporated communities of Bedrock and Paradox, are within 20 miles (32 km) of the Site and have the highest potential for population, job, and/or income growth or destabilization associated with the project. According to local sources, the Mill Facility would be likely to attract most of its workers from western Montrose County (Lear, 2009 and Sullivan, 2009). Energy Fuels also expects to draw some workers from Norwood, in northern San Miguel County, and from unincorporated communities composed of former miners near La Sal in eastern San Juan County, Utah (Filas, 2009). Both of these areas are approximately 35 miles from the Site. While the project may attract some workers from Norwood and La Sal, the majority of mill workers would be likely to reside in western Montrose County. Thus, the potential for growth or destabilization to housing, schooling, and public safety and emergency services is also highest in communities in western Montrose County.

Growth that has occurred in Montrose County since 1980 has largely been on the east side of the county. In 1980, the City of Montrose and Town of Olathe, which are located along the U.S. Highway 50 corridor in eastern Montrose County, accounted for 41 percent of the county's population (Table 3.10-6). By 2008, almost 49 percent of the county's residents lived in these two municipalities. As of 2008, the towns of Naturita and Nucla, in western Montrose County had not yet recovered their population losses from the 1980s. Although the populations of both towns grew during the 1990s, only Naturita's population increased between 2000 and 2008. U.S. Census population data are not available for the unincorporated communities of Bedrock and Paradox. According to on-line sources, the Bedrock community had approximately 230 residents in 2008 (RealTravel, 2008) and Paradox community had approximately 250 residents in 2009 (Paradox Valley School, 2009).

Table 3.10-6
Population of Montrose County Jurisdictions, 1980 – 2008[1]

Area	Population				Population Change		
	1980	1990	2000	2008	1980-1990	1990-2000	2000-2008
Montrose County	24,352	24,423	33,432	40,539	0.3%	36.9%	21.3%
City of Montrose	8,722	8,854	12,334	17,989	1.5%	39.3%	45.8%
Town of Naturita	819	434	635	655	-47.0%	46.3%	3.1%
Town of Nucla	1,027	656	734	732	-36.1%	11.9%	-0.3%
Town of Olathe	1,262	1,263	1,573	1,742	0.1%	24.5%	10.7%
Unincorporated areas	12,552	13,216	18,156	19,421	5.5%	37.4%	7.0%

[1] CDOLA, 2009a.

Norwood and La Sal are small communities. Population trends in the Town of Norwood are consistent with those in western Montrose County. Between 1980 and 1990, Norwood's population fell from 478 to 429 residents. Although the town's population has increased since 1990, its 2008 population of 462 residents remained below its 1980 population (CDOLA, 2009a). The 2000 Census provides the most recent population count for the unincorporated community of La Sal. Unlike Bedrock and Paradox, La Sal is a Census Designated Place, or CDP. In 2000, the La Sal CDP had 339 residents (U.S. Census Bureau, 2000a).

3.10.2.1 Resident Tenure

The limited data available on households' residency patterns suggest that most of the people who live in Montrose County are year-round residents, and that people who live in western Montrose County tend to be long-term residents of the county. Information on housing vacancies and length of residency is collected in the decennial census. According to the 2000 Census, 17.7 percent of the vacant housing units in Montrose County were unoccupied because they were used for seasonal, recreation or occasional use. By way of contrast, 79.7 percent of the vacant housing units in San Miguel County, where Telluride is located, were unoccupied due to seasonal, recreation, or occasional use. In 2000, 75.2 percent of the residents of the Nucla Census County Division (CCD) had lived in Montrose County for at least 5 years, compared to 72 percent of residents of the Olathe CCD and 69 percent of Montrose CCD residents (U.S. Census Bureau, 2000a).

3.10.2.2 Transient Populations

Historically, farms and orchards in eastern Montrose County have attracted seasonal farm workers. For the past several years, the number of migrant workers in the county has been declining. The decrease in seasonal workers is due to several factors, including a decreasing number of orchards in Montrose County, a reduction in the amount of hand-work required in agriculture, an increase in the presence and enforcement activities of the U.S. Citizenship and Immigration Services, and a reduction in the need for independent migrant labor as several companies employ their own laborers (Economic and Planning Systems, Inc., 2003). The CDLE estimates that 368 non-immigrant farm workers will be working in Delta and Montrose counties between June and December 2009 (CDLE, 2009). Most of these workers are likely to be working on orchards on the eastern side of Montrose County (Leon, 2009).

3.10.3 Surrounding Population

NRC Guidance for Preparation of Environmental Reports for Uranium Mills requires the tabular description of neighboring schools, plants, hospitals, and residential areas within 5 miles (8 km) of the Site (NRC, 1982a). In order to identify the population within 5 miles (8 km) of the Site, in June 2009, Energy Fuels conducted a review of the Montrose County Assessor's Office GIS database available through the Southwest Data Center (Southwest Data Center, 2009). Based on the property data available, 70 parcels with 41 unique owners were identified as being partially within 5 miles (8 km) of the Site. In addition to the mill, only seven of these parcels had addresses. Energy Fuels obtained two of the addresses for off-site monitoring locations and identified the remaining five properties as having potential residences. Five residences on four of the properties were field-verified by Energy Fuels personnel between June 13 and June 17. No residence was observed on the fifth property. Based on consultation with local law enforcement officials, Energy Fuels identified a possible additional residence on Monogram Mesa. Field verification on June 18 identified this residence as a hogan with various out-buildings. Although no residents were on the property, nor did it have an address or utility services, the buildings appeared to be maintained. Based on information provided by local law enforcement officials, two full-time residents are assumed to occupy the structures. Table 3.10-7 summarizes the results of Energy Fuels' residential field verifications.

Table 3.10-7[1]
Population within 5 miles (8 km) of Site[1]

Owner Name	Full-Time Residents	Part-Time Residents	Distance from the Site
Herron[2]	0	1	5.1 km west, 4.7 km north
Boren	2	1	7.6 km west, 6.1 km north
Kinder	1	0	7.6 km west, 6.1 km north
Davis/Fehlman[3]	0	3	5.3 km east, 2.7 km south
Hurdle	1	0	6.4 km east, 3.2 km south
Unknown (hogan structure)	2	0	3.7 km west, 1.0 km south
Total	6	5	

[1] Source: Rogers, 2009.
[2] In mid-June 2009, this residence was occupied on a part-time basis by one person and the property was for sale. For modeling purposes, two full-time residents were assumed, dependent on the future sale of the property.
[3] In mid-June 2009, this residence was occupied on a part-time basis by three people. For modeling purposes, two full-time residents were assumed based on the residents' future plans.

Figure 3.10-2 shows this information graphically and extends the analysis to a 6 mile (10 km) radius. There are currently no community or commercial facilities with associated populations or visitors within 6 miles (10 km) of the Site.

3.10.4 Economic Trends

3.10.4.1 Income

Since 2000, real per-capita income levels (as measured in constant 2008 dollars) in Montrose County have been lower than real per-capita income levels for the state and many neighboring counties in western Colorado (see Figure 3.10-3). In 2007, real per-capita income was $30,156 in Montrose County, $28,211 in Delta County, $33,668 in Mesa County, $43,488 in Ouray County, $51,510 in San Miguel County, and $42,775 averaged across the State of Colorado (U.S. Bureau of Economic Analysis, 2009).

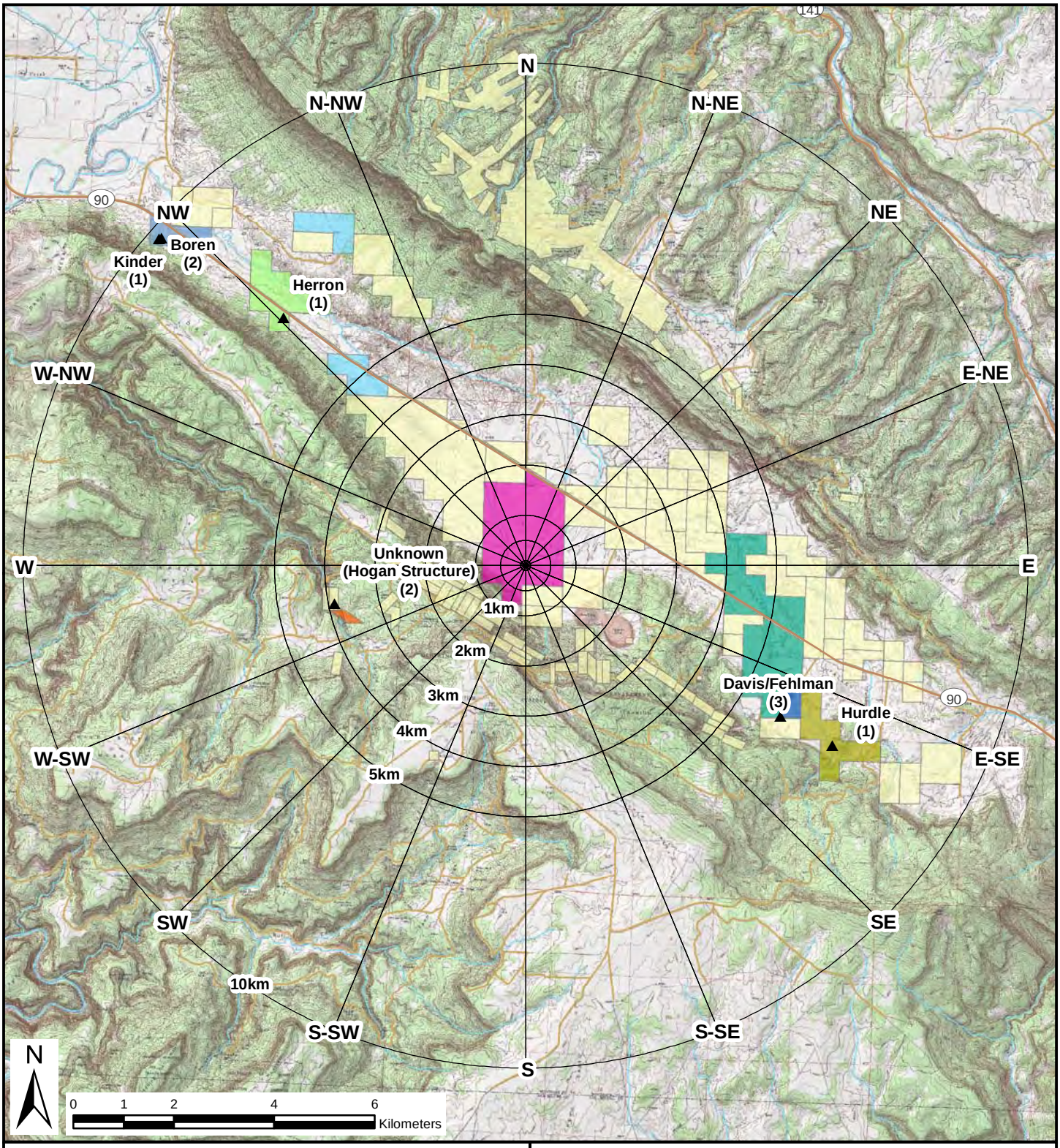
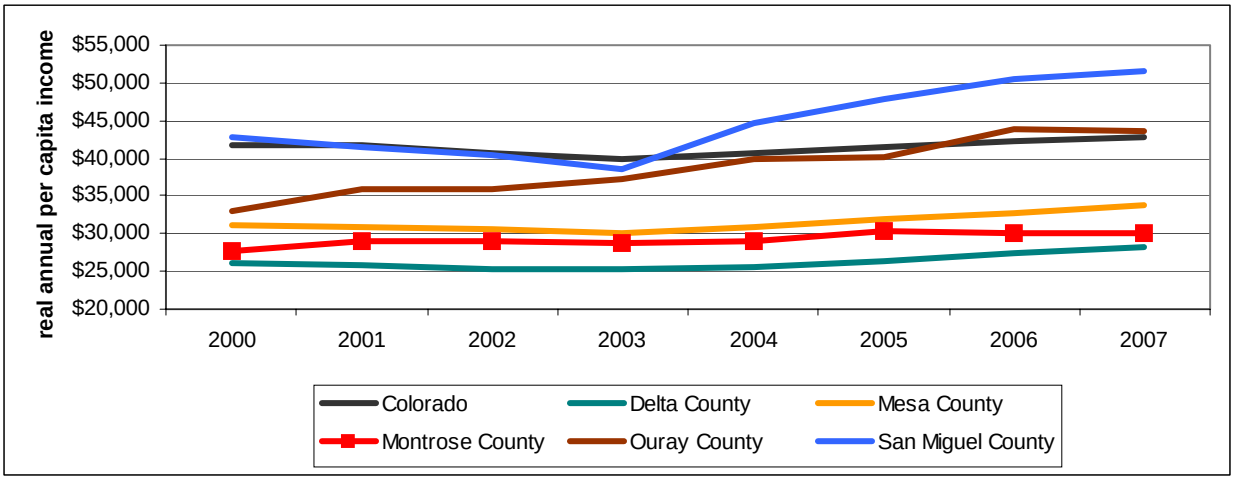


Figure 3.10-2

Population Distribution within 6 miles (10 km) of the Site 2009

Figure 3.10-3
Real Per-Capita Income in Montrose County and Surrounding Colorado Counties, 2000 – 2007[1,2]



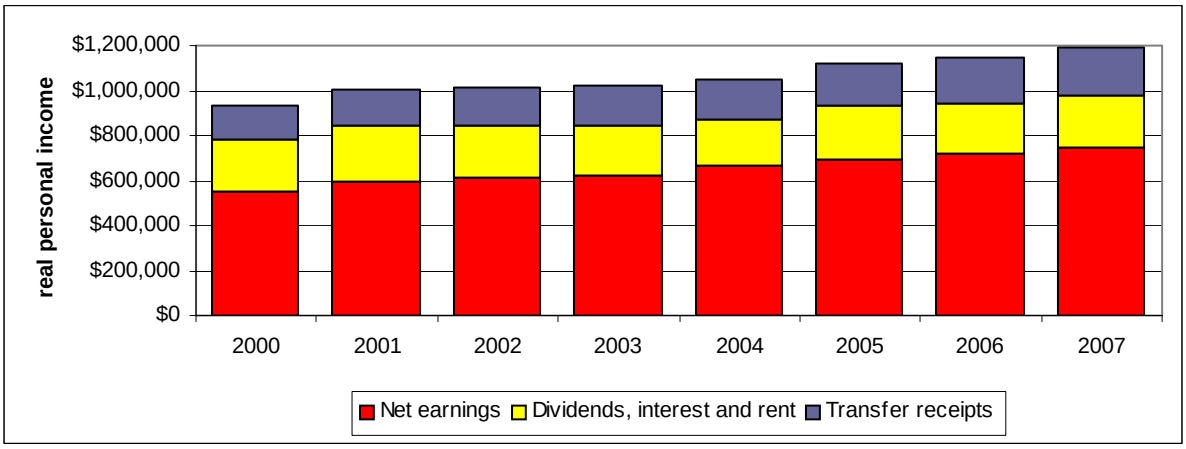
[1] Source: U.S. Bureau of Economic Analysis, 2009.
[2] All dollars expressed in constant 2008 dollars.

Between 2000 and 2007, real per capita income in Montrose County increased 8.9 percent. This was comparable to income growth in relatively-heavily populated neighboring counties. During this time, real per-capita income increased 8.1 percent in Delta and Mesa counties. Real per-capita income increased more substantially in counties with lower populations. Between 2000 and 2007, real per-capita income increased 31.6 percent in Ouray County and 20.4 percent in San Miguel County. Over this period, real per-capita income increased 2.6 percent across the State of Colorado.

Personal income is made up of net earnings, dividends, interest and rent, and personal current transfer receipts. Net earnings consist of total earnings less contributions for government social insurance adjusted to place of residence. Income from personal dividends, interest, and rent is also referred to as “investment income”. Transfer receipts are income for services not currently rendered, and include retirement, disability insurance benefits, medical payments (primarily Medicare and Medicaid), income maintenance benefits, unemployment insurance benefits, veterans benefits, and federal grants and loans to students.

Figure 3.10-4 shows that earnings comprise the majority of personal income in Montrose County. Between 2000 and 2007, net earnings comprised between 59 and 62 percent of personal income in Montrose County. During this time, investment income comprised between 20 and 25 percent of personal income, and transfer receipts comprised between 16 and 18 percent (U.S. Bureau of Economic Analysis, 2009).

Figure 3.10-4
Components of Personal Income in Montrose County, 2000 – 2007[1,2]



[1] Source: U.S. Bureau of Economic Analysis, 2009.
[2] All dollars expressed in constant 2008 dollars.

3.10.4.2 Employment

According to the CDLE, employment in Montrose County increased 28.6 percent between 2000 and 2008 (see Table 3.10-8). The decrease in employment between 2007 and 2008 reflected the national slowdown in economic activity.

Table 3.10-8
Montrose County Employment Level, 2000 - 2008[1]

Year	Employment Level
2000	15,654
2001	16,203
2002	16,855
2003	17,178
2004	18.095
2005	18.914
2006	19,608
2007	20,137
2008	19,840

[1] Source: CDLE, 2009.

Employment by Industry. The Construction, Manufacturing, Retail Trade, Health Care and Social Assistance, and Accommodation and Food Services sectors provide over 60 percent of wage employment in Montrose County (see Table 3.10-9). In 2008, average annual wages varied from a low of $14,338 in Accommodation and Food Services to highs of $56,628 in Utilities, $69,576 in Mining, and $143,312 in Management of Companies and Enterprises (U.S. Bureau of Labor Statistics, 2009a).

Table 3.10-9
Montrose County Non-Farm Employment and Wages by Industry, 2000 and 2008[1,2]

Industry	2000		2008	
	Average Employment	Average Annual Wages	Average Employment	Average Annual Wages
Total industry employment	11,869	$23,464	13,064	$32,734
Agriculture, Forestry, Fishing, Hunting	269	$18,460	229	$25,272
Mining	115	$42,692	179	$69,576
Utilities	281	$41,392	300	$56,628
Construction	1,091	$28,184	1,452	$38,480
Manufacturing	1,472	$24,440	1,325	$29,744
Wholesale trade	469	$25,948	510	$40,768
Retail trade	1,875	$20,904	2,324	$25,792
Transportation & Warehousing	515	$24,180	607	$30,628
Information	212	$22,256	241	$30,316
Finance & Insurance	302	$28,184	402	$42,744
Real Estate, Rental & Leasing	197	$19,084	326	$34,320
Professional & Technical Services	391	$27,404	537	$41,132
Mgmt of Companies & Enterprises	25	$37,128	25	$143,312
Administrative & Waste Services	413	$15,444	498	$24,076
Educational Services	NA[3]	NA	NA	NA
Health Care & Social Assistance	1,606	$24,076	2,225	$33,696
Arts, Entertainment & Recreation	156	$12,636	271	$20,176
Accommodation & Food Services	1,154	$9,204	1,192	$14,300
Other services	368	$21,320	413	$30,732
Public Administration	958	$33,748	1,037	$47,528

[1] Source: U.S. Bureau of Labor Statistics, 2009a.
[2] These employment levels exclude proprietors and farm employment.
[3] NA=not available.

Tourism-related Employment. Tourism also contributes to employment in Montrose County. A wide range of businesses, primarily within the leisure and hospitality, transportation, and retail sectors, provides travel-related goods and services. Due to its economic diversity, the tourism industry is not categorized as a distinct industry sector that can be readily evaluated through employment data reported by the Bureau of Labor Statistics. In 2008, the travel consultancy firm of Dean Runyan Associates evaluated the economic impacts of travel in Colorado (Dean Runyan Associates, 2008). This study estimated that, in 2007, approximately 990 full and part-time jobs in Montrose County were generated by overnight and day visitor spending in the county. (Note that these tourism-related employment estimates are expressed in jobs rather than workers.) One worker may have more than one job). Table 3.10-10 shows that, after rising to a high of 1,190 jobs in 2005, tourism-related employment in Montrose County fell to 990 jobs in 2007. This represents a 1 percent decrease in tourism-related jobs between 2000 and 2007.

Hunting and fishing contribute to tourism-related employment in Montrose County. In 2004, the CDOW commissioned a study estimating the economic impacts of hunting and fishing in Colorado (BBC Research & Consulting - BBC, 2008a). This study, which was revised in 2008, estimated that, in 2002 (the latest year for which hunting and fishing data have been analyzed), the total economic impacts of hunting and fishing were $23.6 million in Montrose County. The study also estimated that, in 2002, 310 jobs in Montrose County were related to hunting and fishing. These findings suggest that, while hunting and fishing contribute to economic activity in Montrose County, a substantial portion of tourism-related employment in the county is not related to hunting and fishing activities.

Table 3.10-10
Montrose County
Tourism-Related Employment, 2000 - 2008

Year	Employment (jobs)	Average Annual Earnings
2000	1,000	$16,500
2001	970	$18,454
2002	950	$18,211
2003	1,080	$21,111
2004	1,150	$20,783
2005	1,190	$20,504
2006	1,150	$23,130
2007	990	$27,374

[1] Source: Dean Runyan Associates, 2008.

Basic Industries. Several industries that are substantial sources of employment in Montrose County (*e.g.* Retail Trade, Health Care and Social Assistance, and Accommodation and Food Services) circulate money within an economy to provide local goods and services. Although they provide jobs, these industries do not inject investment from outside the county into the local economy to create industries that will export goods and services outside the county and support ancillary industries. Industries that fall into this latter category are the types of industries that drive an economy and are known as “direct basic industries” (BBC, 2008b).

Basic industries have a higher concentration of employment within the local economy as compared to a reference economy, and are identified through location quotients. Location quotients are calculated by dividing the percent of employment in an industry sector within the local economy (Montrose County) by the percent of employment in the same industry sector in the reference region (Colorado). A location quotient greater than 1.0 implies that there is a greater concentration of employment in an industry sector within a local economy as compared to the reference region. A location quotient of 1.0 implies that the concentration of employment in that industry sector is the same in the local economy as the reference region. A location quotient less than 1.0 implies that there is less employment in an industry sector as a percentage of total employment in the local economy than in the reference region. Basic industries are identified as having a location quotient greater than 1.0.

Montrose County location quotients for 2000 and 2007 for all industry sectors compared to the State of Colorado are shown in Table 3.10-11. The location quotients for 2000 and 2007 for all industrial sectors compared to the State of Colorado are shown in Table 3.10-8. The location quotients indicate several industries in Montrose County that employ a greater portion of the county’s workforce than the statewide average. These industries include Agriculture, Forestry, Fishing and Hunting, Utilities, Manufacturing, and Transportation and Warehousing. These are all typical basic industries (BBC, 2008b).

Historically, the mining industry has been a basic industry in Montrose County. Although employment in Montrose County’s mining sector increased between 2000 and 2008, the portion of the county’s workforce employed within the mining sector fell below the statewide average. Table 3.10-11 shows that employment growth in Montrose County’s mining sector has lagged the statewide average. The mining sector’s location quotient of 1.8 in 2000 indicates that there was a greater concentration of employment in Montrose County’s mining sector as compared to the statewide average. The location quotient of 0.84 shows that, in 2007, there was a lower

concentration of employment in Montrose County's mining sector as compared to the statewide average.

Table 3.10-11
Location Quotients
by Industry for Montrose County, 2000 and 2007[1]

Industry	2000	2007
Agriculture, Forestry, Fishing, Hunting	3.32	3.10
Mining	1.80	0.84
Utilities	3.85	3.49
Construction	1.20	1.53
Manufacturing	1.42	1.56
Wholesale Trade	0.86	0.79
Retail Trade	1.40	1.38
Transportation & Warehousing	1.11	1.24
Information	0.36	0.52
Finance & Insurance	0.54	0.60
Real Estate, Rental & Leasing	0.78	1.10
Professional & Technical Services	0.47	0.52
Mgmt of Companies & Enterprises	0.25	0.11
Administrative & Waste Services	0.52	0.53
Educational Services	0.09	0.06
Health Care & Social Assistance	1.55	1.47
Arts, Entertainment & Recreation	0.61	0.83
Accommodation & Food Services	1.03	0.89
Other Services	1.03	0.98
Public Administration	1.41	1.17

[1] Source: BBC, 2008b.

Major Employers in Montrose County. Most of the major employers in Montrose County are located along the Highway 550 corridor in eastern Montrose County (see Table 3.10-12).

Tri-State Generation is the largest employer in western Montrose County. Approximately 70 workers are employed at Tri-State Generation's Nucla Station coal plant. Another 28 workers are employed at the New Horizon Mine, which is owned by Western Fuels of Colorado, of which Tri-State Generation is the parent company (Sullivan, 2009). The second largest employer in western Montrose County is the San Miguel Power Association, which has 25 employees in its Nucla office (Spangler, 2009).

Some residents of Naturita and Nucla work in construction, education, small local businesses, and government offices. According to an informal survey of Bedrock and Paradox residents, many people in these communities reported that they work in ranching, truck driving, the local charter school, government (*e.g.* Colorado and Montrose County Departments of Transportation, BOR's desalination plant), and small businesses that include retail, lodging, and agricultural activities. Some residents reported that they work in construction and service industries in Telluride, and a few reported that they work out of their homes (Berger, 2009).

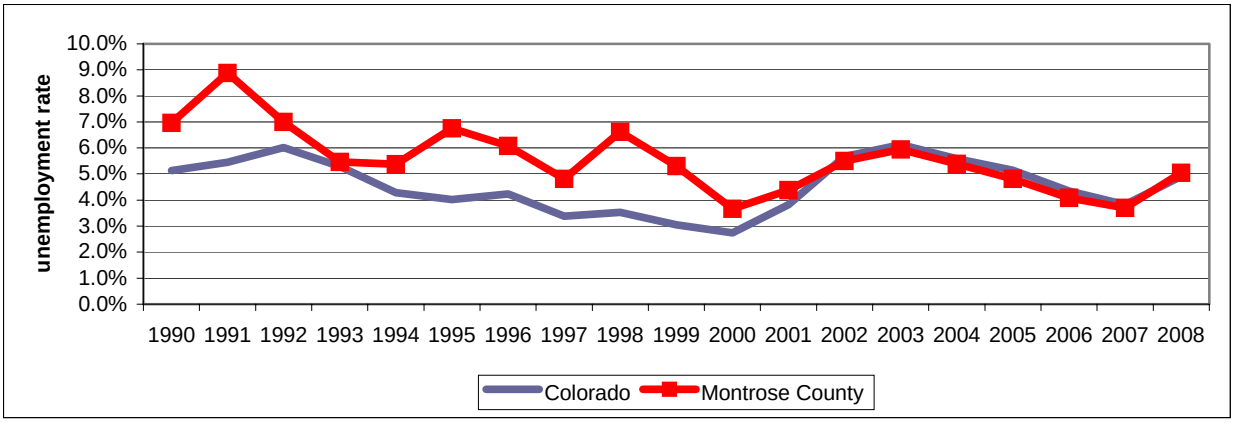
Table 3.10-12
Major Employers in Montrose County[1]

Employer	Location	Number of Employees
Montrose County School District	County-wide	850
Montrose Memorial Hospital	Montrose	530
Russell-Stover Candies	Montrose	400
Wal-Mart	Montrose	380
Volunteers of America	Montrose	350
Montrose County	Montrose	340
City Market	Montrose, Olathe	210
City of Montrose	Montrose	175
Community Options	Montrose	160
Home Depot	Montrose	120
Delta-Montrose Electric Assn.	Montrose	115
Hansen-Weatherport	Olathe	96
Gordon Composites	Montrose	90
Wells Fargo	Montrose	85
Rocky Mountain Steel	Olathe	72
Nucla Station	Nucla	70
Best Sign Systems	Montrose	59

[1] Source: Montrose Economic Development Corporation, 2009.

Unemployment Rates. During the 1990s, the unemployment rate in Montrose County was generally higher and more volatile than the unemployment rate across the State of Colorado (see Figure 3.10-5). Between 1990 and 1999, the unemployment rate varied between a low of 4.8 percent and a high of 8.9 percent in Montrose County, and 3.0 percent and 6.0 percent in Colorado (U.S. Bureau of Labor Statistics, 2009b). The county's unemployment rate has been less volatile and followed the statewide average more closely since 2000. Both unemployment rates increased between 2000 and 2003, and fell through 2007. Between 2007 and 2008, the unemployment rate increased from 3.7 percent to 5.0 percent in Montrose County and from 3.8 percent to 4.9 percent across the state.

Figure 3.10-5
Unemployment Rates in Colorado and Montrose County, 1990 – 2008[1]

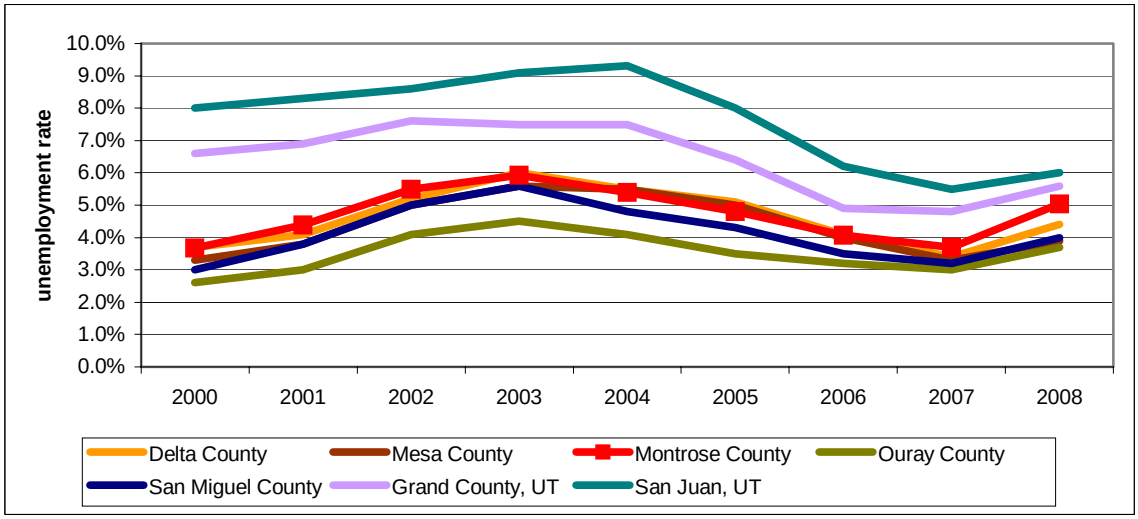


[1] Source: U.S. Bureau of Labor Statistics, 2009b.

As shown in Figure 3.10-6, the unemployment rate in Montrose County has generally been higher than unemployment rates in neighboring Colorado counties and lower than

unemployment rates in adjacent Utah counties since 2000 (U.S. Bureau of Labor Statistics, 2009b).

Figure 3.10-6
Unemployment Rates in Montrose County and Surrounding Colorado Counties, 2000 – 2008[1]



[1] Source: U.S. Bureau of Labor Statistics, 2009b.

Commuting Patterns. The decennial census collects information on commuting patterns. In 2000, 85.3 percent of Montrose County residents worked in the county (U.S. Census Bureau, 2000b). Most residents of Montrose County who worked outside the county worked in San Miguel and Delta counties (see Table 3.10-13). In 2000, 5.4 percent of Montrose County workers worked in San Miguel County and 3.7 percent worked in Delta County. Another 1.6 percent worked in Ouray County and 1.2 percent worked in Mesa County.

Table 3.10-13
Percent of Residents of Montrose County and Surrounding Counties who work in Neighboring Counties, 2000[1]

County of Work	County of Residence						
	Delta (percent)	Dolores (percent)	Mesa (percent)	Montezuma (percent)	Montrose (percent)	Ouray (percent)	San Miguel (percent)
Delta	78.6	0.0	0.3	0.2	3.7	0.3	0.1
Dolores	0.0	56.7	0.0	0.3	0.0	0.0	0.4
Mesa	3.6	0.3	95.7	0.2	1.2	0.6	0.0
Montezuma	0.0	22.3	0.0	85.5	0.0	0.0	0.8
Montrose	9.0	0.3	0.2	0.0	85.3	11.9	1.0
Ouray	0.2	0.0	0.0	0.0	1.6	72.2	0.5
San Miguel	0.5	10.6	0.1	0.9	5.4	12.4	95.3

[1] Source: U.S. Census Bureau, 2000b.

In 2000, the greatest number of non-residents working in Montrose County lived in Delta and Ouray counties. These counties are adjacent to the north and south of Montrose County, respectively, and are connected to Montrose County by U.S. Highway 50. In 2000, 9 percent of the workforce in Delta County and 11.9 percent of the workforce in Ouray County commuted to Montrose County.

The Census Bureau does not report the county in which out-of-state commuters work. In 2000, 2.7 percent of workers residing in Grand County, Utah and 10.4 percent of workers living in San Juan County, Utah worked outside the state (U.S. Census Bureau, 2000b).

Table 3.10-14 shows that, in 2000, a higher percentage of residents of western Montrose County (Nucla CCD) commuted outside the county for work than residents of eastern Montrose County (Montrose and Olathe CCDs). This is most likely due to limited employment opportunities in western Montrose County. In 2000, 31.4 percent of workers living in the Nucla CCD worked outside the county, 12.1 percent of workers living in the Montrose CCD worked in another county, and 17 percent of workers living in the Olathe CCD worked in another county (U.S. Census Bureau, 2000b).

Table 3.10-14
Montrose County Residents – Place of Employment by Percent, 2000[1]

	Resident of		
Place of employment	**Montrose CCD (percent)**	**Nucla CCD (percent)**	**Olathe CCD (percent)**
Worked in Montrose County	87.9	68.6	83.0
Worked in another Colorado county	11.2	29.1	16.5
Worked in another state	0.9	2.3	0.5

[1] Source: U.S. Census Bureau, 2000b.

3.10.5 Housing

3.10.5.1 Permanent Housing

Most of Montrose County's housing stock consists of owner-occupied single-family homes. In 2000, the latest year for which housing tenure data are available, 88 percent of Montrose County's housing units were single-family and mobile homes, and owners occupied 75 percent of occupied housing units (U.S. Census Bureau, 2000a). Between 2000 and 2008, 87 percent of residential building permits authorized in Montrose County were for single-family homes and 13 percent were for multi-family units (U.S. Census Bureau, 2009b).

According to housing estimates generated by the CDOLA, Montrose County's housing supply increased 21.5 percent between 2000 and 2008 (CDOLA, 2009b). Consistent with population trends, most housing growth has been on the eastern side of the county. According to CDOLA, between 2000 and 2008 the number of housing units increased 44 percent in the City of Montrose, 12 percent in Olathe, 4 percent in Naturita, 0 percent in Nucla, and 7 percent in other parts of the county (see Table 3.10-15).

Montrose County's housing market has slowed since 2006. According to the Montrose Economic Development Corporation, the number of residential sales in the City of Montrose fell from 797 in 2006 to 678 in 2007 and 472 in 2008. Housing prices in Montrose increased modestly: the average residential sale price increased from $218,171 in 2006 to $220,334 in 2007 (a 1 percent increase) and $223,679 in 2008 (a 1.5 percent increase) (Montrose Economic Development Corporation, 2009). According to information provided by the Montrose County Assessor's Office, between 2007 and 2008, the average residential sale price was $116,060 in Naturita, $138,915 in Nucla, and $347,440 in the Redvale/Norwood area (Johnson, 2009 and Montrose County, 2009c).

Table 3.10-15
Housing Units in Montrose County Jurisdictions, 2000 – 2008[1]

Year	Montrose County	City of Montrose	Naturita	Nucla	Olathe	Other Areas
2000	14,202	5,581	314	369	571	7,367
2001	14,475	5,948	316	369	581	7,261
2002	14,774	6,165	231	369	589	7,330
2003	15,191	6,476	323	369	598	7,425
2004	15,571	6,759	325	369	607	7,511
2005	16,070	7,121	326	369	617	7,637
2006	16,517	7,557	326	369	628	7,637
2007	17,027	7,928	326	369	633	7,771
2008	17,251	8,039	326	369	640	7,877

[1] Source: CDOLA, 2009b.

The Colorado Multi-Family Housing Vacancy and Rental Survey indicates that Montrose County's residential rental market has weakened since 2007 (see Table 3.10-16). According to the survey, which is conducted quarterly for the Colorado Division of Housing, the average vacancy rate in Montrose County increased from 4.0 percent to 5.5 percent between the third quarters of 2007 and 2008. The rental market weakened further between the first quarters of 2008 and 2009, when the average vacancy rate increased from 4.8 percent to 9.4 percent and the average rental rate fell from $611 to $595 (Von Stroh, 2009).

Table 3.10-16
Residential Vacancy and Rental Rates in Montrose County[1]

Quarter/ Year	Average Vacancy Rate	Average Rent	Quarter/ Year	Average Vacancy Rate	Average Rent
3rd Qtr – 2000	3.8%	$519	1st Qtr – 2005	1.9%	$577
1st Qtr – 2001	1.6%	$550	3rd Qtr – 2005	3.8%	$584
3rd Qtr – 2001	3.3%	$542	1st Qtr – 2006	5.1%	$573
1st Qtr – 2002	3.3%	$534	3rd Qtr – 2006	6.1%	$556
3rd Qtr – 2002	2.4%	$505	1st Qtr – 2007	5.1%	$569
1st Qtr – 2003	6.3%	$513	3rd Qtr – 2007	4.0%	$601
3rd Qtr – 2003	4.6%	$574	1st Qtr – 2008	4.8%	$611
1st Qtr – 2004	3.4%	$548	3rd Qtr – 2008	5.5%	$612
3rd Qtr – 2004	3.5%	$553	1st Qtr – 2009	9.4%	$595

[1] Source: Von Stroh, 2009.

Most housing units near the Site are single-family or mobile homes on large acreage parcels. In 2000, single-family and mobile homes accounted for 94 percent of the housing stock in the Nucla CCD, and owners occupied 77 percent of the occupied housing units (U.S. Census Bureau, 2000a). Table 3.10-17 reports housing characteristics for the towns of Naturita, Nucla, and Norwood, and the La Sal CDP. Census data on housing characteristics in the unincorporated communities of Bedrock and Paradox are not available. In 2000, single-family and mobile homes comprised 91 percent of the housing supply in Naturita, 93 percent in Nucla, 86 percent in Norwood, and 95 percent in La Sal. Owners occupied 82 percent of the occupied housing units in Naturita, 66 percent in Nucla, 63 percent in Naturita, and 58 percent in La Sal (U.S. Census Bureau, 2000a).

Multi-listing service (MLS) data from early June 2009 included 50 houses for sale in the Naturita and Nucla areas. According to local sources, the local rental market, which includes a 10-unit apartment complex in Nucla, fluctuates greatly. A local developer has plans to develop 36 two-

and three-bedroom townhouses in Naturita. Four units are currently under construction and market conditions will determine when the additional units will be built. The owner plans to sell or rent the units, depending on demand (Davis, 2009).

Table 3.10-17
Housing Characteristics in Towns near the Site, 2000[1]

Housing Characteristic	Town of Naturita	Town of Nucla	Nucla CCD	Town of Norwood	La Sal CDP
Miles from Piñon Ridge Site	13	16	NA	35	34
Population	635	734	1,258	438	339
Housing units	312	378	1,434	253	126
Occupied housing units	259	318	1,169	194	104
Owner occupied housing units	213	209	902	122	60
Renter-occupied housing units	46	109	267	72	44
Single-family and mobile homes	284	353	1,354	217	120
Multi-family units and RVs	26	23	65	34	6

[1] Source: U.S. Census Bureau, 2000a.

3.10.5.2 Short-term Housing

Short-term housing accommodations near the Site include motels, apartments, houses, mobile homes, and recreational vehicle (RV) parks. There are approximately 77 motel rooms, 11 short-term apartment/house/mobile home rentals, and 119 RV sites in the Naturita and Norwood areas (see Table 3.10-18). A mobile home park in La Sal may provide additional opportunities for RV placement.

Table 3.10-18
Short-term Housing near the Site[1]

Establishment	Location	Number of Rooms
Blake House	Naturita	9 rooms
Naturita Lodge	Naturita	10 rooms, 2 apartments
Ray Motel	Naturita	42 rooms, 4 bedroom house
Paradox Valley Inn	Paradox	3 bed & breakfast suites with kitchen, 1 room
Charley's Place	Norwood	2 bedroom house
Norwood Inn	Norwood	12 rooms
Stella's Farmhouse	Norwood	3 bedroom house
High Country RV Park	Naturita	21 full service hookups, 98 pull-through sites
San Miguel Trailer Park	Norwood	2 2-bedroom trailers, 2 3-bedroom trailers
La Sal Mobile Home Park	La Sal	Variable number of sites

[1] Sources: Nucla-Naturita Area Chamber of Commerce, 2009; Norwood Inn and Rental Properties, 2009; and Cannon, 2009.

3.10.6 Community Services

3.10.6.1 Schools

The Site is located in Montrose County's West End RE-2 school district. With the exception of the Redvale area, the West End RE-2 school district covers the portion of Montrose County that lies west of the Uncompahgre Plateau. The district includes an elementary school located in Naturita, a junior/senior high school in Nucla and a charter school in Paradox. Student enrollments in the West End RE-2 school district fell 23 percent between 2000 and 2008: from 448 students in October 2000 to 345 students in the October 2008 (see Table 3.10-19). According to enrollment records maintained by the Colorado Department of Education, grades 9 through 12 had the greatest student losses during this period (Colorado Department of

Education, 2009). Between 2000 and 2008, the pupil/teacher ratio within the West End RE-2 school district ranged between a low of 11.9 in 2005 and 2006 and a high of 15.8 in 2002.

Table 3.10-19
Student Enrollments, West End RE-2 and Norwood R-2J School Districts, Fall 2000 – Fall 2008[1]

District	2000	2001	2002	2003	2004	2005	2006	2007	2008
West End RE-2									
Student Enrollment	448	431	416	407	402	381	353	335	345
Pupil/Teacher Ratio	13.2	14.7	15.8	12.2	14.3	11.9	11.9	12.1	12.5
Norwood R-2J									
Student Enrollment	299	326	317	304	292	285	276	296	300
Pupil//Teacher Ratio	11.8	11.4	12.5	12.3	12.8	12.1	11.7	13.2	12.3

[1] Source: Colorado Department of Education, 2009.

San Miguel County's Norwood R-2J school district also serves students in western Montrose County. A portion of the Norwood R-2J school district, the majority of which covers San Miguel County west of the Uncompahgre National Forest, extends into the Redvale area of Montrose County, north of Norwood. The district has one pre-K through 12th grade school, located in Norwood. District-wide enrollments ranged from a high of 326 students in October 2001 to a low of 276 students in October 2006, and were nearly the same level in October 2008 (300 students) that they were in October 2000 (299 students). Between 2000 and 2008, the pupil/teacher ratio within the Norwood R-2J school district ranged between a low of 11.4 in 2001 and a high of 13.2 in 2007 (Colorado Department of Education, 2009).

3.10.6.2 Medical Services

Physicians and other medical practitioners in Naturita, Norwood, Montrose, and Grand Junction provide medical services to residents of western Montrose County. The Basin Clinic in Naturita is operated by Montrose Memorial Hospital to provide primary family care and 24-hour emergency medical services. The clinic's medical staff includes one full-time nurse, two part-time nurses, three physician assistants with emergency training, and a physician who visits the clinic twice a week. The clinic has a heliport in Naturita to transport patients to hospitals in Montrose or Grand Junction. According to the clinic's director, the Basin Clinic's patient-provider ratio has room for expansion (Haag, 2009).

The Uncompahgre Medical Center (UMC) in Norwood also provides primary and emergency care to area residents. UMC is one of three federally qualified community health centers on Colorado's western slope that does not deny health care based on financial limitations. UMC's medical staff includes one physician, two physician assistants, one nurse, one paramedic, and one nursing assistant. Facilities include on-site labs, x-ray and imaging services, and air service to St. Mary's Hospital in Grand Junction for emergencies.

The nearest hospitals are in Montrose and Grand Junction. Both cities are approximately 1.5 hours by road from the Site. Montrose Memorial Hospital is a full-service regional hospital with 75 beds. There are two full-service hospitals in Grand Junction. St. Mary's Hospital and Regional Medical Center has 318 beds and is a regional center for cardiovascular and orthopedic services, obstetrics, intensive care for newborns, trauma care, neurosurgery, general surgery, and women and children's services. Grand Junction's Community Hospital is an acute care facility with 78 beds.

3.10.6.3 Public Safety

The Montrose County West End Sheriff's Substation provides first-call police services in the area of the Site. The West End Sheriff's Substation is a public safety answering point that dispatches 911 calls. The substation's staff includes one sergeant, five deputies and five dispatchers. Table 3.10-20 shows the number of law enforcement calls and offenses reported to the West End Sheriff's Substation between 2006 and 2008.

Table 3.10-20
Montrose County Crime Statistics[1]

Dispatch Call	2006	2007	2008
Total law enforcement calls	5,843	5,568	5,347
Reported offenses			
Alcohol-related	28	20	38
Assault	13	19	6
Burglary	19	15	9
Death investigations	7	16	14
Disputes & disturbances	69	67	64
Drug-related	20	12	8
Motor vehicle theft	8	8	3
Property damage	3	2	4
Sex offenses	7	7	3
Theft	55	40	48
Traffic-related	589	616	826
Trespassing	20	14	23

[1] Source: Johansen, 2009.

The Nucla/Naturita Fire Protection District and Paradox Volunteer Fire Department provide fire protection services in the area of the Site. The Nucla/Naturita Fire Protection District is an all volunteer unit that provides emergency medical services, including ambulance service, and fire protection services. The Paradox Volunteer Fire Department reported that, although it has sufficient equipment to service the current population, it has had trouble attracting volunteer firefighters (Berger, 2009).

3.10.6.4 Water and Wastewater Services

The Mustang Water Authority provides potable water to the towns of Naturita and Nucla. The current water supply system, built in 2004, can supply a maximum amount of 1.2 million gallons of treated surface water per day. Average daily production is currently 300,000 gallons per day, or 25 percent of its current capacity (Carter, 2009). Individual wells provide water to several rural households in the Paradox and Bedrock areas. The Paradox Pipeline Company provides an alternative source of potable water to rural households. This member-owned cooperative currently has approximately 50 active members who typically use between 36,000 and 38,000 gallons per month per household (Oliver, 2009). Although the cooperative's supply of treated groundwater is adequate for the needs of current residents, opportunities to expand services to new households are limited by the cooperative's existing water rights.

Naturita and Nucla have lagoon system wastewater treatment plants that are currently operating below their maximum capacities. Naturita's wastewater treatment plant has a maximum treatment capacity of 200,000 gallons per day, and currently treats an average of 60,000 gallons per day (Carver, 2009). The Nucla Sanitation District's plant has a maximum treatment capacity of 300,000 gallons per day. Peak usage, which typically occurs in July, varies between 80,000 and 100,000 gallons per day (LaBondy, 2009).

In January 2009, the towns of Naturita and Nucla jointly applied to the CDPHE Water Quality Control Division's Water Pollution Control Revolving Fund for a new regional wastewater treatment plant, wastewater collection, and interceptor system to serve both towns (CDPHE, 2009b). In August 2009, the Mustang Water Authority joined the towns of Naturita and Nucla to initiate a joint feasibility study to explore options for a new regional wastewater treatment plant (Carver, 2009). Outside of Naturita and Nucla, wastewater is treated by on-site septic systems.

3.10.7 Fiscal Conditions

3.10.7.1 County Revenues

The largest sources of revenue to the Montrose County government are charges for services, federal and state revenues, property taxes, and sales and use taxes (see Table 3.10-21).

Table 3.10-21
Montrose County Budget Revenue Sources[1,2]

Revenue Source	2007	2008	2009
Property and other tax revenues	$10,782,635	$11,202,857	$11,835,053
Sales and Use taxes	$7,746	$10,154,417	$9,202,205
Licenses and permits	$529,654	$618,375	$596,675
Federal and state revenues	$15,019,291	$13,127,529	$13,554,135
Received from other governments	$1,213,546	$934,504	$1,267,876
Charges for services	$59,470,633	$63,917,641	$67,741,519
Other financing sources	$5,334,151	$3,962,253	$3,512,484
Subtotal revenues	$92,357,655	$103,917,576	$107,709,947
Internal resources	$4,829,058	$7,021,963	$5,483,768
Total resources	**$97,186,713**	**$110,939,539**	**$113,193,715**

[1] Source: Montrose County, 2009c.
[2] Non-hospital revenues.

Between 2007 and 2009, charges for services accounted for approximately 63 percent of Montrose County's revenues. These charges include clerk and recorder fees, fuel flowage charges paid to the airport by the fixed base operator, charges to inmates for personal items and telephone calls, and impact fees. In 2008, Montrose County implemented an impact fee on residential developments to fund capital improvements in the road and bridge, fairgrounds, administration, and sheriff's departments. Between 2007 and 2009, revenues from charges and fees for services increased 14 percent.

Since 2007, federal and state funds have accounted for approximately 14 percent of Montrose County's revenues. These federal and state funds are primarily grant monies used to provide Social Service and other county programs. The county's receipt of federal funds includes "payment in lieu of taxes" (PILT), which offsets a portion of property tax revenue lost from nontaxable federal lands within county boundaries. Payments are based on federal acreage in the county for all federal land agencies. Between 2007 and 2009, Montrose County PILT increased 52 percent, from $1,277,559 to $1,946,682 (USDI, 2009). Overall, federal and state revenues to Montrose County decreased 10 percent between 2007 and 2009.

Since 2007, property taxes and other tax revenues have accounted for approximately 11 percent of Montrose County's revenues. Other tax revenues include severance and cigarette taxes, which do not provide a large source of revenue to the county. Between 2007 and 2009, property taxes and other tax revenues to Montrose County government increased 10 percent (Montrose County, 2009c).

Sales and use taxes account for approximately 9 percent of Montrose County's estimated 2008 and 2009 revenues. Montrose County's original sales tax authority ended in June 2006. In November 2007 voters approved two new revenue sources: a public safety sales tax at the rate of 0.75 percent for public safety programs and a 1 percent sales and use tax for road and bridge improvements.

Additional sources of funds to Montrose County government include revenues from other governments, which primarily consist of payments from cities, other counties, and special districts as reimbursement for election costs, dispatch and law enforcement services, the housing of prisoners for other governments, and various pass-through grants. Other financing sources include terminal rents, excise tax rebates, user fee commissions, parking revenue for the airport, investment income, sale of fixed assets, and other miscellaneous sources of revenue.

3.10.7.2 Property Taxes

Mineral processing, which includes uranium milling, affects the county's fiscal status largely through the processing activity's impact on the property, or ad valorem, tax base. As shown in Table 3.10-22, Montrose County's property tax base has been increasing for the past several years. Total assessed valuation on taxable property in Montrose County grew 83 percent between 2003 and 2008; from $316.2 million to $578 million.

Table 3.10-22
Montrose County Assessed Valuation, 2003 – 2008 (million $'s)[1]

Year	2003	2004	2005	2006	2007	2008
Assessed valuation	$316.2	$330.5	$397.7	$431.2	$553.4	$578.0

[1] Source: CDOLA, 2009c.

As shown in Table 3.10-23, residential property accounts for over 40 percent of Montrose County's assessed valuation. Between 2003 and 2008, residential property accounted for 45 percent of the increase in the county's total assessed valuation. Industrial property currently accounts for less than 5 percent of the county's assessed valuation. Between 2003 and 2008, industrial activities accounted for 3 percent of the increase in Montrose County's total assessed valuation.

Table 3.10-23
Montrose County Assessed Valuation by Property Class, 2003 and 2008[1]

Class of Property	**2003**		**2008**	
	Assessed Valuation	**Percent of Total**	**Assessed Valuation**	**Percent of Total**
Vacant	$26,219,530	8.3	$69,931,840	12.1
Residential	$127,415,710	40.3	$245,623,610	42.5
Commercial	$83,784,250	26.5	$158,178,470	27.4
Industrial	$15,793,170	5.0	$24,614,920	4.3
Agricultural	$16,284,450	5.2	$17,763,480	3.1
Natural resources	$2,066,190	0.7	$6,607,160	1.1
Producing mines	$53,490	0.02	$390,160	0.1
Oil & gas	$0	0.0	$281,580	0.05
State assessed	$44,538,710	14.1	$54,655,700	9.5
Total	$316,155,500	100.0	$578,046,920	100.0

[1] Source: CDOLA, 2009c.

3.10.7.3 Town Revenues

Sales tax is the largest source of revenues to the towns of Naturita and Nucla. According to the Town Clerks, sales tax typically accounts for approximately 50 percent of each town's revenues (Lear, 2009; Smith, 2009b). Each town assesses a 4 percent sales tax. Property taxes comprise a smaller portion of town revenues. Property taxes typically comprise approximately 12 percent of Naturita's revenues (Lear, 2009) and 20 percent of Nucla's revenues (Smith, 2009b).

3.10.7.4 Severance Taxes

The State of Colorado assesses a severance tax on metallic minerals, including uranium and vanadium, of 2.25 percent of the gross income from the mining operations in excess of $19 million per year. Gross income is determined by the value of the ore immediately after its removal from the mine, and does not include any value added subsequent to mining by any treatment processes or transportation from the mine (Colorado Department of Revenue, 2009a).

Severance taxes are divided equally between CDNR and CDOLA. Half of the CDNR's portion is used to finance loans for state water projects administered by the Colorado Water Conservation Board. The other half of CDNR's portion is used to finance programs administered by the COGCC, Colorado Geological Survey - Division of Minerals and Geology, Colorado Water Conservation Board, CDOW, and the Division of Parks and Outdoor Recreation (Schrock, 2008).

CDOLA's half of severance tax revenue is distributed to local governments. Seventy percent is available through discretionary loans and grants to local governments in areas impacted by the mineral extraction industry. Local governments apply for the loans and grants, which must be used to plan, construct and maintain public facilities or to provide public services. In 2008, local governments in Montrose County received $1,835,609 in energy and mineral impact awards (see Table 3.10-24).

Table 3.10-24
Energy and Mineral Impact Awards in Montrose County, 2008[1]

Applicant	Project	Amount Awarded
Montrose County	Montrose County II35 Road Design	$55,000
Montrose County	Montrose County Master Plan Update	$190,000
Montrose County	Montrose County Septage Receiving Station	$50,000
Montrose County RE1J School District	Montrose County RE1J Support Services Bldg	$432,774
Montrose Recreation District	Montrose Recreation District Indoor Facility	$300,000
City of Montrose	Montrose Seventh Street Bridge	$360,000
West End School District RE-2	West End School District Elementary Upgrades	$350,835
West Montrose Sanitation District	West Montrose San Dist Wastewater treatment	$100,000
Montrose County Total		$1,835,609

[1] CDOLA, 2009d.

The remaining 30 percent of CDOLA severance tax revenue is distributed directly to local governments. In the past, direct local distributions were determined by the proportion of mining employment in the county. In 2008, local governments in Montrose County received $274,458 in severance tax direct distributions (see Table 3.10-25).

Table 3.10-25
Severance Tax Direct Distribution to Local Governments in Montrose County, 2008[1]

Local Government Entity	Distributed Amount
Montrose County	$144,810
City of Montrose	$44,478
Town of Naturita	$39,256
Town of Nucla	$43,486
Town of Olathe	$2,428
Montrose County total	$274,458
[1] CDOLA, 2009d.	

In 2009, the Colorado legislature passed SB08-218, which changes how CDOLA will distribute severance taxes. Beginning in the 2009 fiscal year, CDOLA's direct distributions to local governments will be based on:

- the proportion of energy industry employees within a given county to the total number of energy industry employees living in the state;
- the proportion of mine and well permits issued in a given county to the total number of such permits issued in the state; and
- the proportion of overall mineral production within the county relative to overall mineral production in the state (Schrock, 2008).

3.11 PUBLIC AND OCCUPATIONAL HEALTH

3.11.1 Background Exposure to Ionizing Radiation

Nationwide, people (non-smokers) are exposed to an average of about 310 millirems per year (mrem/yr) of natural background radiation (National Council on Radiation Protection and Measurements - NCRP, 2006). In Colorado, the average exposure rate is 400 mrem/yr (Moeller, 2006). The higher dose in Colorado is due to its higher elevation and higher terrestrial radiation, as discussed below. Table 3.11-1 presents a summary of the natural background radiation sources in the United States and in Colorado.

Table 3.11-1
U.S. Regional and Colorado Natural Background Radiation Doses

Source	U.S. Average Natural Background Radiation Dose (mrem/yr) [1]	Colorado Average Natural Background Radiation Dose (mrem/yr) [2]
Cosmic and cosmogenic radioactivity	34	50
Terrestrial radioactivity	22	49
Internal radioactivity	254	301
Inhaled radioactivity		
Rounded Total	310	400
[1] Source: National Council on Radiation Protection and Measurements, 2006. [2] Source: Moeller, 1999.		

The earth's atmosphere serves as a shield against cosmic radiation but the atmosphere provides less protection at higher elevations. In Denver, which is 5,280 feet above sea level, the

cosmic radiation dose is 50 mrem/year. Additionally flying in an airplane increases one's exposure to cosmic radiation and it is not uncommon for commercial airline crews to be exposed to 500 mrem/year.

Geography plays a major role in terrestrial radiation exposure rates. Annual exposure rates over fresh water are virtually zero because the water serves as a shield; however the dose rate over the open ocean is about 20 mrem/year because sea water contains much radioactive material of natural origin, such as radium and uranium. Soil type is also a contributor to terrestrial radiation. Above sandy soils, found along coastal plains, the terrestrial radiation levels are around 5 to15 mrem/year; for sedimentary rocks dose rates are about 30 to 55 mrem/year; and above igneous rock and soils high in uranium, such as the Colorado Plateau, doses are up to 160 mrem/year. Additionally, construction materials can factor into external radiation doses. Clay and concrete are high in radioactive substances of natural origin but, in contrast, wood does not contain radioactive substances and the dose rates inside wood structures are generally lower than those outside.

Two of the naturally occurring radionuclides that contribute to internal radiation exposure are radium and a potassium isotope found in a variety of foods. On average, the dose rate from the potassium isotope is around 15 mrem/year for women and 19 mrem/year for men. Radioactive potassium irradiates the entire body, whereas, radium is not a nutrient and the radiation is mostly absorbed by the skeleton. The amount of radium present in the body is affected primarily by what one ingests and on average is only about 1 to 2 mrem/year. Well-water consumption may increase radium intake because groundwater in some areas contains higher levels. The radium dose from eating a quarter to half-pound of Brazil nuts is more than the daily dose for workers at facilities licensed to handle radioactive materials (Moeller, 1999).

The largest natural source is inhaled radioactivity, mostly from Radon-222 and its radioactive decay products in poorly ventilated homes and buildings, which accounts for about 200 mrem/yr. Radon gas is an invisible, odorless gas that is formed from the disintegration of Radium-226. However, smoking a pack and a half of cigarettes a day will add about 1,300 mrem/year to one's effective dose.

Manmade sources such as fossil fuels, smoke detectors, glazed ceramics, fluorescent lights, luminous watches, televisions, and video display terminals are responsible for less than 3 percent of the total dose rate. The effective dose from a chest x-ray is 2 to 3 mrem. Currently, the maximum allowable dose for anyone who spends all of his or her time just outside the fence surrounding a nuclear power plant is 10 mrem/year; the equivalent of about 3 percent of the naturally occurring background-radiation dose rate (Moeller, 1999).

3.11.2 Occupational Injuries

The U.S. Department of Labor has two databases that report occupational injuries: the Census of Fatal Occupational Injuries (CFOI) and the Statistics Survey of Occupational Injuries and Illnesses (SOII). Colorado is among the few states for which the SOII does not report occupational injury data. Table 3.11-2 provides the numbers of fatal occupational injuries between 2003 and 2008 for all industries and for two subcategories – Private Industry and Mining.

Table 3.11-2
Fatal Occupational Injuries in Colorado by Selected Industries [1]

Industry	2003	2004	2005	2006	2007	2008
All industries	102	117	125	137	126	102
Private Industry	94	NA	119	124	117	93
Mining	6	7	6	3	6	6

[1] Source: U.S. Department of Labor, 2009a. More detailed information from the CFOI is available (U.S. Department of Labor, 2009b).

3.11.3 Summary of Health Effects Studies

Recent studies in the Montrose County and Colorado Plateau areas as well as the Karnes County, Texas area, the Monticello City, Utah area, and the Grants, New Mexico area have been completed specifically to investigate health status in relation to possible exposure to uranium and vanadium during mining and milling activities. Summaries are provided below:

- Researchers compared mortality rates between 1950 and 2000 in Montrose County to those in five similar counties. They concluded that there was no evidence that residents in Montrose County experienced an increased risk of dying of cancer or other diseases because of environmental exposures associated with uranium and vanadium milling and mining activities (Boice, et al., 2007).

- Researchers evaluated the mortality experiences of 1,484 men employed in seven uranium mills in the Colorado Plateau for at least 1 year after January 1, 1940 (Pinkerton, et al., 2004). The study results stated that mortality from all causes and all cancers was less than expected based on U.S. mortality rates. The study found an excess in mortality from haematopoietic and lymphatic malignancies (other than leukemia), trachea, bronchus, and lung cancer, non-malignant respiratory disease, and chronic renal disease. For workers hired prior to 1955, mortality from lung cancer and emphysema was higher, presumably because their exposure to uranium, silica, and vanadium was higher. However, mortality did not increase with employment duration. The researchers' conclusion stated that based on the study's limitations (i.e., small cohort size, inability to estimate individual exposure, lack of smoking data), that firm conclusions about the relation of increases in mortality and mill exposures were not possible.

- The same researchers that conducted the Montrose County study described above completed a mortality study for Karnes County, Texas in which they contrasted cancer rates in the county before, during, and after uranium operations (Boice, et al., 2003). The study also compared nearby counties with similar demographic characteristics. In conclusion, the study found that those cancers which might be increased following high exposures to uranium and its decay products were not elevated. The researchers qualified their conclusions with a statement that the ecological nature of the study design tempered the strength of the conclusions.

- The Utah Department of Health Office of Epidemiology completed a follow-up study for Monticello, Utah, where from 1943 to 1960 a mill processed uranium and vanadium in a location immediately adjacent to the town. The site and surrounding properties were placed on the EPA's National Priority List in 1986 and 1989 due to the chemical and radioactive contaminants associated with the mill. The initial health study in 2006 did not find conclusive evidence that the cancer rates were increasing in the Monticello area at a greater frequency than the rest of Utah. The current study found lung and bronchial

cancer significantly elevated between 1993-1997, 1998-2007, and 1973-2004 and stomach cancer between 1998 and 2004. The study's limitations included low statistical power due to Monticello's small population; lack of data prior to 1973; and the lack of adjustment or evaluation for individual factors such as smoking or family history. The study recommended further investigation and/or monitoring of the area due to the elevations of lung and bronchial cancer.

- The mortality rate of uranium mining and milling workers near Grants, New Mexico between 1955 and 1960 was analyzed (Boice, et al., 2008). The study included 2,745 men and women alive after 1978 who were employed for at least 6 months. Increased mortality due to respiratory diseases and cirrhosis of the liver was found among the underground miners, which was likely attributable to the historically high levels of radon in the uranium mines combined with the heavy use of tobacco products. There was no statistically significant elevation in any cause of death among the non-miners. The study notes that although the population was relatively small, the follow-up was long (up to 50 years) and complete.

3.11.4 Baseline Radiological Status for the Piñon Ridge Site

Energy Fuels' contractor, Environmental Restoration Group, Inc., prepared a *Baseline Radiological Investigation Report* (ERG, 2009) which provides the radiological baseline data for surface soil (0-5 and 0-15 centimeters), subsurface soils to a depth of 1 meter, vegetation, radon flux, ambient radon, and direct gamma exposure rates representative of the Site. Table 3.11-3 summarizes the scope of the radiological investigation.

Table 3.11-3
Summary of Baseline Radiological Investigation Scope

Survey Method/Endpoint	Baseline Investigation Scope	Parameters Evaluated
Gamma Survey	18-inch high bare detector gamma readings coupled with x- and y- coordinates taken every second moving along 50 to 100 m transects at ≤ 1.5ms per second. Surveys were made over the entire site along 34 transects.	Used to estimate exposure rates, surface soil Ra-226 concentrations, and to identify additional area for biased sampling
Biased Soil Sampling	Biased samples at 34 locations shown on Figures 4.1 and 4.2 (ERG, 2009). Note that PRB-33 and PRB-34 were not planned but were added during the field investigation due to elevated gamma readings in this area. Five of the 34 locations were sampled at depth (15-30 cm and 30-100 cm).	Ra-226 for most samples: Th-230, U-Nat, Pb-210, for a subset (N=5 locations, 2 at depth)
Random Soil Sampling	Random samples at 46 locations (ERG, 2009). PRR-37 and PRR-42 were not collected (replaced by addition of PRB-33 and PRB-34 noted above). All random samples were surface (0-15 cm) samples.	Ra-226 for most samples Th-230, U-Nat, Pb-210, for a subset (N=5)
Exposure and External Dose Rate of Monitoring	External dose rates were assessed using Optically Stimulated Luminescence (OSL) dosimeters at the five air monitoring stations (AMSs).	External Dose and Exposure Rates

Survey Method/Endpoint	Baseline Investigation Scope	Parameters Evaluated
Soil and Vegetation Sampling at Air Monitoring Stations	Five locations: three onsite (AMS-01, AMS-02, and AMS-03) and two located approximately 3 miles offsite (AMS-04 to the northwest and AMS-05 to the southeast). Given the diurnal nature of winds, at various times these stations would be representative of downwind and upwind locations.	Ra-226, Th-230, U-Nat, Pb-210, and Po-210
Radon Measurements	Radon flux measurements at nine locations (coinciding with biased soil samples). Ambient radon concentrations were also measured at the 5 AMSs using passive track etch detectors.	Rn-222

Following the investigation, the baseline report reached the following conclusions:

- The majority of the site exhibits exposure rates ranging between 11 and 20 micro Roentgens per hour (µR/hr), coinciding closely with the summary statistics provided in Section 3 (ERG, 2009) for non-outlier ranges. The lower range or subpopulation of readings ranging from 11 to 14 µR/hr occurs in the northern portion of the Site, coinciding with lower elevation areas.

- Readings between 14 and 20 µR/hr, corresponding to the range between the median and the non-outlier range, are found in the majority of the rest of the Site (comprising approximately 40 percent of the Site area), and appear to coincide with western and eastern drainages (see Figure 3.11-1).

- Elevated levels of radioactivity, as characterized by gamma readings greater than 20,000 cpm (counts per minute) and estimated exposure rates greater than 20 µR/hr, appear to be limited to three areas:

    1) A former drainage area in the southern portion of the Site (south of the proposed mill area), located just north of and adjacent to the offsite topsoil pile (see Figure 3.11-1);

    2) An area in the southwestern portion of the Site, near the reach of the western drainage. This area is characterized by sparse vegetation, topsoil is present at depths exceeding 1 cm, and surficial deposits of fine-grained material appear to exist.

    3) Isolated locations in the upper reaches of the eastern drainage, which were much more localized and less extensive than those noted above.

- Patterns of slightly elevated radioactivity are also apparent in the three site drainages (note darker patterns in Figure 3.11-1), where exposure rates range from approximately 15 to 17 µR/hr.

- The results based on surface soil sampling corroborate the findings discussed above regarding spatial trends of radioactivity at the Site. The majority of the Site is characterized by surface Radium-226 concentrations < 2.6 pCi/g, with a central tendency of 1 pCi/g, which is close to the national average. Areas in the southern portion of the Site exhibit higher levels of radioactivity indicative of natural and possibly historic anthropogenic influences.

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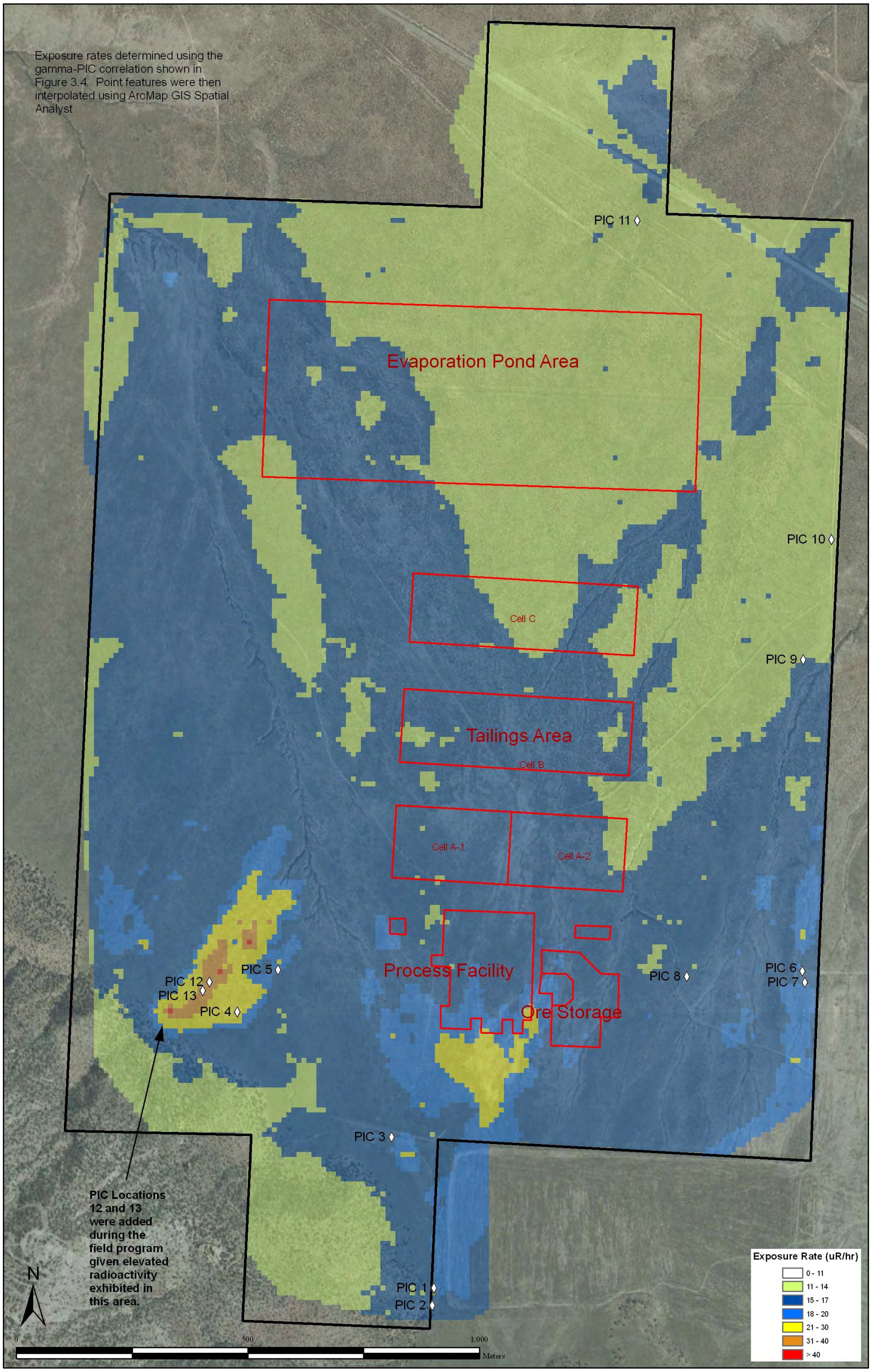
Figure 3.11-1
Exposure Rates Based on October 2007 Gamma Survey



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- Most Radium-226 concentrations at the Site range between 0.5 and approximately 1 pCi/g, close to the detection limit in some cases. However, isolated areas of elevated Radium-226 (ranging up to 24 pCi/g based on sample results) do occur, coinciding with a former drainage in the southeastern portion of the site and a sparsely vegetated area coinciding with parts of the western drainage.

- Radon-222 flux rates ranged between 0.41 and 3.78 pCi/m^2/s within the footprint of the proposed tailings area. Although Radon-222 flux rates are dependant on Radium-226 concentrations in the soil, they also vary based on soil moisture, soil type, barometric pressure, wind speed and temperature. Accordingly, flux measurements taken at the same location exhibited considerable fluctuation between monitoring events, depending on the season.

- Gamma exposure rates on the Site ranged from 101.8 mrem/yr near the highway to 127.2 mrem/yr on the south end of the Site. These dose rates represent the gamma radiation received from terrestrial and cosmic sources. The higher exposure rate at the south end of the Site is likely due to the higher Radium-226 concentrations found in the soil within this area, especially in the drainages.

- Radionuclide concentrations in vegetation are near method detection limits (MDLs) and do not correlate to radionuclide concentrations in soil for the same sample locations.

- Ambient Radon-222 concentrations ranged from 0.6 to 4.1 pCi/L and are within the expected ranges for this geographical area. The higher concentrations were recorded in the winter months when wind speeds are generally lower and there is less dispersion of radiation.

In summary, it is clear that the drainage areas within the southern quarter of the Site exhibit radiological anomalies from natural and possibly historic anthropogenic sources within the area. The natural source of the elevated radioactivity in the southern portion of the Site originates from erosion of the Salt Wash Member of the Morrison Formation, which outcrops along the flank of the mesa south of the Site. The Salt Wash Member is the uranium ore host for the nearby uranium mines. This natural source is evident by the elevated radioactivity within the drainages, especially in the extreme southern portion of the site where alluvial fans contain predominantly pebbles and cobbles of conglomeratic sandstone and sandstone with small clay galls. This detritus can be traced back to the exposed Morrison and Burro Canyon formations located further up the mesa.

Possible historic anthropogenic sources within the area include:

- Runoff and windblown dust from former ore stockpiles and existing waste rock dumps at the underground uranium mines located on the mesa south of the Site. These mining activities could have increased erosion and contributed higher levels of radioactivity (especially from the ore stockpiles) to the drainages.

- Runoff from the topsoil stockpile placed in an 80-acre parcel just south of the site in 1980 from an open pit uranium mining operation. This topsoil was removed from the area to the east where the overburden from the open pit was ultimately placed. The

topsoil was placed in a series of thin lifts and reseeded for eventual use in reclamation. The area stripped of the topsoil contained several drainages, which likely contained alluvial materials with higher radiation levels similar to those observed at the Site. The open pit was not mined down completely to the ore zone (i.e., a 20-foot layer of barren rock was left over the ore), so it is unlikely that that windblown dust from this open pit mining operation contributed to higher radioactivity levels in the area.

3.11.5 Background Air Quality Radionuclides

Energy Fuels contracted with Kleinfelder to prepare a *Meteorology, Air Quality, and Climatology, Report* for the Site (Kleinfelder, 2009i). As part of the report, Kleinfelder gathered background radionuclide data from monitors, which were installed at five locations. Data collection methods and analysis protocols are provided in that report. Table 3.11-4 presents a summary of the results of the radionuclide monitoring data.

Table 3.11-4
Radionuclide Annual Average Concentrations (µCi/mL)

Sites	Uranium	Lead-210	Radium-226	Thorium-230
Site 1	3.26×10^{-18}	2.52×10^{-15}	4.54×10^{-19}	-1.85×10^{-19} [1]
Site 2	3.36×10^{-18}	2.69×10^{-15}	6.82×10^{-18}	5.10×10^{-18}
Site 3	3.46×10^{-18}	2.36×10^{-15}	1.37×10^{-18}	4.79×10^{-18}
Site 4	3.33×10^{-18}	2.22×10^{-15}	-2.01×10^{-18} *	3.91×10^{-18}
Site 5	3.29×10^{-18}	2.54×10^{-15}	1.20×10^{-18}	2.28×10^{-18}

[1] Some radionuclides have annual averages less than zero. The negative concentrations are a result of quality control procedures by the analyzing laboratory. Occasionally, field samples have a lower radionuclide count than the laboratory blank sample used to set the "zero" point, thus, some samples have a negative concentration. Presenting negative concentrations rather than data qualifiers allows for temporal trend analysis of the data and is consistent with Section 7.5 of the NRC's Regulatory Guide 4.14. Therefore, the negative concentrations are an acceptable representation of the radionuclide concentrations collected in the Site area.

The report states, that while ambient air standards for radionuclide particulates have not been developed by the EPA, the DOE published a derived concentration guide (DCG) for inhalation doses of different radionuclides. The DCG values represent the radionuclide concentration that if inhaled, would cause a member of the public to receive an unacceptable dose of radiation. The DOE considers 100 mrem/yr an unacceptable dose of radiation. Table 3.11-5 provides the DCG values for the four radionuclides found at the Site.

Table 3.11-5
Summary of DOE-Derived Concentration Guide Values for Inhalation[1]

Radionuclide	DCGs uCi/mL
Uranium	2.0×10^{-12}
Lead-210	9.0×10^{-13}
Radium-226	1.0×10^{-12}
Thorium-230	4.0×10^{-12}

[1] Source: Kleinfelder, 2009i.

In comparison with the results in Table 3.11-4, the annual average concentrations at Sites 1, 2, 3, 4, and 5 are all at least 100 times less than the DCGs.

3.11.6 Background Radionuclides in Animal Tissue

A separate survey, *Baseline Survey of Radionuclides in Animal Tissues at the Proposed Piñon Ridge Mill Site* (Whicker, 2008), was designed to allow comparison of similar measurements during and after mill operations to assess radiological impact to animals. The report states that because uranium is radioactive, its decay leads to the formation of 17 decay products that are also radioactive (Eisenbud and Gesell, 1997). A few of these are sufficiently abundant and long-lived that they have potential biological significance. Because of the ubiquitous presence of uranium in soil and rocks, some of these radionuclides can be measured in biological tissues anywhere on earth in the complete absence of uranium mining or milling activities.

The study involved radionuclide analysis of three cottontail rabbits, three jackrabbits, and tissues from three cows. The specific tissues obtained for analysis were lung, liver, muscle, and bone. The tissues were carefully dissected, cleaned, bagged, and frozen. They were then submitted to Paragon Analytics of Fort Collins, Colorado for analysis of uranium, Th-230, Ra-226, Po-210, and Pb-210. Thirty-seven different tissue samples were submitted and a total of 106 radionuclide-specific results were obtained and reported.

The analysis reported the following results:

- In the case of the uranium measurements, of the 22 samples analyzed, only 12 exceeded the reporting limit. The other values are classified as “U”, or undetected. It is clear that the uranium contents of bone exceed those of muscle tissue, with 7 of the 12 samples containing detectable levels being bone. The error bars, representing variations among individual animals as well as laboratory uncertainties, were relatively large, with coefficients of variation (standard deviation/mean value) ranging from 0.16 to 0.62.

- All sample results from the Th-230 analyses were below the minimum detectable concentrations. This is not surprising because thorium occurs in the environment in chemical forms that are extremely insoluble, and as a result its transport through food chains is very low or negligible. Thorium isotopes are not taken up to any significant degree by plants, and when it is ingested by animals, often in the form of dust particles, the absorption fraction is very low, typically $< 10^{-4}$.

- The results for Ra-226 analyses in bone samples were much more informative and useful than for the other radionuclides. All bone samples contained Ra-226 at sub-pCi/g levels when expressed on a wet mass basis, but well above the minimum detectable concentrations, and considerably higher than measurements for human bone summarized by Eisenbud and Gesell (1997). The coefficients of variation (CV) representing differences among individual animals and laboratory uncertainties were relatively small for the jackrabbits (0.15) and cows (0.14), but higher for the cottontails (0.50). The data indicate that rabbit bone was about three-fold higher in Ra-226 than the cow bone samples.

- Measurements of Po-210 in animal tissues showed that 19 of the 27 sample analyses were below the minimum analytical detection limits, and those that exceeded the detection limits were very low (< 1 pCi/g wet tissue). Although the data reflect very low and variable levels of Po-210 in tissues, there was a tendency for the more detectable levels to occur in cow samples, particularly the liver and lung samples. The liver and kidney are known as main repositories of the small amounts of Po-210 that might be found in the body.

- Fifteen of 28 samples contained Pb-210 at levels below the minimum detectable concentration, while 13 were above. There were no apparent differences between species, but the differences between tissues were obvious. The pattern was for bone to contain the highest concentrations, lung to contain the lowest levels, while liver tissues contained intermediate amounts. Lead is well-known to be found primarily in bone, with intermediate levels in liver and kidney. Variability among individuals of the same species was relatively high, with CV values ranging from 0.34 to 1.76.

The study recommended that Ra-226 levels in bone collected from both species of rabbits be targeted as the most sensitive and useful indicator of any future changes in radiobiological conditions on the Site. The rabbits are abundant on the Site and remain on the Site over their lifetime while cattle, mule deer, and elk do not reside permanently on site. Furthermore, Ra-226 levels are readily measurable in bone with relatively small variability.