3.0 Affected Environment

This chapter describes the current condition of the environment for the GHPA (see **Figure 1-1**) and vicinity that potentially could be impacted by the alternatives presented in Chapter 2.0. Under NEPA, the human environment is the natural and physical environment and the relationship of people to that environment. The affected environment for individual resources was delineated based on the area of potential direct and indirect environmental impacts for the Project and the associated cumulative effects area. For some resources, the resulting study area includes the GHPA, while other resources (e.g., watersheds, air quality, or transportation network) are addressed in a larger regional context.

The environmental baseline information summarized in this chapter was obtained from Cameco's WDEQ-LQD mine permit update (PRI 2009), review of published sources, unpublished data, communications with government agencies, and review of field studies of the area. The level of information provided in this chapter is intended to be commensurate with the potential impacts to the resource described.

3.1 Air Quality

The following sections discuss the meteorology, climatology, and air quality at the GHPA. A discussion of climate change and greenhouse gases (GHGs) also is included in this section of the Draft EIS.

3.1.1 Climate and Meteorology

The GHPA is located in the Gas Hills District of Fremont and Natrona counties, at an elevation of approximately 7,250 feet above mean sea level (amsl). The region experiences diverse weather patterns that fluctuate throughout the year, due in large part to its proximity to the Rocky Mountains and its relatively high elevation.

The climate of the area surrounding the GHPA is semiarid and cool. Prevailing westerly winds are most pronounced during the winter, while in the summer, circulation patterns bring moist air and precipitation from the Gulf of Mexico. Hailstorms are the most destructive type of local storm in the state, and crop and property damage from hail is significant (National Oceanic and Atmospheric Administration 1985). Tornadoes also occur in the state but are less frequent and destructive in the region than in the Midwest. Summers are mild with warm to hot days and cool nights. Winters are harsh with cold temperatures, high winds, and infrequent blizzards. Warm days and cold nights occur during both spring and fall; wet heavy snowfalls can be expected in both of these seasons. The growing season is between 90 and 120 days long, from late May to early September. July is typically the warmest month and January the coldest.

The climatic and meteorological data for the GHPA is from the Gas Hills 4E National Weather Service (NWS) Station, located approximately 1 mile north of the GHPA (**Table 3.1-1**), and the Casper NWS station located approximately 65 miles east of the GHPA, at the Natrona County International Airport near Casper, Wyoming (**Table 3.1-2**). Use of data from the NWS station in Lander, about 55 miles west of the GHPA was considered; however, the data at this station was not determined to be representative of the GHPA due to its proximity to the Wind River Mountains. The Gas Hills 4E NWS station records temperature and precipitation data only. The Lucky Mc Mine, located adjacent to the western part of the GHPA, recorded wind data intermittently from September 1978 through January 1983 (U.S. NRC 2004).

At the Gas Hills 4E NWS station, July is the warmest month and January the coldest. Based on nearly 45 years of record (September 1962 to April 2007), the mean maximum and mean minimum

Table 3.1-1 Gas Hills 4E, Wyoming (483801) Monthly Climate Summary: 9/10/1962 to 4/30/2007

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (°F)	28.4	32.4	40.2	51.0	62.5	73.3	82.2	80.2	69.4	57.0	39.1	30.4	53.8
Average Min. Temperature (°F)	11.0	13.8	19.5	28.4	37.4	46.7	53.6	52.5	42.8	33.1	20.8	13.2	31.1
Average Total Precipitation (inches)	0.38	0.38	0.72	1.20	1.59	1.33	0.86	0.64	0.74	0.68	0.42	0.35	9.28
Average Total Snowfall (inches)	7.3	7.7	9.9	10.4	2.8	0.5	0.0	0.0	1.2	5.5	6.5	7.0	58.7
Average Snow Depth (inches)	2	2	2	1	0	0	0	0	0	0	1	2	1

Source: Western Region Climate Center (WRCC) 2011.

Table 3.1-2 Period of Record Monthly Climate Summary: 8/1/1948 to 12/31/2010 for Casper Weat*h*er Service Office Airport, Wyoming

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (°F)	33.7	37.8	45.8	56.1	66.7	78.6	87.7	85.8	74.4	60.5	44.6	35.2	58.9
Average Min. Temperature (°F)	13.0	16.4	21.6	29.3	38.3	46.9	54.1	52.5	42.4	32.5	22.2	14.9	32.0
Average Total Precipitation (inches)	0.51	0.55	0.90	1.40	2.08	1.41	1.22	0.72	0.95	1.01	0.69	0.55	11.99
Average Total Snowfall (inches)	10.0	10.0	12.9	12.1	3.9	0.2	0.0	0.0	1.3	6.3	9.8	10.4	76.9
Average Snow Depth (inches)	1	1	1	0	0	0	0	0	0	0	1	1	0

temperatures are 82.2 degrees Fahrenheit (°F) and 53.6°F, respectively, in July, and 28.4°F and 11.0°F, respectively, in January (**Table 3.1-1**). The highest and lowest temperatures recorded during the period of record are 96°F and -34°F. The mean annual precipitation at the Gas Hills 4E NWS station is approximately 9.28 inches. About half of the annual precipitation occurs between April and June, while less than a third occurs from October through March. Snow commonly falls as early as October and often as late as May. From 1948 to 2010, annual snowfall at the Casper NWS station averaged

76.9 inches. Monthly snowfall amounts from November through February are relatively uniform, and snowfall generally increases slightly during March and April (WRCC 2011).

Wind conditions at the GHPA are represented by the data collected at the Casper NWS station. A comparison of wind data at the Casper NWS station and those recorded at the Lucky Mc Mine indicated that the Casper wind data are representative of the GHPA. Based on the wind data collected by the Casper NWS station for the period of 1996-2008, average wind speed was about 11.7 mph (WRCC 2011). The fastest observed 2-minute wind was 64 mph in January, with the second fastest of 54 mph in June (**Table 3.1-3**). The highest peak gust wind speed at the Casper NWS station for this period was 81 mph in July and a peak gust wind greater than 50 mph was observed every month of the year.

Table 3.1-3 Casper-Natrona County International AP Climatological Summary: July 1996 to December 2008

Wind (mph)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year Avg.
Daily Avg Wind Speed	14.8	13.6	12.5	11.4	10.5	10.2	8.9	9.3	9.8	10.9	13.4	15.1	11.7
Daily Avg Max 2-Min	27.6	26.0	25.7	25.3	24.7	26.1	24.8	23.7	22.9	23.7	26.1	28.3	25.4
Daily Avg Peak Gust	32.6	31.0	30.6	31.1	30.7	32.5	31.2	29.6	28.4	28.7	31.2	33.9	31.0
Maximum Daily Avg	31.5	31.5	27.7	26.0	26.8	27.3	20.4	21.7	21.2	25.1	29.3	31.6	31.6
Maximum 2-Minute Avg	64	51	49	49	45	54	52	46	44	51	51	53	64
Maximum Peak Gust	78	66	60	63	54	66	81	58	59	61	63	68	81
Avg Number of Days													
Peak Gust >=30	18.6	15.9	16.5	15.0	16.5	16.8	15.8	14.5	11.9	13.9	16.9	20.4	192.6
Peak Gust >=40	7.9	4.7	5.7	5.0	4.9	5.7	4.8	4.0	3.5	3.3	6.2	9.2	64.9
Peak Gust >=50	2.2	0.8	1.4	1.5	0.7	1.4	1.5	0.5	0.2	0.9	1.5	2.3	14.8

Source: WRCC 2011.

Annual-average relative humidity in the area ranges from 64 to 71 percent for the nighttime hours and from 43 to 46 percent for daytime hours. The NWS station recording evaporation data nearest to the GHPA is located approximately 60 miles southeast of the GHPA, at the Pathfinder Reservoir. Annual mean lake evaporation is estimated at approximately 42 inches. The NWS estimates the mean annual potential evapotranspiration rate at Pathfinder Reservoir to be about 22 inches (U.S. NRC 2004).

3.1.2 Air Quality

The GHPA is located in the Casper Intrastate Air Quality Control Region, which covers the central part of the State of Wyoming. The State of Wyoming Ambient Air Quality Standards (WAAQS) for 6 criteria pollutants, sulfur oxides (as sulfur dioxide [SO_2]), particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb), are nearly identical to the National Ambient Air Quality

Standards (NAAQS) with a few exceptions (Wyoming Rules and Regulations of Department of Environmental Quality). One exception is that the WAAQS for SO_2 are more stringent than the NAAQS. Another exception is that the annual PM with an aerodynamic diameter of 10 microns or less (PM_{10}) standard is still in effect in the State of Wyoming even though there is no annual PM_{10} NAAQS. Finally, Wyoming has not yet adopted the 1-hour SO_2 and 1-hour NO_2 NAAQS (WDEQ-AQD 201***2***).

The NAAQS and WAAQS are listed in **Table 3.1-4**.

Table 3.1-4 State and National Ambient Air Quality Standards

Pollutant	Averaging Period	Wyoming Standards ($\mu g/m^3$)[a]	National Standards	
			Primary	Secondary
PM_{10}	24-hour	150[c] $\mu g/m^3$	150[c] $\mu g/m^3$	Same as primary
	Annual	50 $\mu g/m^3$	None	None
$PM_{2.5}$ [b]	24-hour	35 $\mu g/m^3$	35 $\mu g/m^3$	Same as primary
	Annual	15 $\mu g/m^3$	***12*** $\mu g/m^3$	***15 µg/m³***
SO_2	1-hour	***196 µg/m³ (0.075 ppm)***	196 $\mu g/m^3$ ***(0.075 ppm)***	None
	3-hour	1,300[c] $\mu g/m^3$ (0.5 parts per million [ppm])	None	1,300[c] $\mu g/m^3$ (0.5 ppm)
NO_2	1-hour	***188 µg/m³ (0.100 ppm)***	188 $\mu g/m^3$ (0.100 ppm)	***None***
	Annual	100 $\mu g/m^3$ (0.053 ppm)	100 $\mu g/m^3$ (0.053 ppm)	Same as primary
CO	1-hour	40,000[c] $\mu g/m^3$ (35 ppm)	40,000[c] $\mu g/m^3$ (35 ppm)	None
	8-hour	10,000[c,d] $\mu g/m^3$ (9 ppm)	10,000[c] $\mu g/m^3$ (9 ppm)	None
O_3	8-hour (2008 standard)[d]	***147 µg/m³ (0.075 ppm)***	147 $\mu g/m^3$ (0.075 ppm)	Same as primary
	8 hours (1997 standard)[e]	157 $\mu g/m^3$ (0.08 ppm)	157 $\mu g/m^3$ (0.08 ppm)	Same as primary
Pb	Rolling 3-month Average	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$	Same as primary

[a] $\mu g/m^3$ = micrograms per cubic meter.

[b] $PM_{2.5}$ = particulate matter with an aerodynamic diameter of 2.5 microns or less.

[c] Must not be exceeded more than once per year.

[d] To attain this standard, the 3-year average of the 4th highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.075 ***parts per million (ppm)*** (effective May 27, 2008).

[e] (i) To attain this standard, the 3-year average of the 4th highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(ii) The 1997 standard, and the implementation rules for that standard, would remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 O_3 standard to the 2008 O_3 standard.

Sources: USEPA 2011d; WDEQ-AQD 201***2***.

Ambient air quality in the State of Wyoming is good, and the state is currently designated as in attainment for all criteria pollutants except PM_{10} for the city of Sheridan (USEPA 2011d). In 2009 the Wyoming governor recommended to USEPA that Sublette County and Portions of Sweetwater and Lincoln counties in Southwestern Wyoming be declared non-attainment for ozone.

PSD regulations (40 CFR 52.21) limit the maximum allowable incremental increases in ambient concentrations of SO_2, NO_2, and PM_{10} above established baseline levels. The PSD regulations, which are designed to protect ambient air quality in attainment areas, apply to major new sources and modifications to existing sources. The State of Wyoming is in a Class II PSD area and contains 7 Class I PSD areas consisting of national parks and national wilderness areas. PSD Class I areas nearest to the GHPA include Bridger National Wilderness Area about 80 miles ***(128 kilometers [km])*** to the west of the GHPA and Wind Cave National Park in South Dakota approximately 220 miles to the east-northeast. Monitored values of criteria pollutants in Fremont and Natrona counties are listed in **Table 3.1-5**. ***Fremont County had 7 actual exceedences of the 8-hour ozone standard in 2009.***

Table 3.1-5 Monitor Data in the Vicinity of the GHPA 2009

County	CO 8-hr (ppm)	Pb RQmax ($\mu g/m^3$)	NO_2 AM (ppm)	O_3 8-hr (ppm)	PM_{10} 24-hr ($\mu g/m^3$)	$PM_{2.5}$ Wtd AM ($\mu g/m^3$)	$PM_{2.5}$ 24-hr ($\mu g/m^3$)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
Fremont	ND	ND	0.001	0.08	47	8.3	35	IN	IN
Natrona	ND	ND	ND	ND	51	IN	IN	ND	ND

CO 8-hour – Highest second maximum non-overlapping 8-hour concentration (applicable NAAQS is 9 ppm).

Pb RQmax– Maximum running 3 month average (applicable NAAQS is 0.15 $\mu g/m^3$).

NO_2 AM– Highest arithmetic mean concentration (applicable NAAQS is 0.053 ppm).

O_3 8-hour – Highest 4th daily maximum 8-hour concentration (applicable NAAQS is 0.075 ppm).

PM_{10} 24-hour – Highest 2nd maximum 24-hour concentration (applicable NAAQS is 150 $\mu g/m^3$).

$PM_{2.5}$ Wtd AM – Highest weighted annual mean concentration (applicable NAAQS is 15 $\mu g/m^3$).

$PM_{2.5}$ 24-hour – Highest 98th percentile 24-hour concentration (applicable NAAQS is 35 $\mu g/m^3$).

SO_2AM – Highest annual mean concentration (applicable NAAQS is 0.03 ppm).

SO_2 24-hour – Highest second maximum 24-hour concentration (applicable NAAQS is 0.14 ppm).

ND – Indicates data not available.

IN – Indicates insufficient data to calculate summary statistic.

$\mu g/m^3$ – Units are micrograms per cubic meter.

ppm – Units are parts per million.

Source: USEPA 2009.

3.1.2.1 Regulatory Framework and Associated Impacts

Ambient air quality and the emission of air pollutants are regulated under both federal and State of Wyoming laws and regulations as discussed below.

<u>Federal Clean Air Act</u>

The CAA, and the subsequent Federal Clean Air Act Amendments of 1990 (CAAA), require the USEPA to identify NAAQS to protect public health and welfare. The CAA and the CAAA established NAAQS for 7 pollutants, known as “criteria” pollutants. The ambient standards set for these pollutants satisfy “criteria” specified in the CAA. A list of the criteria pollutants regulated under the CAA and their currently applicable NAAQS set by the USEPA are listed in **Table 3.1-4**.

In addition to the designations relative to conforming with the NAAQS, the CAA requires the USEPA to place selected areas within the U.S. into 1 of 3 classes, which are designed to limit the deterioration of air quality when it is “better than” the NAAQS. Class I is the most restrictive air quality category. It was created by Congress to prevent further deterioration of air quality in national parks and wilderness areas of a given size, which were in existence prior to 1977, or those additional areas that have since been designated Class I under federal regulations (40 CFR 52.21). All remaining selected areas outside of the designated Class I boundaries were designated Class II areas, which allow a relatively greater deterioration of air quality, although still below NAAQS. No Class III areas have been designated.

Federal PSD regulations limit the maximum allowable increase in ambient particulate matter in a Class I area resulting from a major or minor kind of stationary source to 4 $\mu g/m^3$ (annual geometric mean) and 8 $\mu g/m^3$ (24-hour average). Increases in other criteria pollutants are similarly limited. Specific types of facilities (listed facilities) that emit, or have the potential to emit, 100 tons per year (tpy) or more of total PM, PM_{10}, or other criteria air pollutants, or any facility that emits, or has the potential to emit, 250 tpy or more of total PM, PM_{10}, or other criteria air pollutants, are considered major stationary sources. Major stationary sources (e.g., coal-fired power plant, refinery, compressor station, or cement plant) are required to notify federal land managers of Class I areas, which may be affected by the emissions from the source within 100 km (62 miles) of the major stationary source.

The PSD increments are triggered for a planning area when a PSD application for a major source or modification affecting that planning area has been deemed complete by the regulatory authority (40 CFR 52.21[b][14]).

New Source Performance Standards, also required under the CAA, are set by the USEPA for specific types of new or modified stationary sources (i.e., sources that are fixed in place, as opposed to mobile sources). New Source Performance Standards set fixed emission limits for classes of sources to prevent deterioration of air quality from the construction of new sources and to reduce control costs by building pollution controls into the initial design of sources.

The Federal Operating Permit, or “Title V,” is a facility-wide permitting program introduced by the CAA that requires facilities with the potential to emit more than 100 tpy of any regulated pollutant (excluding PM), 10 tpy of any single hazardous air pollutant (HAP), or 25 tpy or more of any combination of HAPs, sources” of air pollutants submit a Federal Operating Permit application.

The CAA directs the USEPA to delegate primary responsibility for air pollution control to state governments, which comply with certain minimum requirements. The State Implementation Plan (SIP) was originally the mechanism by which a state set emission limits and allocated pollution control responsibility to meet the NAAQS. The function of a SIP broadened after passage of the CAAA and now includes the implementation of specific technology-based emission standards, permitting of sources, collection of fees, coordination of air quality planning, and prevention of significant deterioration of air quality within regional planning areas and statewide. Section 176 of the CAA, as amended, requires that federal agencies must not engage in, approve, or support in any way any action that does not conform to a SIP for the purpose of attaining NAAQS (USEPA 2008a).

3.1.2.2 Climate Change and GHG Emissions

GHGs, including CO_2; methane; nitrous oxide (N_2O); water vapor; and several trace gas emissions cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the Earth back into space. Science recognizes that such GHGs are essential to the formation and continuation of life on the planet, since global warming has produced the conditions conducive to allow the existence of all living things on the Earth. Science also has identified some potentially unwanted impacts of human activities on global climate. Vulnerabilities to climate change depend considerably on specific geographic and social contexts.

Although climate changing pollutant levels have varied for millennia (along with corresponding variations in climatic conditions), recent industrialization and burning of fossil carbon sources caused CO_2 concentrations to increase from a pre-industrial value of about 280 ppm to 379 ppm in 2005. This increase is likely to contribute to climatic changes that may be disruptive to present plant, animal, and human communities. For example, increasing CO_2 concentrations may lead to preferential fertilization and growth of specific plant species.

The Intergovernmental Panel on Climate Change (IPCC) has completed a comprehensive report assessing the current state of knowledge on climate change, its potential impacts, and options for adaptation and mitigation. According to this report, global climate change may ultimately contribute to a rise in sea level, destruction of estuaries and coastal wetlands, and changes in regional temperature and rainfall patterns, with major implications to agricultural and coastal communities. The IPCC has suggested that the average global surface temperature could rise 1 to 4.5°F in the next 50 years, with significant regional variation. There are uncertainties regarding how climate change may affect different regions. Computer models indicate that such increases in temperature will not be equally distributed globally, but are likely to be accentuated at higher latitudes. Also, warming during the winter months is expected to be greater than during the summer, and increases in daily minimum temperatures is more likely than increases in daily maximum temperatures (IPCC 2007).

The analysis of the regional climate impacts prepared by the U.S. Global Change Research Program (2009) indicates that average temperatures have increased throughout the region with relatively cold days becoming less frequent and relatively hot days more frequent. The observed increase is largely the result of the warmer nights and effectively higher average daily minimum temperatures at many of the sites in the region. The analysis projects continued increases in temperature over this century. The U.S. Global Change Research Program report projects an increase in precipitation in the central and northern portions of Wyoming, although with substantial variability in inter-annual conditions. For central Wyoming the projections range from approximately 10 to 20 percent increase in annual precipitation.

3.2 Cultural Resources and Native American Concerns

3.2.1 Cultural Resources

Cultural resources are definite locations of human activity, occupation, or use identifiable through field inventory (survey), historical documentation, or oral evidence. The term includes archaeological, historic, or architectural sites; structures or places with important public and scientific uses; and may include definite locations (sites or places) of traditional, cultural, or religious importance to specified social and/or cultural groups. Cultural resources are concrete, material places and things that are located, classified, ranked, and managed through the system of identifying, protecting, and utilizing for public benefit (BLM 8100 Manual).

3.2.1.1 Regulatory Framework

Federal historic preservation legislation provides a legal environment for documentation, evaluation, and protection of cultural resources that may be affected by federal undertakings or by private undertakings operating under federal license, with federal funding, or on federally managed lands. These include, but are not limited to the NHPA, ARPA, and Archaeological and Historic Preservation Act of 1974. ***EO*** 11593 (Protection and Enhancement of the Cultural Environment) also provides necessary guidance on protection and enhancement of cultural resources.

The NHPA requires federal agencies to take into account the effects of their actions on properties listed on or eligible for listing on the National Register of Historic Places (NRHP). Section 106 of the NHPA establishes a 4-step review process by which cultural resources are given consideration during the evaluation of proposed undertakings. The regulations require that federal agencies initiate Section 106 consultation early in project planning, when a broad range of alternatives can be considered (36 CFR 800.1[c]). Cultural resources that are listed or eligible for inclusion in the NRHP are referred to as “historic properties.”

3.2.1.2 Criteria of Eligibility

The NRHP, maintained by the NPS on behalf of the Secretary of the Interior, is the nation’s inventory of historic properties. The NPS has established 3 main standards that a property must meet to qualify for listing on the NRHP: age, integrity, and significance. To meet the age criteria, a property generally must be at least 50 years old. To meet the integrity criteria, a property must “possess integrity of location, design, setting, materials, workmanship, feeling, and association” (36 CFR 60.4). Finally, a property must be significant according to 1 or more of the following criteria:

- Criterion A – Be associated with events that have made a significant contribution to the broad patterns of our history;
- Criterion B – Be associated with the lives of persons significant in our history;
- Criterion C – Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D – Have yielded, or may be likely to yield, information important in prehistory or history.

3.2.1.3 Cultural-Historical Overview

The following brief general summaries were extrapolated from Frison (2001), Kalasz et al. (2007), Metcalf (1987); Natrona County (2011), U.S. NRC (2009a), and Roberts (2011).

Prehistoric Narrative

The GHPA is part of the Northwestern Plains which cover a large share of eastern Montana and Wyoming east of the Rocky Mountains along with the northwest corner of Nebraska, extreme western North and South Dakota, and an extension into southwest Alberta. There are 6 periods of human occupation in the Northwestern Plains that span approximately 12,000 years: Paleoindian, Early Plains Archaic, Middle Plains Archaic, Late Plains Archaic, Late Prehistoric, and Protohistoric. The following are brief general summaries of these cultural periods.

Paleoindian (ca. 12,000 before present [B.P.] – 8,000/7,500 B.P.)

The Paleoindian period is the earliest well-documented era of human occupation in Wyoming and is represented by groups that occupied North America at the end of the last glaciation. The Northwestern Plains Paleoindian period is distinguished in the archaeological record by a sequence of large, lanceolate projectile points and specialized hide-processing tools. Corresponding with the projectile point sequence is a series of cultural complexes consisting of Clovis, Goshen, Folsom, Agate Basin, Hell Gap, Cody-Alberta, Frederick, Lusk, James Allen, and Angostura. Paleoindians subsisted primarily on large game such as mammoths and bison (of which some species are now extinct) with only rare evidence of smaller game or plant food use. Known sites of this period include campsites and kill sites, and temporary rock shelters and caves toward the end of the period.

Early Plain Archaic (ca. 8,000/7,500 – 5,000 B.P.)

The Early Plains Archaic period is roughly contemporaneous with the Altithermal climatic episode, a period marked by significantly elevated temperatures, reduced effective moisture, and a general desiccation of the landscape for a period of 2,000 to 3,000 years. During this period there was a change in projectile point styles from lanceolate to somewhat smaller corner and side-notched projectile points. Hunting and gathering wild foods were the primary subsistence practices. Known sites of this period include evidence of basin houses, communal hunting, grinding stones, hearths, storage pits, and milling basins.

Middle Plains Archaic (5,000 – 3,000 B.P.)

The Middle Plains Archaic period coincides with the appearance of the McKean Complex. This complex was named for a northeastern Wyoming site and refers specifically to a series of stylistically related projectile points. The stemmed-indented base and lanceolate McKean Complex projectile points represent a morphological change from the side and corner-notched varieties of the Early Plains Archaic period. Sites with Middle Plains Archaic tool assemblages are widespread throughout the Northwestern Plains and indicate exploitation of the complete range of habitats available in the plains and adjacent upland areas at that time. The McKean people were foragers who, in addition to hunting bison, trapped small mammals and reptiles, and collected seeds and plants. During this period, there is an abundance of roasting pits, hearths, boiling pits, structures, stone circles, and ground stone artifacts, possibly related to a more intense processing of plant resources. The use of house pits was more prominent during this period.

The Late Plains Archaic Period (3,000 – 1,500 B.P.)

During this period, climatic conditions became somewhat cooler and wetter, and there was a shift to the exploitation of larger game animals, in particular bison. The Late Plains Archaic is characterized generally by smaller, corner-notched projectile points, which replaced the McKean Complex points. The smaller points dominated most tool assemblages until the introduction of the bow and arrow around 1,500 years B.P. Cultural complexes include Pelican Lake, Yonkee, and Besant. There is some evidence for the introduction of cord-marked pottery and horticulture during the Late Plains Archaic. Broad-spectrum hunting and gathering continued throughout the period, with an increase in communal hunting of bison as evidenced by numerous kill sites in the archaeological record. Late Plains Archaic sites display a wider variety of artifacts than previous periods including basketry, woodworking debris, sinew, hide, shell, and atlatl fragments. Similar to the previous period, Late Plains Archaic sites are found in a wide variety of ecosystems in the plains and adjacent areas.

Late Prehistoric Period (1,500 – 300 B.P.)

The beginning of the Late Prehistoric period coincides with the appearance of the bow and arrow, which replaced the atlatl and dart. During the early part of the period, projectile points generally were corner notched and smaller versions of Late Plains Archaic dart points. Over the course of the period corner-notched were replaced by side-notched forms, with tri-notching appearing at the end of the period. Subsistence focused on scheduled small and medium-game hunting, plant food gathering, and bison hunting, according to a seasonal round. Storage pits for food and other items located within structures and grinding tools are common. Artifact assemblages consist of diverse cultural materials and occasionally include pottery. Longer-term habitation sites are evident, as is increasing complexity in communal hunting systems such as bison jumps and traps. In addition, stone circles are common across the Northwestern Plains, and numerous human burial sites are known from the archaeological record.

Protohistoric Period (300 – 150 B.P. [1700s to ca. 1860])

The Protohistoric period began sometime in the 18th century when European trade goods were brought into the area, and ends with the development of the Rocky Mountain fur trade around 150 years ago. Initial trade items included glass beads, iron, brass, and the horse. The introduction of the horse to American Indians of the Plains resulted in increasingly sophisticated hunting strategies and in the ability to explore larger areas of the region. Artifact assemblages include early glass trade beads, ceramics, horse bones, and decorative items such as shell beads, tumblers, pendants, metal projectile points and knives, basketry, and carved steatite items.

The Shoshone were present in southeastern Wyoming in the 1600s and 1700s. About this time, the Crow moved into northeastern and north-central Wyoming and the Apache-Kiowas moved out of the Black Hills into southeastern Wyoming. The Apache-Kiowa migration through the Black Hills was followed by that of the Cheyenne who moved through western South Dakota and then into central Wyoming where they were joined by the Arapaho who settled in southern Wyoming. By the mid-1800s, much of the eastern and central portions of the state were occupied by nomadic Siouan-speaking tribes, primarily the Hunkpapa, Minneconjou, Brule, and Oglala.

<u>Historic Narrative (1800s to the Present)</u>

The first Europeans to traverse southeastern Wyoming may have been members of a party led by Robert Stuart, who crossed the continent from west to east in 1812-1813 while employed by the American Fur Company. Much of their route eventually would become the Oregon Trail. By the 1830s, French fur trappers and traders were in the area around the Laramie Mountains, and in 1834 Fort William was established by William Sublette and Robert Campbell at the confluence of the North Platte and Laramie rivers. In 1841, as Fort William began to deteriorate, it was replaced by Fort John. Fort John soon became known as Fort Laramie. In 1849, Fort Laramie was purchased by the U.S. Army and the facility was expanded to provide protection to travelers along the Oregon Trail.

Overland migration along the Oregon Trail generally is considered to have begun in 1843, although the route of the trail had become well known to missionaries, traders, trappers, and scientific exploration parties during the previous decade. Use of the trail by emigrants bound for the West Coast increased substantially, and traffic remained high until the mid-1860s. The trail not only led settlers to the Pacific Coast but also became the principal route for miners headed to the California gold fields and Mormons bound for the Great Basin. Fort Laramie's importance grew as a result of the westward migration despite the decrease in the fur trade, and the post was a principal stopping place and supply point along the route. The use of the trail declined during the Civil War and dropped dramatically with the completion of the transcontinental railroad in the late 1860s.

The spread of western settlement and increasing traffic on emigrant trails, which crossed Native American territories and hunting grounds, resulted in conflicts with Native Americans who already occupied the area. Treaties, most notably the Fort Laramie Treaty of 1851, were signed with the intent of removing tribes along the emigrant trails to reservations, and allowing for the building of trails and forts to protect settlers moving west on the Texas, Oregon, California, Mormon, Bozeman, and Bridger trails in central and eastern Wyoming. In 1868, the Wind River Indian Reservation, which currently encompasses more than 2.2 million acres, was established for the Eastern Shoshone. Ten years later, the government moved a band of Northern Arapaho from Colorado into the Wind River Valley and onto the reservation. Today, the Shoshone and Arapaho share the reservation and govern it jointly.

The livestock industry in Wyoming is considered to have originated in the 1840s during the heyday of the Oregon Trail when tens of thousands of cattle, sheep, and horses were herded across the area. With completion of the transcontinental railroad, the stock ranching industry boomed, due to access to the large markets on the East and West coasts. Cattle ranching was well established in the 1860s and the sheep industry by the 1870s. The first permanent ranches were formed in the early 1870s, with many of these becoming large by the 1880s. After the devastating blizzard of 1886, the sheep industry made significant gains, and by 1900 there were 3.3 million head of sheep in Wyoming.

Located approximately 4 miles north/northwest of the GHPA and 2.5 to 3.0 miles north of the access road is the Casper to Lander Road, which became an important transportation route between Casper and the Lander Valley in the 1880s after the arrival of the railroad in Casper. It was a freight and stagecoach route and an integral part of the development of the Wind River Basin. The road remained in use until the railroad reached Shoshoni, Riverton, and Lander in 1906.

In the 1880s, farmers began homesteading much of the open range, leading to conflicts with ranchers over fencing. By 1910, much of the range in Wyoming was fenced in order to establish boundaries and prevent livestock from straying. The last great period of homesteading occurred between the end of World War I and the mid-1930s in response to passage of the Stock-Raising Homestead Act of 1916, which expanded the size of homesteads. The Great Depression and the droughts that occurred at the same time led to the abandonment of many farms and the outmigration of a significant portion of Wyoming's population. Many of the homesteads were bought out in the 1930s and 1940s to create larger farms that used mechanized equipment.

Uranium discoveries northeast of Casper near Pumpkin Buttes led to the development of 5 uranium processing plants. By 1955, the Atomic Energy Commission established a regional buying station for yellowcake in Riverton. The uranium boom helped Riverton's economy and the town was soon known as Wyoming's "uranium capitol." The Lucky Mc uranium mine completed the state's largest uranium mill in the center of the Gas Hills Mining District in 1958. The mill annually produced 700,000 pounds of uranium concentrate. Production slowed during the 1960s; however, exploration work continued and then exploded during the 1970s in response to the spiking yellowcake prices and the growing industry. The uranium industry plummeted in the early 1980s because of the decline in the price of yellowcake. Much of the uranium ore in Wyoming, as well as in other areas of the U.S., comes from deposits in sandstone, which tend to be of lower grade compared to uranium ore found in other countries. Because of the lower grade, many of the uranium deposits became uneconomical when the price of uranium declined during this time.

Oil production continued strong, peaking both nationally and in Wyoming in 1970. All but a handful of refineries closed in the 1970s and 1980s. Although most oil fields in Wyoming are aging, oil production remains important to the state. However, oil no longer is the primary energy mineral produced in the state.

3.2.1.4 Cultural Resources Inventories

The earliest cultural resources investigations within and near the GHPA were conducted from 1976 to 1979. These investigations were conducted by the Office of the Wyoming State Archaeologist and

Powers Elevation Company, Inc. Due to changing standards and guidelines in cultural resources inventories, recording techniques, and NRHP eligibility assessment, investigations conducted prior to 1981 generally are not accepted as adequate today. In the 1980s and 1990s, 3 relatively large Class III inventories were conducted within the GHPA, as well as follow-up site revisits requested by the BLM. These 3 inventories are briefly discussed in the following paragraphs.

In 1980, the ***Office of the*** Wyoming State Archaeologist ***(OWSA)*** inventoried 1,100 acres within the GHPA (Hauff et al. 1982). A total of 19 archaeological sites were recorded during the inventory. The 19 sites consisted of 15 prehistoric lithic scatters, 2 prehistoric lithic scatters with stone circles, 1 prehistoric lithic scatter with stone circles and historic corrals, and 1 historic trailer. Of these sites, 14 were determined not eligible for the NRHP with concurrence from the Wyoming SHPO; the eligibility of the remaining 5 sites was undetermined at the time.

In 1992, a Class III cultural resources inventory was conducted in the GHPA by Pronghorn Archaeological Services (PAS) (Phillips 1993). Approximately 1,600 acres of the GHPA were inventoried. The inventory resulted in the recordation of 14 sites and 4 isolated artifacts. Of the 14 sites, 1 was recommended as eligible for the NRHP by the field archaeologist, 4 were unevaluated pending subsurface testing, and 9 were recommended as not eligible for the NRHP. The eligible site consisted of several stone circles and related cairns (a man-made pile or stack of stones used as a marker) and the 4 unevaluated sites consisted of 3 prehistoric camps and 1 lithic scatter. The 9 sites recommended as not eligible consisted of 6 lithic scatters, 2 prehistoric camps, and 1 stone circle.

In addition to the inventory, PAS re-examined the 19 sites previously recorded by the OWSA in 1980 (Phillips 1993). All but 3 of the re-examined sites were recommended as not eligible for listing on the NRHP. The 3 sites had the potential to contain buried prehistoric deposits and were considered unevaluated pending subsurface testing.

In 1997, an additional 2,840 acres of the GHPA were inventoried to Class III standards by PAS (Phillips 1993). The inventory resulted in the recordation of 20 prehistoric sites and 14 isolated artifacts; 3 previously recorded sites were relocated. Only 1 of the sites was recommended as eligible for listing in the NRHP. The 20 prehistoric sites consisted of 8 open camps, 3 isolated stone circles (2 with associated debitage), 6 isolated hearth features, and 3 lithic scatters. One of the prehistoric open camps also contained historic debris. Of the 3 previously recorded sites, 2 were open camps and 1 was an excavated hearth. The single eligible site was identified as a prehistoric open camp with associated stone circles.

In 2011, Larson-Tibesar Associates (LTA) conducted archaeological investigations in the GHPA, which included evaluation of 34 previously recorded unevaluated prehistoric sites, Class III inventory of previously unsurveyed areas, a visual assessment of the Casper to Lander Road, a sample survey of previously inventoried areas, and an evaluation of the Gas Hills as a historic mining district (Larson et al. 2012). During evaluation of the 34 previously recorded sites it was discovered that 4 of the sites are located outside the GHPA; no further work was conducted at these sites. The remaining 30 sites are listed in **Table 3.2-1**. Of these sites, 10 could not be relocated during the investigations. Evaluation of the remaining 20 sites resulted in the recommendation of 15 as not eligible for the NRHP and 5 as eligible under Criterion D. Avoidance is recommended for the 5 eligible sites, 2 of which are located just outside the boundaries of the proposed mine units (Larson et al. 2012).

It should be noted that 9 of the previously recorded unevaluated sites contain stone features which typically are of concern to Native American tribes. In April 2007, the BLM conducted tribal consultation at 3 of the sites (48NA420/48FR917, 48FR3234, 48NA2151/48FR3235). At that time, it was agreed that no drilling would occur within 100 feet of 48FR420/48FR917 and within 300 feet of the other sites. In addition, it was agreed that if drilling was proposed on areas level with or above 48FR3235/48NA2151, additional consultation may be necessary.

Table 3.2-1 Previously Recorded Unevaluated Sites Located Within the GHPA

Site Number	NRHP Eligibility Evaluation	Cultural Affiliation/Site Type
48NA420/48FR917	Eligible (Tribal site visit 2007)	Late Prehistoric and Late Archaic occupation areas with stone circles; historic artifacts
48NA2151/FR3235	Could not be relocated (exact location of the site needs to be resolved – potentially eligible) (Tribal site visit 2007)	Unknown prehistoric stone circles and lithic scatter
48FR135	***Eligible (Tribal site visit 2012)***	***Unknown prehistoric stone circles.***
48FR144	Not Eligible	Unknown prehistoric lithic scatter
48FR145	Not Eligible	Possible Late Archaic lithic scatter with fire cracked rock; historic debris
48FR234	Could not be relocated	Unknown prehistoric lithic scatter
48FR930	Not Eligible	Unknown prehistoric lithic scatter
48FR931	Not Eligible	Late Archaic lithic scatter
48FR3228	***Eligible (Tribal site visit 2012)***	***Unknown prehistoric stone circle and lithic scatter.***
48FR3232	***Eligible***	***Unknown prehistoric stone circles, hearths, and lithic scatter.***
48FR3234	Eligible (Tribal site visit 2007)	Unknown prehistoric stone circle
48FR3236[a]	Eligible	Unknown prehistoric stone circles
48FR3239	Not Eligible	Unknown prehistoric lithic scatter
48FR3240	Eligible	Unknown prehistoric stone circles and lithic scatter
48FR3864	Could not be relocated	Unknown prehistoric lithic scatter
48FR3865	Could not be relocated	Unknown prehistoric lithic scatter
48FR3866[a]	Eligible	Unknown prehistoric stone circles and lithic scatter
48FR3867	Could not be relocated (may have been misplotted - site description is similar to 48FR3866)	Unknown prehistoric stone circles and lithic scatter
48FR3868	Could not be relocated	Unknown prehistoric hearth
48FR3869	Could not be relocated	Unknown prehistoric lithic scatter with hearths
48FR3870	Eligible	Unknown prehistoric stone circle
48FR3871	Not Eligible	Unknown prehistoric lithic scatter with fire cracked rock
48FR3872	Could not be relocated	Unknown prehistoric hearth
48FR3873	Not Eligible	Unknown prehistoric lithic scatter
48FR3874	***Eligible***	Unknown prehistoric stone circle, hearth, and lithics
48FR3875	Not Eligible	Unknown prehistoric hearth
48FR3876[a]	Eligible	Late Archaic lithic scatter
48FR3877	Could not be relocated	Unknown prehistoric hearth

Table 3.2-1 Previously Recorded Unevaluated Sites Located Within the GHPA

Site Number	NRHP Eligibility Evaluation	Cultural Affiliation/Site Type
48FR3878	Not Eligible	Unknown prehistoric hearth
48FR3879	Eligible	Unknown prehistoric stone circle
48FR3880	Not Eligible	Unknown prehistoric lithic scatter
48FR3881[a]	Eligible	Unknown prehistoric stone circles
48FR3882	Eligible	Unknown prehistoric stone circle

[a] Located outside of the proposed mine unit boundary.

Source: Larson et al. 2012.

LTA also completed Class III inventory of 2,655 acres of land within the GHPA that had not been previously inventoried to Class III standards (Larson et al. 2012). As a result of the inventory, 11 new sites and 24 previously recorded sites were identified within the GHPA (**Table 3.2-2**). Of these, 3 sites (48NA420/48FR917, 48NA4985, 48FR6903) are recommended as eligible for inclusion in the NRHP; the remaining 10 sites are recommended as not eligible. Avoidance is recommended for the 3 eligible sites, 2 of which are located outside the boundaries of the proposed mine units. Of the sites listed in the table, 2 (48NA420/48FR917, 48FR6903) contain stone circles, which typically are of concern to Native American tribes.

Table 3.2-2 Sites Recorded in New Inventory areas within the GHPA

Site Number	NRHP Eligibility Evaluation	Cultural Affiliation/Site Type
48NA420/48FR917[a]	Eligible	Late Prehistoric and Late Archaic occupation areas with stone circles; historic artifacts
48NA4981/48FR6906	Not Eligible	Unknown prehistoric lithic scatter; historic debris
48NA4982	Not Eligible	Late Prehistoric lithic scatter
48NA4983	Not Eligible	Unknown prehistoric lithic scatter
48NA4984	Not Eligible	Unknown prehistoric hearth
48NA4985[b]	Eligible	Archaic occupation area with datable features and diagnostic artifact
48FR931[a]	Not Eligible	Late Archaic lithic scatter
48FR6902	Not Eligible	Unknown prehistoric lithic scatter
48FR6903[b]	Eligible	Late Prehistoric stone circles, hearths, and lithics
48FR6904	Not Eligible	Unknown prehistoric lithic scatter
48FR6905/48NA4980	Not Eligible	Unknown prehistoric lithic scatter; historic Thunderbird Mine
48FR6907	Not Eligible	Unknown prehistoric lithic scatter; historic debris
48FR6910	Not Eligible	Unknown prehistoric lithic scatter

[a] Also in **Table 3.2-1**.

[b] Located outside of the proposed mine unit boundary.

Source: Larson et al. 2012.

A visual assessment of the Casper to Lander Road (48FR1783/48NA4218) was conducted by LTA as part of the 2011 archaeological investigations. An initial desktop viewshed analysis indicated a small portion of the GHPA is visible from the road, generally along the upper, north facing slopes of the Beaver Divide which includes some parts of the southern segment of Mine Unit 3 and southern edge of the eastern portion of Mine Unit 2. Following the desktop analysis, the segment of the Casper to Lander Road from which the GHPA is visible was visited and evaluated for NRHP eligibility. The segment of the road has been destroyed and therefore is recommended as non-contributing to the overall eligibility of the road.

In 2011, LTA conducted a sample survey of 3 previously inventoried areas within the GHPA. The purpose of the survey was to verify the results of prior inventories in terms of accuracy and conformation to current Class III inventory standards. Total acreage of the 3 areas was 5,341 acres.

Sampling results of the first area indicate relatively consistent findings between LTA and previous inventories conducted by PAS. The only difference between the 2 inventories was the documentation by LTA of 1 new site with stone circles and a multi-artifact isolated resource (IR), and the inability to locate a previously recorded site. ***O***ne of the newly recorded sites ***is*** recommended as eligible for the NRHP.

Results of the sampling survey for the second area indicate differences in terms of higher site/IR counts for LTA (11 sites/multi-artifact IRs) compared to site/IR counts for PAS (5 sites/multi-artifact IRs). LTA documented 3 new sites and 4 new multi-artifact IRs. Of the newly recorded sites, only 1 is recommended as eligible for the NRHP.

Of the 3 areas sampled, the third area had been the most disturbed by previous mining and reclamation. Sampling results indicate differences in terms of higher site/multi-artifact IR counts for LTA (9 sites/ multi-artifact IRs) compared to site/IR counts for the OWSA (2 sites). LTA documented 2 new sites and 4 new multi-artifact IRs. None of the newly recorded sites are recommended as eligible for the NRHP.

In sum, LTA encountered 16 archaeological sites during the sampling survey, of which 12 are previously recorded sites and 4 are newly recorded sites (**Table 3.2-3**). The majority of the sites contain prehistoric lithic scatters with unknown cultural affiliation. Of the 16 sites, 7 are recommended as eligible for the NRHP and the remaining 9 sites are recommended as not eligible.

Table 3.2-3 Sites Encountered During the Sample Survey

Site Number	Previously Recorded/Newly Recorded	NRHP Eligibility Evaluation	Cultural Affiliation/Site Type
48FR144[a]	Previously Recorded	Not Eligible	Unknown prehistoric lithic scatter
48FR145[a]	Previously Recorded	Not Eligible	Possible Late Archaic lithic scatter with fire cracked rock; historic debris
48FR930[a]	Previously Recorded	Not Eligible	Unknown prehistoric lithic scatter
48FR3232	Previously Recorded	Eligible	Complex with unknown lithic scatter, hearths, and stone circles
48FR3234[a]	Previously Recorded	Eligible	Unknown prehistoric stone circle
48FR3238	Previously Recorded	Not Eligible	Unknown prehistoric lithic scatter
48FR3866[a,b]	Previously Recorded	Eligible	Unknown prehistoric stone circles and lithic scatter
48FR3871[a]	Previously Recorded	Not Eligible	Unknown prehistoric lithic scatter with fire cracked rock

Table 3.2-3 Sites Encountered During the Sample Survey

Site Number	Previously Recorded/Newly Recorded	NRHP Eligibility Evaluation	Cultural Affiliation/Site Type
48FR3879[a]	Previously Recorded	Eligible	Unknown prehistoric stone circle
48FR3881[a,b]	Previously Recorded	Eligible	Unknown prehistoric stone circles
48FR6908	Newly Recorded	Not Eligible	Unknown prehistoric lithic scatter
48FR6909	Newly Recorded	Eligible	Unknown prehistoric stone circle
48FR6911[b]	Newly Recorded	Eligible	Late Archaic prehistoric lithic scatter
48NA420/48FR917 [a]	Previously Recorded	Eligible	Late Prehistoric and Late Archaic occupation areas with stone circles; historic artifacts
48NA2151/48FR3235[a,b]	Previously Recorded	Eligible	Unknown prehistoric stone circles and lithic scatter
48NA4987[b]	Newly Recorded	Eligible	Unknown prehistoric stone circle and lithic scatter

[a] Also in **Table 3.2-1.**

[b] Located outside of or adjacent to the proposed mine unit boundary.

Source: Larson et al. 2012.

Based on previously and recently conducted cultural resources inventories, a total of 78 cultural resources are located within the GHPA. Of these, 23 are eligible for listing on the NRHP and 55 are not eligible. A total of 9 NRHP-eligible sites and 16 ineligible sites are located in proposed disturbance areas and could be directly affected by ground-disturbing activities associated with the Proposed Action Alternative. For those sites located in proposed disturbance areas, 9 require***d*** Native American consultation to determine eligibility***, and all were determined to be eligible for listing on the NHRP***.

3.2.2 Native American Concerns

Ethnographic resources are associated with the cultural practices, beliefs, and traditional history of a community. Examples of ethnographic resources include places in oral histories or traditional places, such as particular rock formations, the confluence of 2 rivers, or a rock cairn; large areas, such as landscapes and viewscapes; sacred sites and places used for religious practices; social or traditional gathering areas, such as dance areas; natural resources, such as plant materials or clay deposits used for arts, crafts, or ceremonies; and places and natural resources traditionally used for non-ceremonial uses, such as trails or camping locations.

3.2.2.1 Regulatory Framework

Federal law and agency guidance require the BLM to consult with Native American tribes concerning the identification of cultural values, religious beliefs, and traditional practices of Native American people that may be affected by actions on BLM-administered lands. This consultation includes the identification of places (i.e., physical locations) of traditional cultural importance to Native American tribes. Places that may be of traditional cultural importance to Native American people include, but are not limited to, locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world; locations where religious practitioners go, either in the past or the present, to perform ceremonial activities based on traditional cultural rules or practice; ancestral habitation sites; trails; burial sites; and places from which plants, animals, minerals, and waters possessing healing powers or used for other subsistence purposes, may be taken. Some of these locations may be considered sacred to particular Native American individuals or tribes.

In 1992, the NHPA was amended to explicitly allow that "properties of traditional religious and cultural importance to an Indian tribe may be determined to be eligible for inclusion in the NRHP." If a resource has been identified as having importance in traditional cultural practices and the continuing cultural identity of a community, it may be considered a traditional cultural property. The term "traditional cultural property" first came into use within the federal legal framework for historic preservation and cultural resource management in an attempt to categorize historic properties containing traditional cultural significance. To qualify for nomination to the NRHP, a traditional cultural property must be more than 50 years old, must be a place with definable boundaries, must retain integrity, and must meet certain eligibility criteria as outlined for cultural resources in the NHPA.

In addition to NRHP eligibility, some places of cultural and religious importance also must be evaluated to determine if they should be considered under other federal laws, regulations, directives, or policies. These include, but are not limited to, the Native American Graves Protection and Repatriation Act of 1990, AIRFA, ARPA, and EO 13007 of 1996, Indian Sacred Sites.

3.2.2.2 Native American Consultation

In compliance with the NHPA, the BLM initiated government-to-government consultation for the Gas Hills Project on May 6, 2011, by sending letters to the following federally recognized tribes: Ute Indian Tribe, Northern Arapaho Tribe, Eastern Shoshone Tribe, Crow Nation, Northern Cheyenne Tribe, Shoshone-Bannock Tribe, Rosebud Sioux Tribe, Oglala Sioux Tribe, Cheyenne River Sioux Tribe, Lower Brule Sioux Tribe, Fort Peck Assiniboine Sioux Tribes, Standing Rock Sioux Tribe, Crow Creek Sioux Tribe, and Yankton Sioux Tribe. The letters were sent to inform the various tribes of the Gas Hills Project and invite the tribes to comment on the proposed undertaking. Additionally, the letters included a request for information on any resources or places of traditional, religious, and cultural importance to the tribes that may be located in the Gas Hills area. Included with the letters was a map of the GHPA and a response form for the tribes to indicate their level of interest and return to the BLM. To date, only the Standing Rock Sioux Tribe and Northern Cheyenne Tribe have responded to the letter. Both tribes are interested in participating in the consultation efforts for the Project. ***The Northern Cheyenne later chose to defer to the local tribes for the remainder of the Project.***

On May 7, 2012, the BLM sent a second letter to the above-listed federally recognized tribes. The letter included a description of the Project area, information on previously and recently conducted cultural resources inventories, and a request for comments and/or concerns regarding the Gas Hills ISR Project. Attached to the letter were a: 1) Project map; 2) figure showing an example of a typical mine unit; and, 3) response form on which the tribes could indicate their interest in participating in the consultation efforts, and their availability to participate on a conference call to discuss the Project. To date, the Standing Rock Sioux Tribe, Crow Nation, and Ute Indian Tribe have responded to the letter.

From May 16 to June 5, 2012, the BLM conducted follow-up calls to the 14 federally-recognized tribes. The BLM called the tribes to verify receipt of the May 7, 2012, letter and to invite the tribes to participate on a conference call tentatively scheduled for mid-June 2012.

In early June 2012, the BLM invited the 14 federally-recognized tribes listed above, plus the Sisseton-Wahpeton Oyate Tribe, to participate on a conference call scheduled for June 13, 2012. Of the 15 tribes, 6 tribes were able to participate on the call. The 6 tribes included the Northern Arapaho Tribe, Shoshone-Bannock Tribe, Sisseton-Wahpeton Oyate Tribe, Rosebud Sioux Tribe, Yankton Sioux Tribe, and Standing Rock Sioux Tribe. During the call, the BLM discussed the results of cultural resources inventories conducted in the GHPA and tentative dates for ***2*** week-long field tours. Tentative dates for the field tours were the week of August 6 and the week of August 20, 2012. If needed, an alternative week for a field tour would be the week of September 17, 2012. Some of the tribal representatives on the call expressed concern that the archaeologists conducting the previous inventories may have missed sites of tribal concern. The field tours would provide an opportunity for the tribes to tour the GHPA and identify sites that may have been missed.

From September 17 to 21, 2012, the BLM conducted a field tour of the GHPA. A total of 6 tribes participated in the field tour. These 6 tribes included the Northern Arapaho Tribe, Eastern Shoshone Tribe, Crow Nation, Oglala Sioux Tribe, Fort Peck Assiniboine Sioux Tribes, and Sisseton-Wahpeton Oyate Tribe. During the field tour, tribal representatives identified sites of concern that would require reroutes and avoidance by the Project, including previously recorded sites as well as newly identified sites. Tribal consultation ***would*** be ongoing to identify additional sites of concern, and to determine avoidance distances and/or mitigation measures required for each site. ***Tribal consultation would continue throughout development of the Project and would be phased along with the Section 106 review of each mine unit. Ongoing tribal consultation may include additional field tours or tribal surveys of the GHPA, as appropriate.***

Located approximately 8 miles north of the GHPA is the Castle Gardens Rock Art Site. The site contains a large number of prehistoric drawings estimated to date from the Late Prehistoric Period. Several styles of art are evident, and many excellent shield motif representations are present. It is assumed that the functions of the drawings are concerned mostly with spiritual beliefs or a record of important events. The site is considered to be a spiritual site to the Eastern Shoshone, Northern Arapaho, and other tribes, and modern traditional use of the site has been documented as well. Castle Gardens Rock Art Site is listed on the NRHP and has been nominated for Areas of Critical Environmental Concern (ACEC) designation.

3.3 Geology

3.3.1 Physiography and Topography

The Project is located in the Wind River Basin and is part of the Wyoming Basin physiographic province (Fenneman 1928). The Wyoming Basin is a 40,000-square-mile area located in central and southwestern Wyoming and parts of northwestern Colorado and is characterized by rolling plains, dissected badlands, and small mountain ranges (Howard and Williams 1972). The Wind River Basin is bounded by the Owl Creek Mountains to the north, the Granite Mountains to the south, the Wind River Mountains to the west, and to the east a gentle uplift referred to as the Casper Arch (Wyoming State Geological Survey [WSGS] 2011). The GHPA is located on the southern edge of the Wind River Basin just to the north of the Granite Mountains.

Important physiographic features in the Gas Hills area include the Gas Hills, Rattlesnake Hills, Black Mountain, and the Beaver Rim (**Figure 3.3-1**). The Rattlesnake Hills is a 15-mile-long northwest to southeast trend of hills east of the GHPA, which range up to 8,200 feet amsl at Garfield Peak. Black Mountain, which tops out at about 8,000 feet amsl southeast of the GHPA. An important physiographic feature in the GHPA is the Beaver Rim or Beaver Divide, prominent escarpments that trend from the southern extent of the Wind River Mountains to the Rattlesnake Hills and forms the southern physiographic boundary of the Wind River Basin (Soister 1968). The Beaver Rim skirts the south boundary of the GHPA and the change in elevation along the escarpment varies from 500 to 700 feet. The Beaver Rim is a divide between north-flowing drainages to the north and south-flowing drainages to the south. The Gas Hills, for which the mining district is named, are located just to the northwest of the GHPA and are composed of hogbacks of steeply dipping Cretaceous rocks (Love 1954).

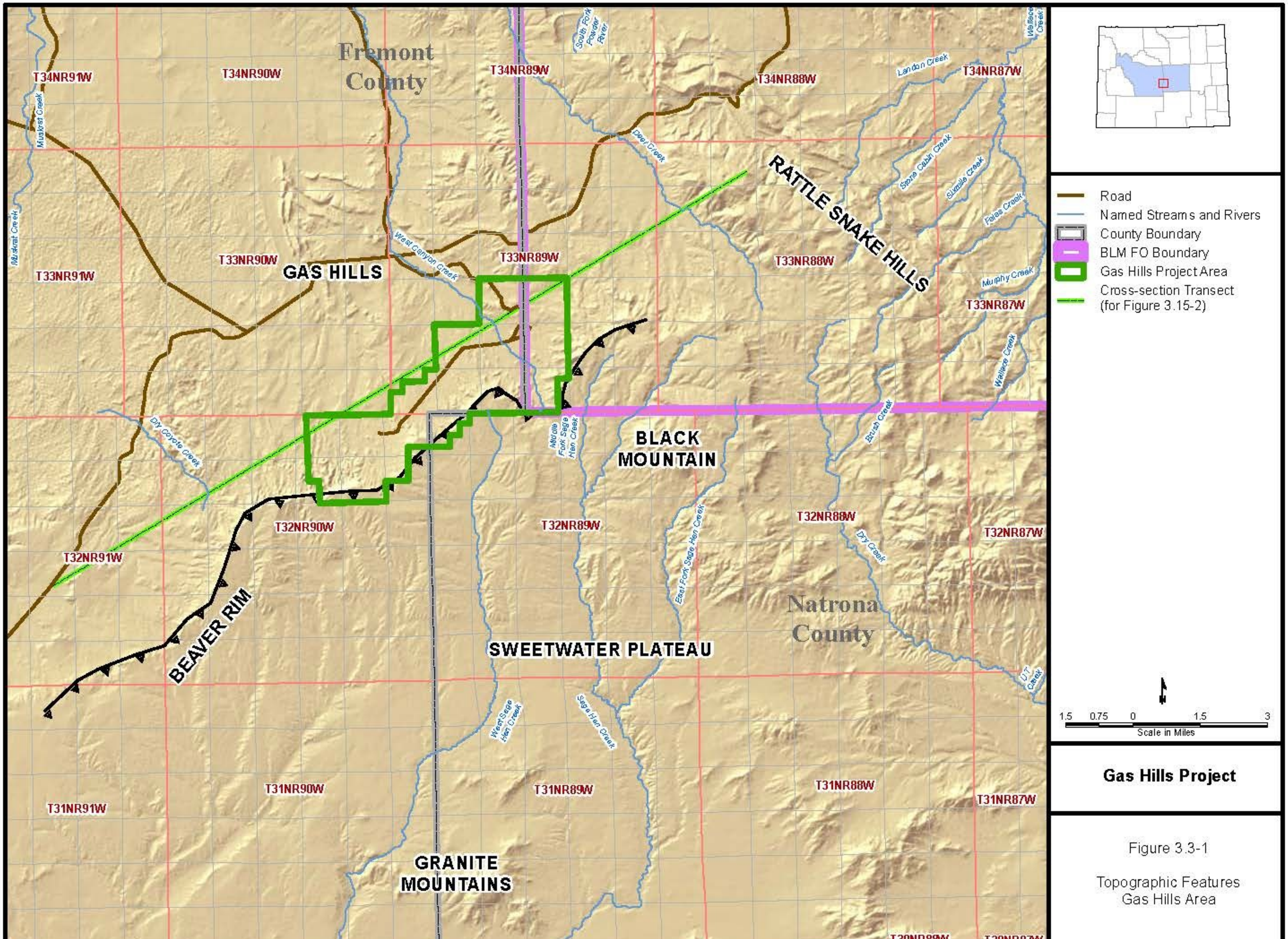
The topography north of the Beaver Rim consists of hummocky low hills and deeply dissected northwest trending drainages. Elevations in the GHPA range from around 7,400 feet amsl at the top of the Beaver Rim to around 6,700 feet amsl along the north side of the GHPA. The topography of the GHPA is dominated by the steep slopes of the Beaver Rim on the south to gentler sloping ground north of the escarpment. South of the GHPA is an area that slopes gently to the south and is referred to as the Sweetwater Plateau (Soister 1968).

3.3.2 Regional Geology

The Wind River Basin is a large asymmetric synclinal basin approximately 200 miles long and 90 miles wide. The basin contains about 30,000 feet of sedimentary rock (Jensen 1972) ranging in age from Cambrian to recent. Tertiary-aged deposits cover a large portion of the basin and older Paleozoic and Mesozoic rocks are exposed on the edges of the basin or in isolated uplifts within the basin (Love and Christiansen 1985).

The surficial deposits in the GHPA are alluvium, colluvium, and landslide debris (Van Houten 1964). The alluvium and colluvium are found primarily along the floodplains of drainages and low lying surfaces and consist of sand and silt sized material derived from the Tertiary bedrock in the area. Landslide deposits are present at the base of the Beaver Rim and are composed of large rotated blocks along the edge of the rim or mixed earth flows and rock slides.

Bedrock deposits within the mine permit boundary consist primarily of Tertiary rocks and a small outcropping of Paleozoic rocks in the northeast part of the GHPA. **Table 3.3-1** lists the rocks that are exposed within the Gas Hills ***region.*** **Figure 3.3-2** shows the bedrock geology in the GHPA.



Gas Hills Project

Figure 3.3-1

Topographic Features
Gas Hills Area

Table 3.3-1 Stratigraphic Chart, GHPA

Era	System	Series	Age (Ma[a])	Formation[b]/ Map Symbol	Description	Thickness (feet)
Cenozoic	Quaternary	Holocene	<0.015	Alluvium[b]/**Qa**	Gravel, sand, silt, clay.	Not determined
				Landslide Material[b]/**Qls**	Mixed material composed of blocks, talus, and earth flows composed of material eroded from the Beaver Rim.	Not Determined
		Pleistocene	0.015-2.6	Pediment Gravels/**Qt**	Gravels, cobbles and coarse sand derived from granite.	Less than 15
	Tertiary	Miocene	16-26	Split Rock Formation[b]/ **Tm**	Conglomerate, sandstone, and tuff.	Up to 100
		Oligocene	31-36	White River Formation[b]/ **Twr**	Tuff and tuffaceous bentonitic mudstone, sandstone, and conglomerate.	Up to 450
		Eocene	45-49	Wagon Bed Formation[b]/ **Twb**	Bentonitic and locally tuffaceous mudstone and sandstone, and volcanic sandstone, and conglomerate.	500
			38-49	Tertiary Intrusives/**Ti**	Alkalic igneous rocks, dacite, and quartz latite.	Undetermined
			49-55	Wind River Formation[b]/ **Twdr**	Lenticular mudstone, sandstone, and conglomerate, locally tuffaceous in upper part.	800+

Table 3.3-1 Stratigraphic Chart, GHPA

Era	System	Series	Age (Ma[a])	Formation[b]/ Map Symbol	Description	Thickness (feet)
Mesozoic	Cretaceous	Upper	82-87	Cody shale/**Kc**	Soft gray shale becoming sandy in the upper part.	3,000+
		Upper	87-95	Frontier Formation/**Kf**	Sandstone interbedded black shale with tuff and bentonite beds.	580
		Lower	95-100	Mowry Shale-Muddy Sandstone-Thermopolis Shale/**Kmt**	Dark gray to black bentonitic shale and sandstone and interbedded sandstone and shale.	650
	Lower Cretaceous-Upper Jurassic		100-140	Cloverly and Morrison /**KJ**	Sandstone and conglomerate with interbedded claystone and sandstone in lower part. Morrison: Fine- to very fine-grained well sorted sandstone.	280
	Jurassic - Triassic		140-205	Sundance and Nugget Sandstones/ **JTR**	Sundance: Fine-grained sandstone and green shale. Nugget: Fine- to coarse-grained hard calcareous sandstone.	410
	Triassic		205-240	Chugwater Group/**TRc**	Interbedded red sandstone, siltstone, shale, and limestone.	1,000

Table 3.3-1 Stratigraphic Chart, GHPA

Era	System	Series	Age (Ma[a])	Formation[b]/ Map Symbol	Description	Thickness (feet)
Paleozoic	Permian		250-280	Phosphoria Formation[b]/**Pp**	Dolomite with interbedded red shale and anhydrite.	325
	Pennsylvanian	Middle	290-310	Tensleep Sandstone[b]/ **PM**	Fine- to coarse-grained sandstone with cherty dolomite.	200
		Lower	310-340	Amsden Formation[b]/ **PM**	Red and green shale, cherty dolomite, and sandstone.	260
	Mississippian	Lower	340-360	Madison Limestone[b]/ **Mm**	Limestone; massive to thick-bedded.	300
	Cambrian	Middle	500-570	Gros Ventre[b]/ **Cfg**	Reddish brown siltstone and sandstone with limestone pebble conglomerate.	400
				Flathead[b]/**Cfg**	Interbedded coarse-grained sandstone and conglomerate derived from granitic rocks.	220
Precambrian			2,600	Not defined/**PC**	Granite, granitic gneiss, schist, and pegmatites.	Not known

[a] Ma = Million years ago.

[b] Exposed within the GHPA.

Note: Separation of geological layers (Systems or Series) that uncomfortably overlie each other are indicated by the dashed line in the table.

Sources: ***PRI 2009***; Finn 2007; Love 1970, 1954; Love and Christiansen 1985; Love et al. 1993; Soister 1967.

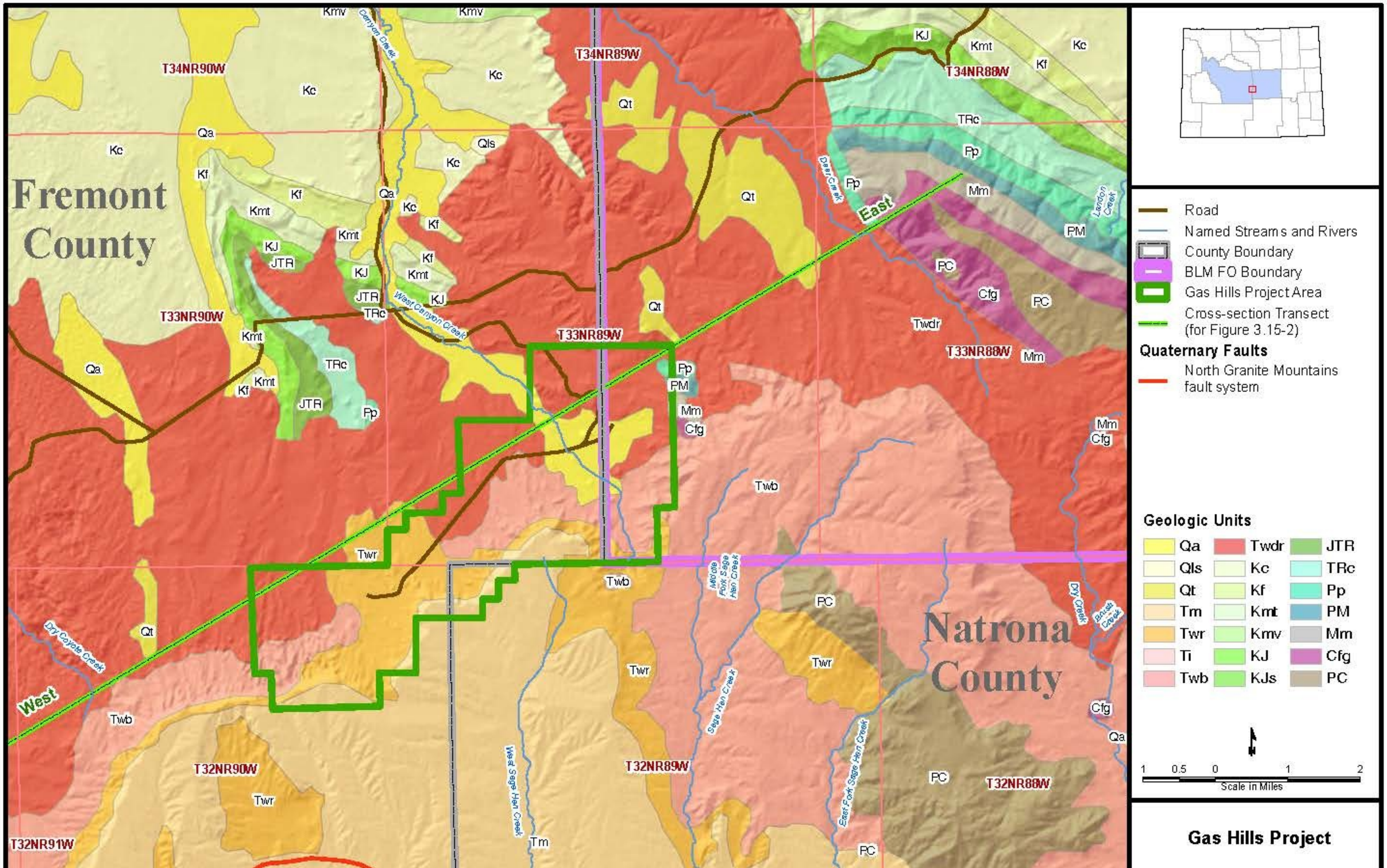


Figure 3.3-2

Bedrock Geology

The Tertiary rocks in the GHPA area are up to several hundred feet thick and cover a rugged pre-Tertiary erosion surface formed on Mesozoic and Paleozoic rocks (Love 1954; PRI 2009). The Wind River Formation generally outcrops at the base of the Beaver Rim, while the Wagon Bed Formation forms the lower slopes of the escarpment (Soister 1967). The White River and Split Rock formations form the upper layers of the Beaver Rim. The rocks beneath the Tertiary beds in the GHPA range in age from upper Cretaceous to Triassic and have been folded into a series of northwest-southeast trending en-echelon anticlines and synclines and form angular unconformities with the overlying Tertiary beds (PRI 2009).

The major structural elements in the region were created during the formation of the Rocky Mountains (the Laramide Orogeny) that occurred from late Cretaceous to early Tertiary. One of the largest uplifts occurred in early Eocene and created the Granite Mountains (Love 1970). The Wind River and Wagon Bed Formations were derived from material that was shed from the Granite Mountains as uplift occurred until Middle-Eocene time. During the Oligocene, vigorous volcanic activity to the northwest of the GHPA formed the modern Rattlesnake Hills. Erosion of the volcanic deposits resulted in the transportation of volcanic material over many miles, in addition to thick air-borne ash, which was deposited over many thousands of square miles. The White River Formation consists of volcanic debris plus slightly reworked volcanic ash almost 1,000 feet thick (Love 1970). The Split Rock Formation was deposited in a basin formed by subsidence of the Granite Mountains block due to crustal extension during the Miocene. The Split Rock Formation is largely composed of sand deposited by wind and water that attained a maximum thickness of nearly 3,000 feet, burying all but the highest peaks of the Granite Mountains. Although subsequent uplift in the Pleistocene resulted in erosion of some of the material, the Granite Mountains are still largely buried in detritus that surrounds the peaks. This later episode of Pleistocene uplift and erosion was responsible for creating the Beaver Rim and the southward tilt of the Sweetwater Plateau, resulting in the present-day drainage flow pattern.

Important structural features in the Gas Hills area include the North Granite Mountains fault system, Rattlesnake Hills, and the Gas Hills. The trace of the North Granite Mountains fault system is about 2 to 3 miles south of the GHPA (Love 1970) (**Figure 3.3-2**). The fault system consists of 60 miles of east-west trending normal faults bounding the north side of the Granite Mountains. The fault zone is believed to have been active in early Eocene during the major growth period of the Granite Mountains and again in the Pliocene when the mountain range subsided. The Rattlesnake Hills, just 3 miles northeast of the GHPA, is an anticline where Mesozoic and Paleozoic rocks are exposed. Along the crest of the hills and in a 150-square mile volcanic field around the Rattlesnake Hills are volcanic rocks in the form of dikes, sills, and plugs (Carey 1954). The volcanism is believed to have begun in middle Eocene and had ceased by the end of Eocene. The Gas Hills consist of hogbacks of tightly folded steeply dipping Cretaceous rocks (Love 1954). The geologic structure that forms the Gas Hills is referred to as the Dutton Basin Anticline, an exhumed structure that provides evidence of the northwest-southeast trending structures of the pre-Tertiary rocks beneath the GHPA and plunge to the northwest along regional dip into the Wind River Basin (Berg and Thompson 1957; Soister 1967). Precambrian granitic rocks are exposed in the southern part of the Rattlesnake Hills and comprise the main body of Black Mountain to the southeast of the GHPA.

3.3.3 Geologic Hazards

3.3.3.1 Seismic Hazards

Seismicity

Seismicity concerns the intensity, frequency, and location of earthquakes in a given area. Since 1973, there have been 25 earthquakes greater than 2.0 magnitude within 60 miles of the Project. The strongest earthquakes recorded were 4.8 magnitude quakes that took place in 1973 and 1975 approximately 15 miles west and southwest of the GHPA (Case et al. 2003, 2002; U.S. Geological Survey [USGS] 2011a). The data indicate that the seismic potential of the area is low.

Faults

Faults are dislocations of earth material where crustal blocks on opposite sides of the faults have moved in relation to each other (USGS 2009). Rapid slippage of blocks of earth past each other can cause energy to be released, resulting in an earthquake. An active fault is a fault where movement has occurred in the last 10,000 years and a potentially active fault is a fault where movement has possibly occurred during Quaternary time or the last 1.6 million years. The closest potentially active fault zone is the South Granite Mountains fault zone located approximately 25 miles south of the GHPA. The 80 mile-long fault zone trends west to east. Movement within the last 15,000 years has been documented in the Green Mountain area, along the Ferris Mountains and in the Muddy Gap area (USGS 2006).

There are other recognized fault zones in the Granite Mountains region, but there is no conclusive evidence that these features are active. The North Granite Mountains fault system may have been active from the Pliocene until early Quaternary (less than 1.6 Ma), but there is no evidence of movement within the last 10,000 years. The Split Rock Syncline, located north of and parallel to South Granite Mountains fault system, is a structure that was likely formed in response to uplift on the South Granite Mountains fault system It may have been active into Quaternary, but there is no conclusive evidence of movement within the last 10,000 years (USGS 2006).

Ground Motion

Ground motion hazards result when the energy from an earthquake is propagated through the ground. The USGS ground motion hazard mapping indicates that potential ground motion hazard in the GHPA is low. The hazard map used estimates of peak ground acceleration expressed as a percentage of the acceleration of gravity with a 10 percent probability of exceedence in 50 years (Petersen et al. 2008). Peak acceleration from a probable maximum earthquake event for the area is estimated to be less than 6 percent of gravity reference.

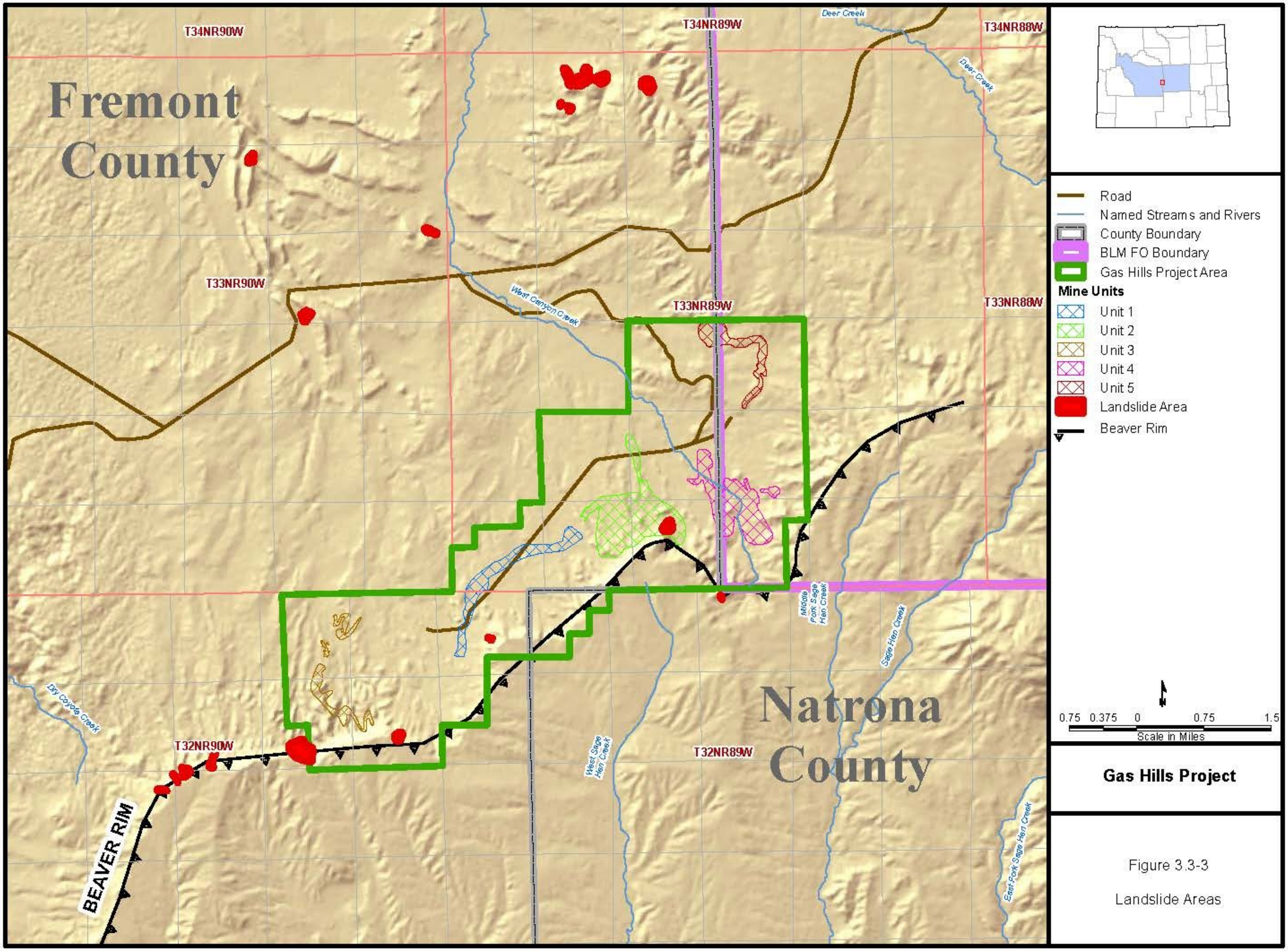
3.3.3.2 Landslides

Landslide is a term used for various processes involving the movement of earth material down slopes (USGS 2004). Landslides can occur in a number of different ways in different geological settings. Large masses of earth become unstable and by gravity begin to move downhill. The instability can be caused by a combination of factors including steep slopes, periods of high precipitation, undermining of support by natural processes (stream erosion), or unintentional undercutting or undermining the strength of unstable materials by construction of roads and structures.

Landslide deposits have been identified at the base of the Beaver Rim (WSGS 2004) (**Table 3.3-1**). Erosion along the steep escarpment results in instability at the edge and mass earth movements occur. The landslide deposits are limited to the slopes of the Beaver Rim (**Figure 3.3-3**). North of the rim, there are isolated rock slides and block slides associated with steep slopes.

3.3.4 Mineral Resources

Important mineral resources in the Gas Hills include: uranium, oil, gas, and bentonite. Recently, gold was discovered in the Rattlesnake Hills and current exploration is attempting to determine the commercial viability of the precious metal deposits. The following subsections provide a description of the mineral resources within the GHPA including details on the geology and mineralization of the uranium deposits. A detailed description of the geology and hydrogeology of uranium-bearing zones is presented in Section 3.15.2, Groundwater Resources.


Fremont County
Natrona County
T34NR90W
T34NR89W
T34NR88W
T33NR90W
T33NR89W
T33NR88W
T32NR90W
T32NR89W
BEAVER RIM
Deer Creek
West Canyon Creek
Dry Coyote Creek
West Sage Hen Creek
Middle Fork Sage Hen Creek
Sage Hen Creek
East Fork Sage Hen Creek
Road
Named Streams and Rivers
County Boundary
BLM FO Boundary
Gas Hills Project Area
Mine Units
Unit 1
Unit 2
Unit 3
Unit 4
Unit 5
Landslide Area
Beaver Rim
0.75 0.375 0 0.75 1.5
Scale in Miles
Gas Hills Project
Figure 3.3-3
Landslide Areas

3.3.4.1 Uranium

Mining History, Gas Hills District

Uranium mining in the Gas Hills followed a cycle of boom and bust that began in 1954. By 1970, 4 mining companies dominated the Gas Hills District: Federal-American Partners, Union Carbide, Utah Mining Co., and Western Nuclear (Armstrong 1970). The Atomic Energy Commission (AEC) purchasing program ended in 1970, and by 1971 almost all of the produced uranium was being used for the nuclear power industry (Chenoweth 1991). The Gas Hills District produced about 100 million pounds of yellowcake concentrate (U_3O_8) through conventional mining methods (surface and underground), almost half of the total historical production of the state of Wyoming (PRI 2009; Uranium Producers of America 2011). In 1980, spot prices for yellowcake concentrate dropped from $40.00 per pound to $27.00 per pound. Mining activity declined in the 1980s as the mills and mines closed, and by the 1990s, several of the mine properties were undergoing reclamation. In addition, as discussed in Section 2.1.2.1, Historic Mining, tailings from milling activities associated with uranium mining in and adjacent to the GHPA have been capped and are being transferred to management by DOE under UMTRCA.

Geology and Mineralization of the Uranium Deposits

Mineralization in the Gas Hills area of the Wind River Basin consists of sedimentary uranium deposits in the Wind River Formation, with deposits in the GHPA being localized primarily in the Puddle Springs Member of the Wind River Formation (PRI 2009). Sedimentary uranium deposits were formed when oxidizing solutions carrying uranium moved through a sandstone aquifer and encountered a reducing environment, usually related to decaying organic material in the sandstone. The uranium is deposited at the oxidation/reduction interface. Sedimentary uranium deposits in the Wind River Formation in the Gas Hills area are “roll front” deposits in that they have a horseshoe or convex pattern in cross sectional view. These sedimentary uranium deposits often form irregular strings or lobes of ore following the sandstone aquifer in which they were formed.

The uranium ore in the Gas Hills is confined to the Wind River Formation which is composed of several members (Soister 1967) (**Table 3.3-2**). In the GHPA, the formation was deposited by north-flowing fluvial systems in a complex of depositional environments consisting of alluvial fans, stream channels, flood plains, lakes, and swamps (Seeland 1978). The lower fine-grained member of the Wind River Formation is composed of carbonaceous mudstone and shale with conglomerate beds near the base. The Puddle Springs member is comprised of arkosic sandstone and interbedded coarse-grained material derived from Precambrian granite. Some of these conglomerate beds were thick and persistent enough for Soister (1967) to identify them as the Dry Coyote Wash Conglomerate Bed and the Muskrat Conglomerate Bed (**Table 3.3-2**). The Upper Transition Zone consists of arkose and mudstone which is commonly bentonitic and tuffaceous.

Table 3.3-2 Stratigraphic Relationships of the Wind River Formation

<table>
<tr><th>System</th><th>Series</th><th colspan="3">Stratigraphic Unit</th></tr>
<tr><td rowspan="5">Tertiary</td><td rowspan="5">Eocene</td><td colspan="3">Wagon Bed Fm.</td></tr>
<tr><td rowspan="4">Wind River Fm.</td><td colspan="2">Upper Transition Zone</td></tr>
<tr><td rowspan="2">Puddle Springs Arkose Member</td><td>Muskrat Conglomerate Bed</td></tr>
<tr><td>Dry Coyote Conglomerate Bed</td></tr>
<tr><td colspan="2">Lower Fine-grained Member</td></tr>
</table>

Note: Separation of geological layers (Systems or Series) that uncomfortably overlie each other are indicated by the dashed line in the table.

Source: Soister 1967.

The Gas Hills Uranium District contains 4 distinct alluvial fan systems within the Wind River Formation with uranium mineralization. In the GHPA, these 4 mineralized alluvial fans are labeled: the Deer Creek, Canyon Creek, Coyote Creek, and Muskrat systems from east to west across the GHPA (**Figure 3.3-4**). Approximately 90 percent of the nearly 100 million pounds of uranium mined historically in the Gas Hills District has come from sedimentary uranium deposits in the Coyote Creek system. Important historic mines include the Day Loma, Lucky Mc, Sunset, and Bullrush. The remaining 10 percent of historic production has come from the Deer Creek and Canyon Creek systems from mines such as the Buss, Tee, Veca, and Thunderbird. The average grade mined historically in the Gas Hills District was around 0.2 percent U_3O_8 (PRI 2009). The GHPA also includes a large segment of the Canyon Creek system and the eastern margin of the Coyote Creek system (**Figure 3.3-4**).

Mineralization in the GHPA consists of sedimentary uranium deposits hosted in channel sands and conglomerates of the Wind River Formation as roll front ore bodies, typically 15 feet in thickness and varying in width from 100 feet to less than a few feet. The high-grade ore is found within a few feet of the oxidation/reduction front with decreasing grades away from the oxidation/reduction interface.

Sandstones and conglomerates in the Puddle Springs Member often are separated by interbeds of clay or shale, and stacked ore zones can form in sandstone/conglomerate beds separated by interbeds of shale and clay. In plain view, the uranium ore bodies can often be traced for thousands of feet as sinuous zones of mineralization in the sandstone/conglomerate beds. Mineralization consists mainly of uraninite and coffinite with associated pyrite, arsenopyrite, and minor minerals formed from molybdenum, vanadium, and selenium (PRI 2009).

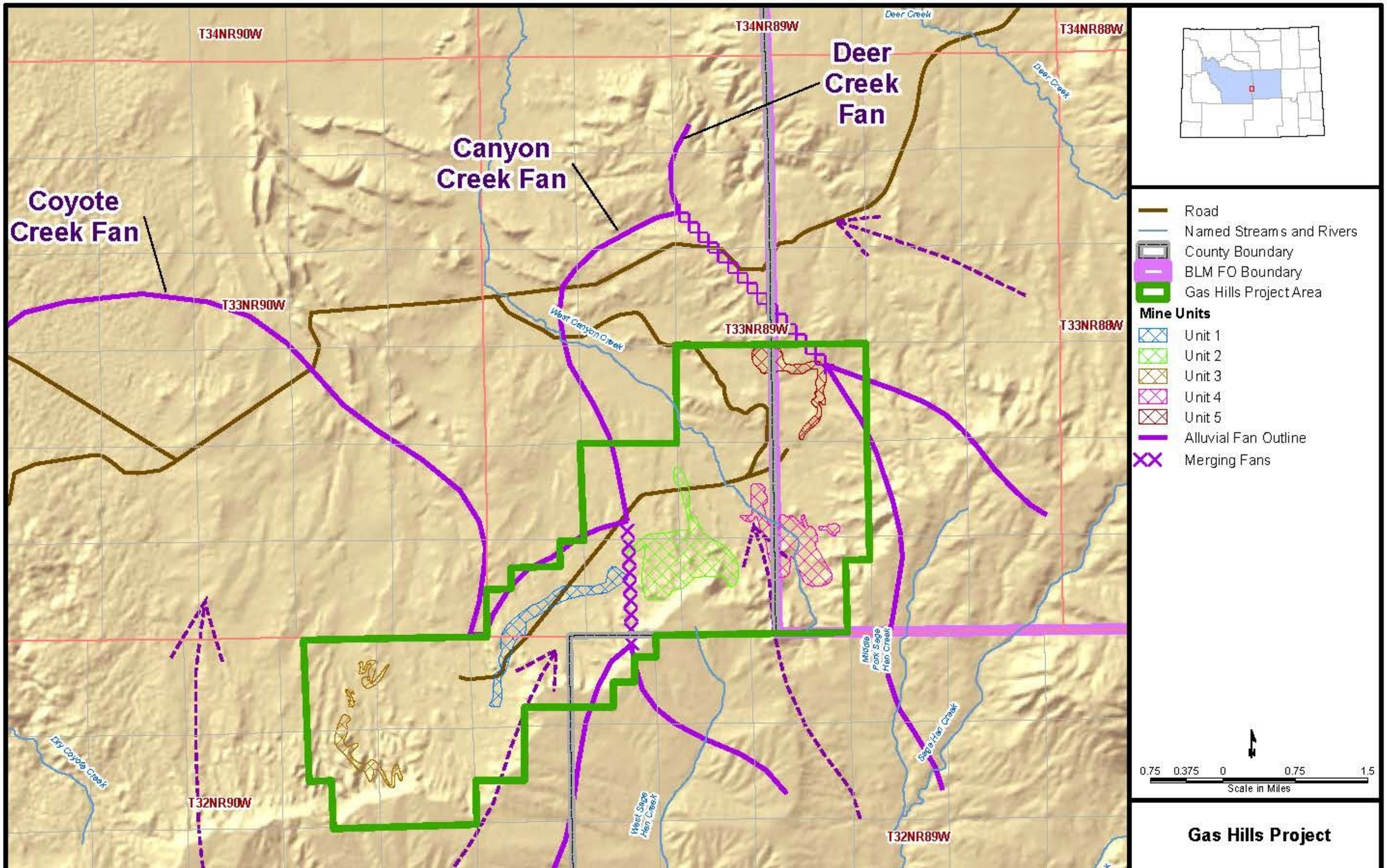
3.3.4.2 Oil and Gas

The first commercial oil field in Wyoming was Dallas Dome, discovered in 1884 and drilled in 1888. Dallas Dome is approximately 35 miles west of the GHPA in the southwest portion of the Wind River Basin. Since 1884, the basin has produced more than 0.5 billion barrels of oil and natural gas liquids, and over 5 trillion cubic feet of natural gas (Fox and Dolton 1995; Wyoming Oil and Gas Conservation Commission [WOGCC] 2011a).

The nearest oil field to the GHPA is the abandoned Travis Field, approximately 2 miles northwest of the GHPA with wells located primarily in Section 13, T33N, R90W (WOGCC 2011b). The field produced from the Phosphoria Formation with a reported production of 4,478 barrels from a depth of 797 to 812 feet (Wyoming Geological Association 1989; WOGCC 2011b). Another nearby field is Jones Draw, about 6 miles east of the GHPA on the east flank of the Rattlesnake Hills in T33N, R87W. The field had very small reported production from a lower Cretaceous zone and is now abandoned. Love (1970) reported oil-stained and oil-saturated beds in the Wagon Bed Formation in a surface uranium mine in Section 3, T32N, R94W, several miles west of the GHPA. It was surmised the oil originated in Paleozoic rocks and seeped into the Tertiary rocks where it was degraded by exposure.

Twenty exploratory oil and gas wells have been drilled within and in the sections surrounding the GHPA (**Table 3.3-3**). All the wells were plugged and abandoned presumably because commercially producible quantities of hydrocarbons were not found. The formations at total depths in these wells are indicative of the complexity of the buried pre-Tertiary structure and topography. For instance, the Nepple Government #1 well bottomed out in Precambrian rocks at a depth of 1,327 feet while the Tiger Oil Co. Government #1 encountered the Tensleep Formation below 4,000 feet depth (WOGCC 2011c). These wells are only 4 miles apart from each other.

There are currently no oil and gas leases within the GHPA. The nearest oil and gas lease to the GHPA is in Section 3, T33N, R90W, approximately 2.5 miles from the GHPA (WYW174775). This lease was issued in 2007 and expires in 2017.



Gas Hills Project

Figure 3.3-4

Alluvial Fan Depositional Systems Gas Hills Area

Table 3.3-3 Oil and Gas Test Wells[a] Drilled in the GHPA

API Number	Company	Well Name	Section, Township, Range	Qtr-Qtr	Total Depth (feet)	Formation at Total Depth
49-025- 05470	E Nepple	Govt 1	Section 7, T32N, R89W	NE SW	1,327	Precambrian
49-013-20185	Mullinnix Assoc	Govt MA67-1	Section 2, T32N, R90W	NW NE	1,042	Nugget
49-013-21482	Jade Oil Co	Federal 1-11	Section 11, T32N, R90W	SW NW	2,460	Tensleep
49-013-05610	Amerada Hess	Strat 66	Section 16, T33N, R89W	SW SW	983	Tertiary
49-013-20105	Rl Girouard	Govt 1	Section 19, T33N, R89W	NW SE	1,600	Red Peak
49-013-05585	Amerada Hess	Strat 81	Section 20, T33N, R89W	NW SE	719	Tertiary
49-013-05583	Amerada Hess	Strat 32	Section 21, T33N, R89W	NW SE	1,690	Tertiary
49-013-05584	Amerada Hess	Strat 64	Section 21, T33N, R89W	NW SE	641	Tertiary
49-013-20675	Conpetro Inc	Federal 1-29	Section 29, T33N, R89W	SW SE	1,802	Phosphoria
49-013-05572	Amerada Hess	Strat 32	Section 29, T33N, R89W	NW SW	875	Tertiary
49-013-05563	Vitro Minerals	Govt 1	Section 29, T33N, R89W	SW SW	503	Wind River
49-013-05771	Amerada Hess	Strat 23	Section 30, T33N, R89W	NW SW	465	Tertiary
49-013-20977	Arco	Canyon Ck 32-1	Section 32, T33N, R89W	NW NE	1,780	Tensleep
49-013-21680	Barnhart Drlg	Federal 1-32	Section 32, T33N, R89W	SW SW	1,700	Not reported
49-013-05558	Bm Burns	Federal-25 1	Section 25, T33N, R90W	SESW	1,299	Chugwater
49-013-05544	Tiger Oil Co	Govt 1	Section 35, T33N, R90W	NE SE	4,138	Tensleep
49-013-05555	Bm Burns	State-Roberts 1	Section 36, T33N, R90W	NE NW	1,265	Phosphoria
49-013-20170	Stuarco Oil Co	Lowe-State 36-21	Section 36, T33N, R90W	NE NW	1,455	Tensleep
49-013-20434	Dillard A R Jr	Mullinnix-Fraser 1	Section 36, T33N, R90W	NE NW	1,265	Tensleep
49-013-05551	Bm Burns	State Roberts 2	Section 36, T33N, R90W	SE NW	2,005	Tensleep

[a] All wells are exploratory wildcats plugged and abandoned, no production.

Source: WOGCC 2011c.

3.3.4.3 Gold

Gold anomalies were discovered in the Rattlesnake Hills in 1981 and 1982 as a result of research by the WSGS (Hausel 2009). Gold was found in a variety of geologic settings, including Precambrian vein and sulfide mineral deposits, as well as in Tertiary igneous rocks. The gold has been found in finely-disseminated low-grade to high-grade mineralization. Recent exploratory drilling has indicated the potential presence of gold deposits but no mining has been proposed.

3.3.4.4 Sand, Gravel, Stone

Sand is very abundant on the Granite Mountains area, but gravel deposits are not as common (Love 1970). Gravel deposits are present in pediments that slope down to the north from the Beaver Rim. The deposits are generally less than 15 feet thick and their location above flood plains led Soister (1967) to conclude that the gravel deposits are Pleistocene in age. Gravel also may occur locally in conglomerate beds in Tertiary rocks, as opposed to deposits associated with alluvium. No gravel pits are located within the GHPA (WDEQ-WQD 2011***b***). However, there are several existing mineral material sales located near the GHPA that have been mined for limestone, sand, gravel, or shale for road construction and maintenance activities (**Figure 3.3-5**). The closest mineral materials sale contract to the GHPA is Pathfinder Mines limestone quarry (WYW151991) in Section 24, T33N, R90W. This quarry has undergone extensive mining and several large stockpiles occupy the site, but the permit has expired and additional mining is not anticipated.

Fremont County has 2 authorized free use permits (WYW168197 and WYW154885) along Fremont County Road 5 between Jeffrey City and the Gas Hills for sand and gravel. Umetco Minerals has an authorized competitive sale contract (WYW139866) at the Rattlesnake Quarry ***for quartzite used as rip-rap material. Natrona County has used material from the Rattlesnake Quarry under free use permit WYW158101.*** The WYDOT has a free use permit along Highway 136 for soil and fill material that is pending ***reclamation.***

Limestone was mined in the late 1980s from the Alcova Limestone in the Dutton Anticline. About 500,000 cubic yards were mined for mining reclamation projects in the Gas Hills (BLM 2009a). Approximately 500,000 *cy* of shale were mined in the Gas Hills area for mine reclamation projects.

3.3.4.5 Bentonite

Bentonite and bentonitic mudstone may occur in beds in the Wind River, Wagon Beds, and White River formations (Van Houten 1964). A bentonite mine permitted under a company named Rock Springs Mineral Processing ***(WYW159806)*** is located a few miles north of the GHPA in Sections 11 and 12, T33N, R90W (WDEQ-WQD 2011***b***). The mining company has mined, and plans to continue mining, bentonite from Cretaceous rocks exposed in the Dutton Basin Anticline that forms the Gas Hills.

3.3.4.6 Coal

The Fort Union Formation, the most likely geologic unit to contain potentially mineable coal resources, is not present in the GHPA (Soister 1967). The Wind River Formation does contain coal, but the beds are thin making them uneconomic (less than 1 foot thick) and were not considered in the most recent USGS coal resource assessment of the Wind River Basin (BLM 2009a; Flores and Keighin 1999)

3.3.4.7 Jade

Jade has been identified in boulders that have eroded from Precambrian rocks of the Granite Mountains and are contained within the Wind River Formation. A jade locality identified by Love (1970) is located about 10 miles southwest of the GHPA.

3.3.4.8 Other Minerals

Small deposits of zeolite and pumice are found in the Gas Hills area (Hausel et al. 1979), but extent and localities are unknown.

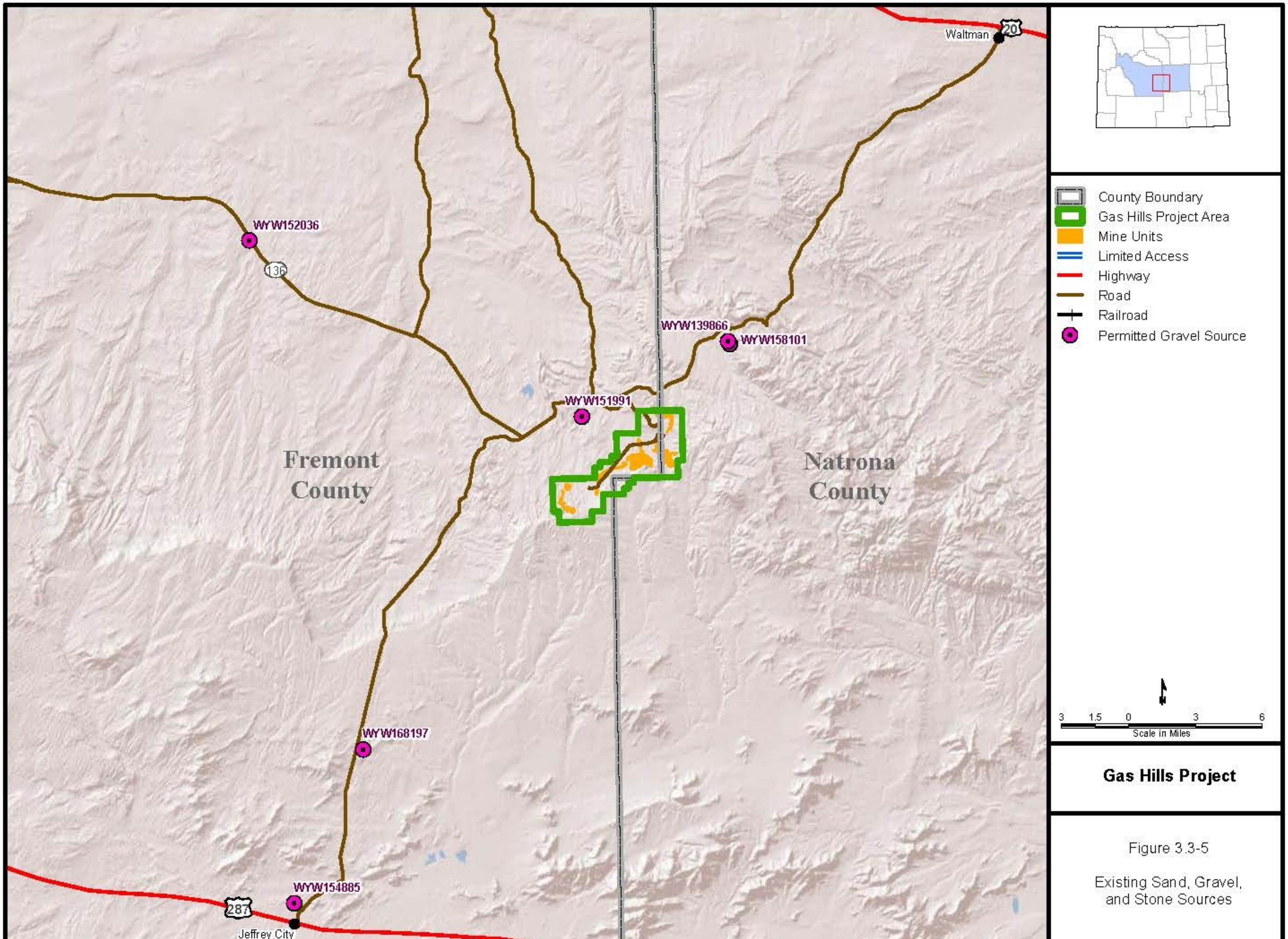


Figure 3.3-5

Existing Sand, Gravel, and Stone Sources

3.4 Land Use

3.4.1 Land Use/Land Cover

Land uses in the GHPA include mining, livestock grazing, and recreation. A large portion of the GHPA is covered by a sagebrush grassland cover type that is conducive to grazing. Livestock grazing and land cover are further discussed in Section 3.5, Livestock Grazing; and Section 3.13, Vegetation. Existing disturbance within the GHPA is approximately 1,300 acres. Of these 1,300 acres, 69 percent, or 890 acres, have been reclaimed and vegetation reestablished. Recreational activities include hunting, hiking, and OHV use. The nearest designated utility corridors are approximately 4 miles to the west and north. There are no communication sites or land withdrawals within the GHPA. The nearest communication site and land withdrawal are approximately 10 miles to the north. Within the northern border of the GHPA is a portion of a historic uranium mining operation, which includes a cap over historic uranium tailings. Management of this cap is currently being transferred to the DOE. Once the transfer is complete a LTSP would be implemented to protect public health, safety, and the environment. This area is shown in **Figure 3.4-1**.

3.4.2 Land Ownership

As shown in **Figure 3.4-1** and summarized in **Table 3.4.1**, the BLM manages most of the surface and minerals within the GHPA, with some state and private lands also present. Instances where surface ownership and the underlying mineral ownership are not owned by the same entity are known as split estate. Less than 1 percent (61 acres) of the lands within the GHPA are split estate, where the BLM does not manage the surface, but does manage the underlying minerals. Private lands and Wyoming State lands make up approximately 6 percent of the remainder of the surface land ownership and mineral estate in the GHPA. The Wyoming Office of State Lands and Investments manages state trust lands. Revenues generated by trust lands and minerals are reserved for the exclusive benefit of public schools and certain other designated public institutions in Wyoming such as the Wyoming State Hospital (Wyoming Office of State Lands and Investments 2011).

Table 3.4-1 Land Management or Ownership in the GHPA

Management or Ownership	Surface		Mineral	
	Percent	**Acres**	**Percent**	**Acres**
Federal	94	7,977	94	8,038
State	2	164	6	480
Private	4	377		
Total	**100**	**8,518**	**100**	**8,518**

Note: Data showing separated state and private ownership was not available.

3.4.3 Land Use Management

3.4.3.1 Special Management Area

As defined in the Lander ***Proposed RMP and Final*** EIS (BLM 20***13***), a Special Recreation Management Area is an area where congressionally recognized recreation values exist or where significant public issues or management concerns occur. There are no ***Special Recreation Management Areas*** contained either wholly or partially within the GHPA. ***The Castle Gardens Rock Art site is located 8 miles north of the GHPA.***

The GHPA does fall within a designated development area (DDA) as defined within the Lander ***Proposed*** RMP ***and Final EIS*** (BLM ***2013).*** DDAs are established for intensive mineral exploration, development, and production, and often use different management and reclamation standards than areas outside a DDA.

3.4.3.2 Areas of Special Designation

No areas of special designation are located either wholly or partially within the GHPA. Areas of special designation that are closest to the GHPA include: Wind River Management Area (10 miles to the northeast); Oregon/Mormon Pioneer National Historic Trail (18 miles to the south); the ***historic*** Bridger Trail (20 miles to the northeast); Pathfinder National Wildlife Refuge (25 miles to the southeast); and the Wind River Indian Reservation (29 miles to the northwest). There are no ACECs within or near the GHPA. The nearest ACEC is the National Historic Trails ACEC, over 18 miles to the southwest. Wilderness study areas (WSAs) closest to the GHPA include Lankin Dome, Split Rock, Miller Springs, and Savage Peak WSA. The nearest WSA, Lankin Dome, is approximately 14 miles to the south.

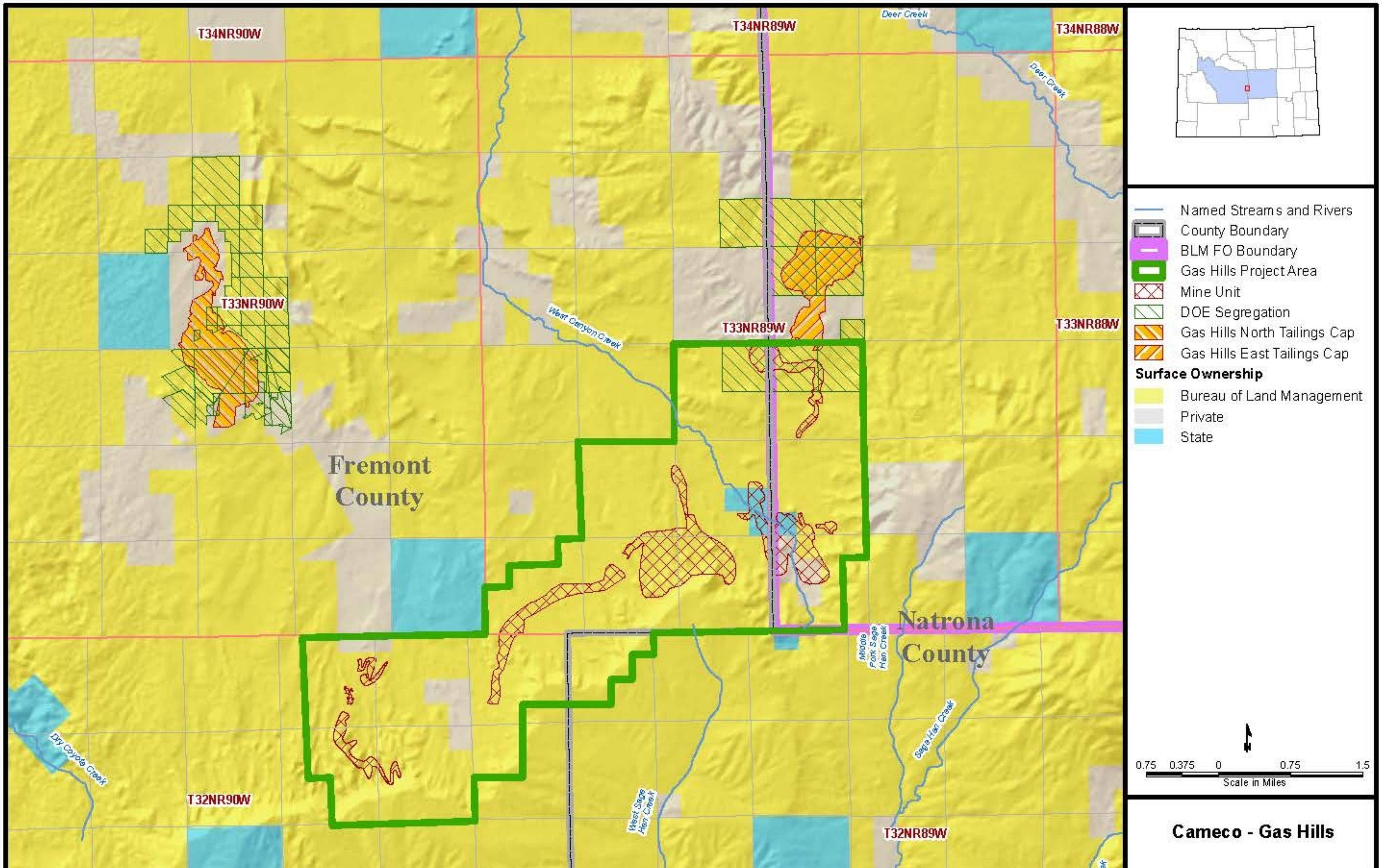


Figure 3.4-1

Surface Ownership

3.5 Livestock Grazing

The study area for livestock grazing is defined as the GHPA. The following section presents range management activities per allotment and water-related range improvements within the study area. Implementation of the Project would result in the expansion of existing operations, thus disturbing areas currently being grazed.

Land ownership within the study area is predominately federal with scattered patches of state and private land. Four BLM grazing allotments are located in the GHPA. Cattle are permitted on all 4 allotments, and sheep also are permitted on the Gas Hill Allotments which graze from early spring to early winter. The majority of the GHPA is within the Gas Hills Allotment. Smaller portions of the Blackjack Ranch and Diamond Springs allotments are located on top of the Beaver Rim, in the GHPA, but outside of the areas that would be impacted by Project disturbance. A small portion of the Matador Allotment is located along the eastern-most portion of the GHPA. The Blackjack Ranch and Matador allotments are grazed summer to fall, and fall to winter, respectively. The vegetation in the area is predominantly grassland and sagebrush steppe. For a more detailed description of the vegetation found in the GHPA see Section 3.13, Vegetation.

Table 3.5-1 provides a summary of each BLM grazing allotment within the study area, including acreage calculations, current stocking rates, and permitted use in animal unit months (AUMs). **Figure 3.5-1** illustrates the BLM grazing allotments within the study area.

Table 3.5-1 Grazing Allotments in the Study Area

Grazing Allotment Name	Total Allotment AUMs[a]	Allotment Acreage within the Project	Projected AUMs within Project[b]	Livestock		Season of Use	Percent of Public Land
				Type	Number		
Blackjack Ranch	3,608	328	32	Cattle	1,200	10/5-10/29; 6/5-7/16	69
Diamond Springs	4,956	180	21	Cattle	1,200	5/31-6/4; 10/30-11/2; 8/22-10/04; 7/17-8/21	56; 56; 92;92
Gas Hills	3,547	7,719	363	Cattle/ Sheep	328/1200	5/16 - 12/10; 5/16 - 12/10	83
Matador	2,096	291	18	Cattle	468	9/30-12/30	76

[a] An AUM represents the quantity of forage necessary to sustain 1 cow-calf pair or 5 sheep for 1 month.

[b] Projected active AUMs were calculated based on the percentage of the allotment within the ***GHPA*** compared to the allotment as a whole.

The BLM has developed the BLM Wyoming Rangeland Health Standards to achieve desired conditions for BLM managed lands ***for all resource uses***. The Wyoming BLM Rangeland Health Standards include the Fundamentals of Rangeland Health and its companion rules, the Standards for Rangeland Health and Guidelines for Grazing Management for BLM in Wyoming. The standards describe specific conditions needed for healthy public lands. The guidelines are the techniques used to achieve or maintain these standards (BLM 2011c). ***All m***anagement and resource use of BLM-managed lands in Wyoming must apply the BLM Wyoming Rangeland Health Standards. The Fundamentals of Rangeland Health outline the conditions that must exist on BLM lands. These include:1. Properly functioning watersheds;

2. Water, nutrients, and energy are cycling properly;
3. Water quality complies with state water quality standards; and
4. Threatened and endangered species habitat is being protected.

The standards address the acceptable conditions for public rangelands based on the health, productivity, and sustainability of the rangelands.

A Rangeland Standards Conformance Review was conducted for the Gas Hills in 1998 (BLM 1998a). The Gas Hills Allotment met all 6 standards; however, previously disturbed mine sites were identified as not being in conformance with the standards. Livestock grazing was not a contributing factor for the failures discussed in the assessment. The status of reclamation and the amount of established vegetation in these areas affected how the resource conditions met the standards. These sites are monitored by the WDEQ Abandoned Mine Land Division and WDEQ-LQD, the BLM, and responsible mining companies under authority of the Surface Mining Control and Reclamation Act of 1977 and the Wyoming Environmental Quality Act of 1969. Previous inventories and studies have indicated that approximately a quarter of the Gas Hills Allotment, located in the northern portion of the allotment, historically has been heavily grazed by both livestock and wildlife and could be improved. Livestock grazing would continue to be managed as prescribed in the Grazing Supplement to the Final RMP/EIS for the Lander Resource Area (BLM 1998a).

Water sources for livestock include intermittent and ephemeral streams, reservoirs, springs, and stock ponds. Range improvements in the GHPA include cattleguards and reservoirs. Range improvements by grazing allotment are listed in **Table 3.5-2** and are shown in **Figure 3.5-1**. Fencing associated with hazards from historic mining activities or historic reclamation exists in the GHPA. The locations of this fencing have not been mapped and are not shown in **Table 3.5-2** or **Figure 3.5-1**.

Table 3.5-2 Range Improvements

Grazing Allotment Name	Range Improvement Type	Range Improvement Name
Diamond Springs	Cattleguard	N/A
Gas Hills	Reservoir	Cameron Spring Reservoir

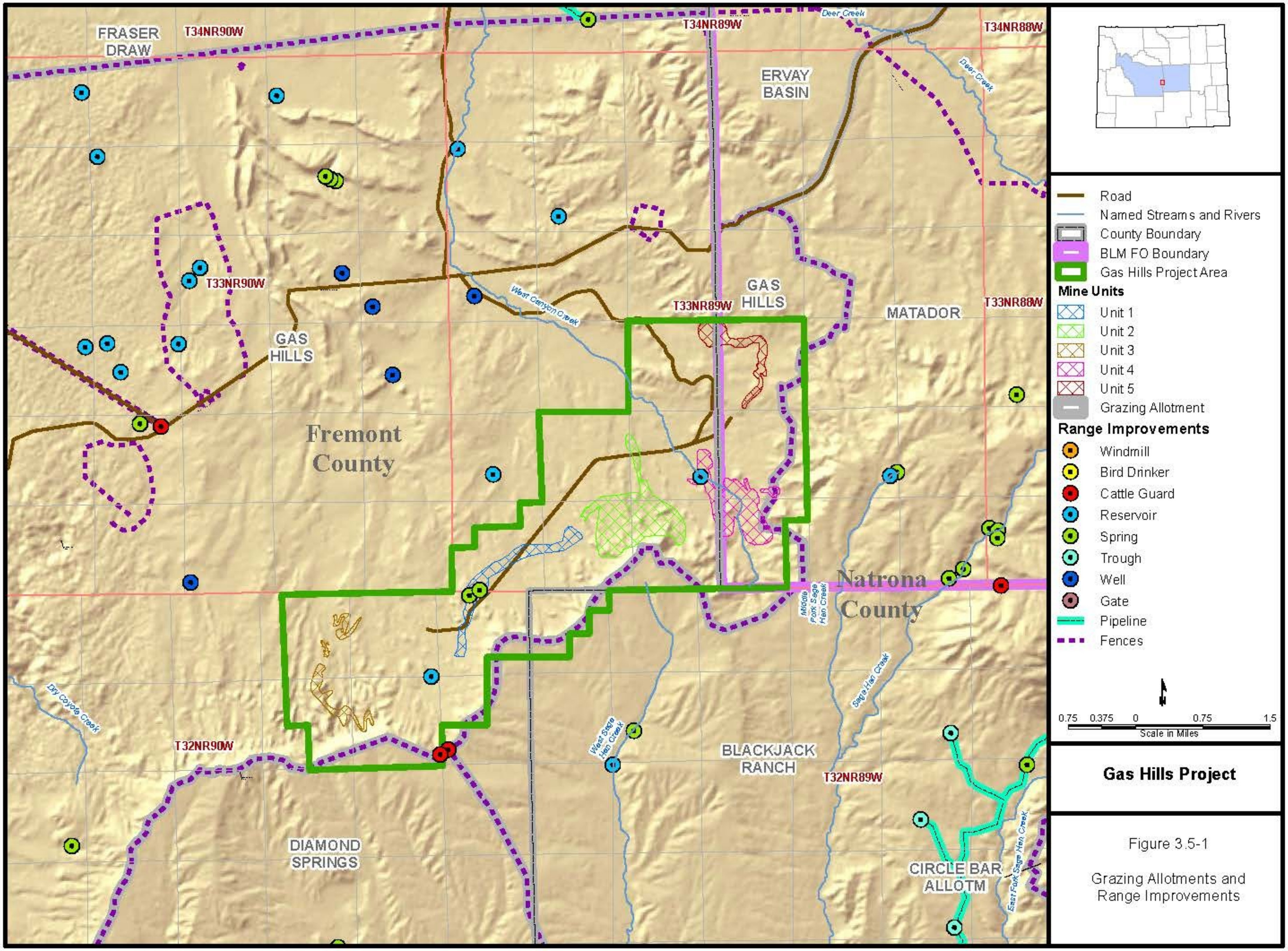


Figure 3.5-1

Grazing Allotments and Range Improvements

3.6 Noise

Sound intensity is measured by the decibel (dB). Audible sounds range from 0 dB (threshold of hearing) to about 140 dB (threshold of pain), and the normal audible frequency range is approximately 20 Hertz to 20 kilohertz. The A-weighted scale, denoted as dB(A), is used in most noise ordinances and standards, and approximates the range of human hearing by filtering out lower frequency noises, which are not as damaging as higher frequency noises. Rustling leaves have a decibel level of 10 dB(A); conversational speech is 60 dB(A); and aircraft takeoff is 120 dB(A).

Ambient, or background, noise is defined as an assortment of sounds from nearby and distant sources, relatively steady and homogeneous, with no particular identifiable source (National Wind Coordinating Committee 2002). Rural ambient noise typically ranges from 20 dB(A) to 40 dB(A) (British Wind Energy Association 2000). The Project is characterized by rural background noise typically consisting of natural noise sources, such as wind and wildlife, as well as manmade noise sources typically associated with ranching, such as noise from cattle and ranch vehicles. Existing noise sources also include traffic along State Highway 136 and Dry Creek Road near the GHPA.

No noise studies have been conducted within the GHPA. With the exception of noise from truck traffic, operations equipment at ISR uranium recovery facilities, such as pumps and compressors, are typically housed within structures, limiting the transmission of noise. There are no schools, hospitals, recreation areas, or residential areas located within or adjacent to the GHPA. There are no known residences within a 2-mile buffer around the GHPA. The nearest town is Jeffrey City, approximately 22 miles to the southwest, with a population of 64 (U.S. Census Bureau 2010).

3.7 Paleontological Resources

3.7.1 Regulatory Framework

3.7.1.1 Federal Regulations and Guidance

Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (P.L. 59-209; 16 USC 431 et seq.; 34 Stat. 225), which calls for protection of historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest on federally administered lands. Federal protection for scientifically important paleontological resources would apply to construction or other related Project impacts that would occur on federally owned or managed lands. This act provides for funding for mitigation of paleontological resources discovered during federal aid highway projects, provided that "excavated objects and information are to be used for public purposes without private gain to any individual or organization." In addition to the foregoing, the National Registry of Natural Landmarks provides protection to paleontological resources. The BLM manages paleontological resources (fossils) on federal lands under the following statutes and regulations (BLM 2012a):

- FLPMA (P.L. 94-579);
- NEPA (P.L. 91-190);
- Title 43 CFR, which addresses the collection of invertebrate, vertebrate, and plant fossils; and
- The Paleontological Resources Preservation Act of 2009 (PRPA) (P.L. 111-011). The law authorizes the BLM and USFS to manage and provide protection to fossil resources using "scientific principles and expertise." The act defines paleontological resources as "any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth."

The PRPA also empowers the USDOI to implement the following provisions:

- Develop appropriate plans for inventory, monitoring, and the scientific and educational use of paleontological resources, in accordance with applicable agency laws, regulations, and policies. These plans shall emphasize interagency coordination and collaborative efforts where possible with non-federal partners, the scientific community, and the general public.
- Develop programs to increase the public's awareness about the significance of paleontological resources shall be established.

In addition to the statutes and regulations listed above, fossils on public lands are managed through the use of internal BLM guidance and manuals. BLM Manual 8270 (BLM 1998b) and the BLM Handbook H-8270-1 (BLM 1998c) contain the BLM's policy and guidance for the management of paleontological resources on public land and information. The manual presents information on the authorities and regulations related to paleontological resources. The handbook gives procedures for permit issuance, requirements for qualified applicants, and information on paleontology and planning.

Important guidance in the protection of paleontological resources is contained in Instruction Memorandum (IM) 2009-011 which provides guidelines for the assessment of potential impacts, field survey procedures, determination of mitigation requirements (if needed), monitoring procedures, documentation of findings, and curation of specimens (BLM 2008a).

3.7.1.2 Potential Fossil Yield Classification System

With issuance of IM 2008-009, the BLM adopted the Potential Fossil Yield Classification (PFYC) system to identify and classify fossil resources on federal lands (BLM 2007***b***). Paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

The PFYC system is a way of classifying geologic units based on the relative abundance of vertebrate fossils or scientifically significant fossils (plants, vertebrates, and invertebrates) and their sensitivity to adverse impacts. A higher class number indicates higher potential. The PFYC is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment. The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis and should be used to assist in determining the need for further mitigation assessment or actions. The BLM intends for the PFYC system to be used as a guideline as opposed to rigorous definitions. Descriptions of the potential fossil yield classes are summarized in **Table 3.7-1**. The entire IM 2008-009, with a description of the PFYC system, is provided in **Appendix *G***.

Table 3.7-1 Potential Fossil Yield Classification System

Class	Description	Basis	Comments
1	Igneous and metamorphic (tuffs are excluded from this category) geologic units or units representing heavily disturbed preservation environments that are not likely to contain recognizable fossil remains.	Fossils of any kind known not to occur except in the rarest of circumstances. Igneous or metamorphic origin. Landslides and glacial deposits.	The land manager's concern for paleontological resources on Class 1 acres is negligible. Ground disturbing activities will not require mitigation except in rare circumstances.
2	Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant invertebrate fossils.	Vertebrate fossils known to occur very rarely or not at all. Age greater than Devonian. Age younger than 10,000 years B.P. Deep marine origin. Aeolian origin. Diagenetic alteration.	The land manager's concern for paleontological resources on Class 2 acres is low. Ground disturbing activities are not likely to require mitigation.
3	Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Also sedimentary units of unknown fossil potential.	Units with sporadic known occurrences of vertebrate fossils. Vertebrate fossils and significant invertebrate fossils known to occur inconsistently; predictability known to be low. Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.	The land manager's concern for paleontological resources on Class 3 acres may extend across the entire range of management. Ground disturbing activities will require sufficient mitigation to determine whether significant paleontological resources occur in the area of a proposed action. Mitigation beyond initial findings will range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.

Table 3.7-1 Potential Fossil Yield Classification System

Class	Description	Basis	Comments
4	Class 4 geologic units are Class 5 units (see below) that have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation.	Significant soil/vegetative cover; outcrop is not likely to be impacted. Areas of any exposed outcrop are smaller than 2 contiguous acres. Outcrop forms cliffs of sufficient height and slope that most exposed surfaces are out of reach by normal means. Other characteristics that lower the vulnerability of both known and unidentified fossil localities.	The land manager's concern for paleontological resources on Class 4 areas is toward management and away from unregulated access. Proposed ground disturbing activities will require assessment to determine whether significant paleontological resources occur in the area of a proposed action and whether the action will impact the paleontological resources. Mitigation beyond initial findings will range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.
5	Highly fossiliferous geologic units that regularly and predictably produce invertebrate fossils and/or scientifically significant invertebrate fossils, and that are at risk of natural degradation and/or human-caused adverse impacts.	Vertebrate fossils and/or scientifically significant invertebrate fossils are known and documented to occur consistently, predictably, and/or abundantly. Unit is exposed; little or no soil/vegetative cover. Outcrop areas are extensive; discontinuous areas are larger than 2 contiguous acres. Outcrop erodes readily; may form badlands. Easy access to extensive outcrop in remote areas. Other characteristics that increase the sensitivity of both known and unidentified fossil localities.	The land manager's highest concern for paleontological resources should focus on Class 5 areas. Mitigation of ground disturbing activities is required and may be intense. Areas of special interest and concern should be designated and intensely managed.

Source: BLM 2008b, 2007***b***.

Rock units with a PFYC of 3 are the most problematic from a management perspective and require some decision and action because in Class 3 units fossil content varies in important abundance, and predictable occurrence or the units have unknown fossil potential. For Class 3 units the concern is moderate or cannot be determined from existing data. Class 3 units include a broad range of paleontological potential including unknown potential to moderate or infrequent occurrence of important fossils. Management consideration covers a broad range of options and could include pre-disturbance surveys, monitoring, or avoidance. Proposed surface-disturbing activities on Class 3 rock units require sufficient assessment to determine whether important paleontological resources occur in the area of a proposed action and whether that action could affect the paleontological resources.

3.7.2 Fossil Resources in the Gas Hills Project Area

Only formations that may potentially be disturbed by the proposed mining activities in the GHPA are considered in this discussion. Those formations are geologic units listed in **Table 3.7-2**.

Table 3.7-2 Geologic Formations with Potential for Fossils

Formation-Deposit	PFYC Rating	Fossil Types
Alluvium, terrace, wind-blown deposits	1 to 2	Not determined.
Split Rock Formation	3	Vertebrates, invertebrates, and plants.
White River Formation	5	Vertebrates, invertebrates, and plants.
Wagon Bed Formation	5	Vertebrates, invertebrates, and plants.
Wind River Formation	4 to 5	Vertebrates, invertebrates, and plants.

Source: BLM 2008***a***.

The Wind River, Wagon Bed, White River, and Split Rock formations have the potential for “outstanding” paleontological resources of high scientific value (BLM 2009b). The Wind River Formation includes localities that have yielded fossils of some of the earliest mammals. Of special interest are the remains of an extinct mammal called a Titanothere that was probably related to modern horses, found in locations close to the GHPA (Van Houten 1964). Titanothere jaw fragments also have been found in the Wagon Bed and White River formations.

A paleontological survey of the GHPA (ARCADIS 2011) was conducted in July and August 2011 in order to assess fossil resources. Four historic fossil localities are located within the GHPA boundary and provided a variety of vertebrate fossils from the White River Formation and Wind River Formation. Twenty-five new localities were found within the GHPA; at one locality a high-value specimen was discovered. All of the new localities are in the White River Formation and demonstrate the potential for scientifically important fossils in the GHPA.

3.8 Public Health and Safety

Public health and safety includes the transportation and use of hazardous materials, generation of solid waste, and potential exposure of the public and workers to radioactivity. The following section provides a discussion of the regulatory framework of how various hazardous materials and solid wastes are defined under numerous programs. It also describes the kinds of radioactive materials that would be generated through ore processing and radioactive background that could be encountered on-site from past mining activities.

3.8.1 Exposure to Radioactive Materials

Radioactive exposure is measured by a quantity called the roentgen and is a measurement of the ionizations of molecules in a given mass of air by gamma rays or x-rays (***Idaho State*** University 2011). A unit called the roentgen equivalent man (rem) is used to relate the radiation exposure to potential live tissue damage since different kinds of radioactivity can cause different effects even for the same amount of absorbed radiation. The rem is often expressed in terms of millirem (mrem).

3.8.1.1 Background Radiological Materials

The annual natural background radiation exposure to U.S. residents varies by location and elevation, but is about 360 mrem per year (mrem/yr) (Idaho State University 2011). The average U.S. resident also receives additional radiation exposure from manmade sources such as medical tests and consumer products. **Table 3.8-1** compares various radiation exposures from activities or exposure thresholds.

Table 3.8-1 Comparative Doses of Radioactivity

Activity or Event	Dose
Annual background radiation in the U.S.	360 mrem
Flying 3,000 miles	3 mrem
Chest x-ray	10 mrem
CT scan	500 mrem-1,000 mrem
Annual whole body limit for workers	5,000 mrem
Annual thyroid limit for workers	50,000 mrem
Radiation sickness (Acute Radiation Syndrome)	100,000 mrem whole body
Erythemia (skin reddening)	500,000 mrem to skin

Source: Idaho State University 2011.

Background doses of radiation typically are a function of elevation change. An increase in elevation correlates to an increase in the exposure to cosmic radiation. The average cosmic radiation in the GHPA is expected to be greater than the national average due to its higher elevation. The presence of radon, a radioactive gas naturally found in soil, is dependent on the type, porosity, and moisture content in the soil and/or bedrock. The average natural and manmade radiation dose for the state of Wyoming is 316 (mrem/yr), lower than the U.S. average. This is attributable to a lower Wyoming average radon dose, 133 (mrem/yr), than the U.S. average of 200 (mrem/yr) (USEPA 2005).

In order to determine the health and safety risk to the public, as well as to Project workers, a radiological survey and soil sampling program was conducted to establish the background radiological environment over the GHPA (U.S. NRC 2004). The gamma exposure rates of the project site averaged approximately 175 mrem/yr. This is slightly more than half the equivalent annual dose the average individual in the U.S.

receives from all sources of natural radiation, including contributions from naturally occurring radioactive material in the soil. A pre-operational air modeling program at 4 locations across the Gas Hills area produced similar results.

Within the northern border of the GHPA is a portion of an historic uranium mining operation currently owned by Umetco, which includes a cap over historic uranium tailings (Gas Hills East). This cap includes a radon barrier, filter layer, frost-protection layer, and a riprap cover. This area is shown in **Figure 2-1**. The purpose of this cap is to reduce the radon gas emission rate to below the regulatory standard (20 picocuries [pCi] per square meter per second), as well as physically contain contaminated materials. This area has been withdrawn from public access and is surrounded by warning signs and a barbwire fence. Management of this cap is currently being transferred to the DOE. Once the transfer is complete a LTSP would be implemented to protect public health, safety, and the environment. This area is shown in **Figure 3.4-1**. Although there is no current activity at the GHPA, occupational health and safety risks to workers would include exposure to radioactive materials. Radiation safety practices for workers at uranium ISR facilities should be such that the dose to the workers is kept as low as is reasonably achievable. Radiation exposure limits are specified in 10 CFR Part 20. Both the Occupational Safety and Health Administration (OSHA) and the U.S. NRC, through an MOU, have jurisdiction over occupational safety and health at U.S. NRC***- or NRC-agreement State***-licensed facilities (OSHA 1988).

Long-term monitoring of the capped area, once management is assumed by the DOE, will consist of the following measures (DOE 2010):

- Annual site inspection;
- Follow-up inspections and inspection reports, as necessary;
- Site maintenance, as necessary;
- Emergency measures in the event of catastrophe; and
- Environmental monitoring to include groundwater, vegetation, and land use.

In addition to monitoring, there are site control features to restrict access including fencing, boundary monuments, a site marker, and warning signs. These control features are to be inspected and maintained as needed.

Throughout the Gas Hills region, naturally occurring uranium results in the formation of radon-222, a radioactive gas. Radon gas is formed through the radioactive decay of uranium. Uranium and radon are ubiquitous in the U.S. although concentrations vary regionally and depend on the amount of uranium present in the soil, rocks, and water (http://www.epa.gov/radon/zonemap.html). Exposure to elevated levels of radon gas can increase cancer risk. The USEPA indicates that radon gas is responsible for 21,000 deaths in the U.S. per year (http://www.epa.gov/radon/pubs/citguide.html). Because of the health risk posed by radon gas, the USEPA air quality standard is 4 pCi per liter ***(pCi/L)***. Since radon is heavier than air, radon concentrations tend to be most common in confined spaces with limited air flow, such as residential basements during winter months. Regardless of the setting, whether it is residential or industrial, radon gas emissions typically are mitigated by external venting.

3.8.2 Hazardous Materials and Solid Waste

3.8.2.1 Waste Definitions

For purposes of this analysis, 2 major types of waste are considered; solid waste and nuclear waste. These types of waste are described below.

<u>Solid Waste</u>

Solid waste consists of a broad range of materials that include garbage, refuse, waste water treatment plant sludge, non-hazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances) resulting from industrial, commercial, mining, agricultural, and community activities (USEPA 2005). Solid wastes are regulated under different subtitles of Resource Conservation and Recovery Act (RCRA) and include hazardous waste (discussed in the previous section) and non-hazardous waste. Non-hazardous wastes are regulated under RCRA Subtitle D. Under RCRA, the USEPA regulates certain radioactive wastes.

Hazardous Materials (Non-radioactive)

"Hazardous materials," which are defined in various ways under a number of regulatory programs, can represent potential risks to both human health and the environment when not properly managed. The term hazardous materials include the following materials that may be utilized or disposed of in construction and operation:

- Substances covered under OSHA Hazard Communication Standards (29 CFR 1910.1200 and 30 CFR 42): The standard covers many chemicals and substances commonly used at industrial worksites.
- “Hazardous materials" as defined under USDOT regulations at 49 CFR, Parts 170-177: The types of materials that may be used in construction and operational activities and that would be subject to these regulations would include, cement, fuels, some paints and coatings, and other chemical products.
- “Hazardous substances” as defined by Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and listed in 40 CFR Table 302.4: The types of materials that may contain hazardous substances that would be subject to these requirements would include solvent-containing materials (e.g., paints, coatings, degreasers), acids, and other chemical products.
- “Hazardous wastes” as defined in the RCRA: Procedures in 40 CFR 262 are used to determine whether a waste is a hazardous waste. Hazardous wastes are regulated under Subtitle C of RCRA.
- Any “hazardous substances” and "extremely hazardous substances" as well as petroleum products such as gasoline, diesel, or propane, that are subject to reporting requirements if volumes on-hand exceed threshold planning quantities under Sections 311 and 312 of Superfund Amendment and Reauthorization Act (SARA): The types of materials that may be used in construction and operational activities and that could be subject to these requirements would include fuels, coolants, acids, and solvent-containing products such as paints and coatings.
- Petroleum products defined as "oil" in the Oil Pollution Act of 1990: The types of materials that would be subject to these requirements include fuels, lubricants, hydraulic oil, and transmission fluids.

In conjunction with the definitions noted above, the following lists provide information regarding management requirements during transportation, storage, and use of particular hazardous chemicals, substances, or materials:

- The SARA Title III List of Lists or the Consolidated List of Chemicals Subject to Emergency Planning and Community Right-to-Know Act and Section 112(r) of the CAA.
- The USDOT listing of hazardous materials in 49 CFR 172.101.

Certain types of materials, while they may contain potentially hazardous constituents, are specifically exempt from regulation as hazardous wastes. Used oil, for example, may contain toxic metals, but would not be considered a hazardous waste unless it meets certain criteria. Other wastes that might otherwise be classified as hazardous are managed as “universal wastes” and are exempted from hazardous waste regulation as long as those materials are handled in ways specifically defined by regulation. An example of a material that could be managed as a universal waste is lead-acid batteries. As long as lead-acid batteries are recycled appropriately, requirements for hazardous waste do not apply.

Radioactive Waste

How radioactive waste is defined is complex because of the diverse nature of how the waste is generated. Of particular concern for the Project is what is termed low-level radioactive waste (USEPA 2011a). While not necessarily being of low radioactive content, low-level radioactive waste does not include:

- Spent nuclear fuel;
- High-level waste;
- Transuranic waste; and
- Uranium and thorium mill tailings.

The U.S. NRC and states under agreement with U.S. NRC regulate commercial disposal of low-level radioactive waste in near-surface disposal facilities. The DOE regulates disposal at its own sites.

Other defined radioactive wastes include low-activity radioactive waste that contains very small concentrations of radionuclides. The concentrations are small enough that managing these wastes may not require all of the radiation protection measures necessary to manage higher-activity radioactive material to be fully protective of public health and the environment. Low level or low activity radioactive wastes may be mixed with RCRA-defined waste and are regulated under the RCRA.

The U.S. NRC has the major regulatory authority over the proposed mining operations. The U.S. NRC licenses facilities that handle or use radioactive materials including nuclear power reactors, non-power research, test and training reactors, fuel cycle facilities, medical, academic, and industrial uses of nuclear materials; and the transport, storage, and disposal of nuclear materials and waste. The U.S. NRC also is responsible for developing, implementing, and enforcing U.S. NRC licensing criteria, USEPA standards and regulations, and other federal regulations at these facilities (USEPA 2000).

Federal regulation of radioactive materials has evolved over the years. Originally the AEC was charged with the responsibility for the regulation of nuclear materials (USEPA 2000). When the USEPA was created in 1970, certain limited regulatory authority was transferred from the AEC, now the U.S. NRC, and other regulatory entities to the USEPA.

Since the USEPA was created, Congress has enacted statutes delegating authority to the USEPA to regulate hazardous materials in specific environmental media. These statutes (including the CAA; the Safe Drinking Water Act; and the CERCLA, expanded the scope of the agency’s radiological protection authority.

3.9 Recreation

The area in and around the GHPA typically is used for hunting, hiking, and OHV use. There are no developed recreation areas within or adjacent to the GHPA (**Figure 3.9-1**). Designated recreation areas closest to the GHPA include: Agate Flats (6 miles to the south); Castle Gardens Rock Art Site (7 miles to the north); and the Heritage Tourism and Recreation Area (12.5 miles to the south). The Oregon and Bridger National Historic trails are each nearly 20 miles to the south and northeast from the GHPA, respectively. Data for the number of hikers, hunters, and other recreational users in the study area is difficult to collect due to the dispersed nature of recreational activities. Therefore, it is not available for this analysis. Within the GHPA, all of the BLM-managed land is designated as being limited to existing roads and vehicle routes.

Portions of the Muskrat ***and Sweetwater Rocks*** Mule Deer Hunt Areas, the Split Rock and Deer Creek ***Pronghorn*** Hunt Areas, and the Muskrat Elk Hunt Area are located within the GHPA. Hunt Areas are defined by a distinct geographic area. Harvest strategies are developed to address specific management issues within specific portions of each unit (**Figures 3.9-2** and **3.9-3**). Despite the higher availability of pronghorn antelope in the GHPA, mule deer are hunted at a higher rate. WGFD (2009b) reports only 79 elk were harvested in the Muskrat Hunt Area, well below the rates for pronghorn and mule deer harvest totals. Due to their relatively low population density, elk are less attractive for hunting in the GHPA and are not further discussed in this section.

Tables 3.9-1 and **3.9-2** show hunting statistics from 2005 through 2009 for mule deer and pronghorn, respectively; they also detail the percentages of the major Hunt Areas within the GHPA. Big game hunting season typically is from mid-August through early November.

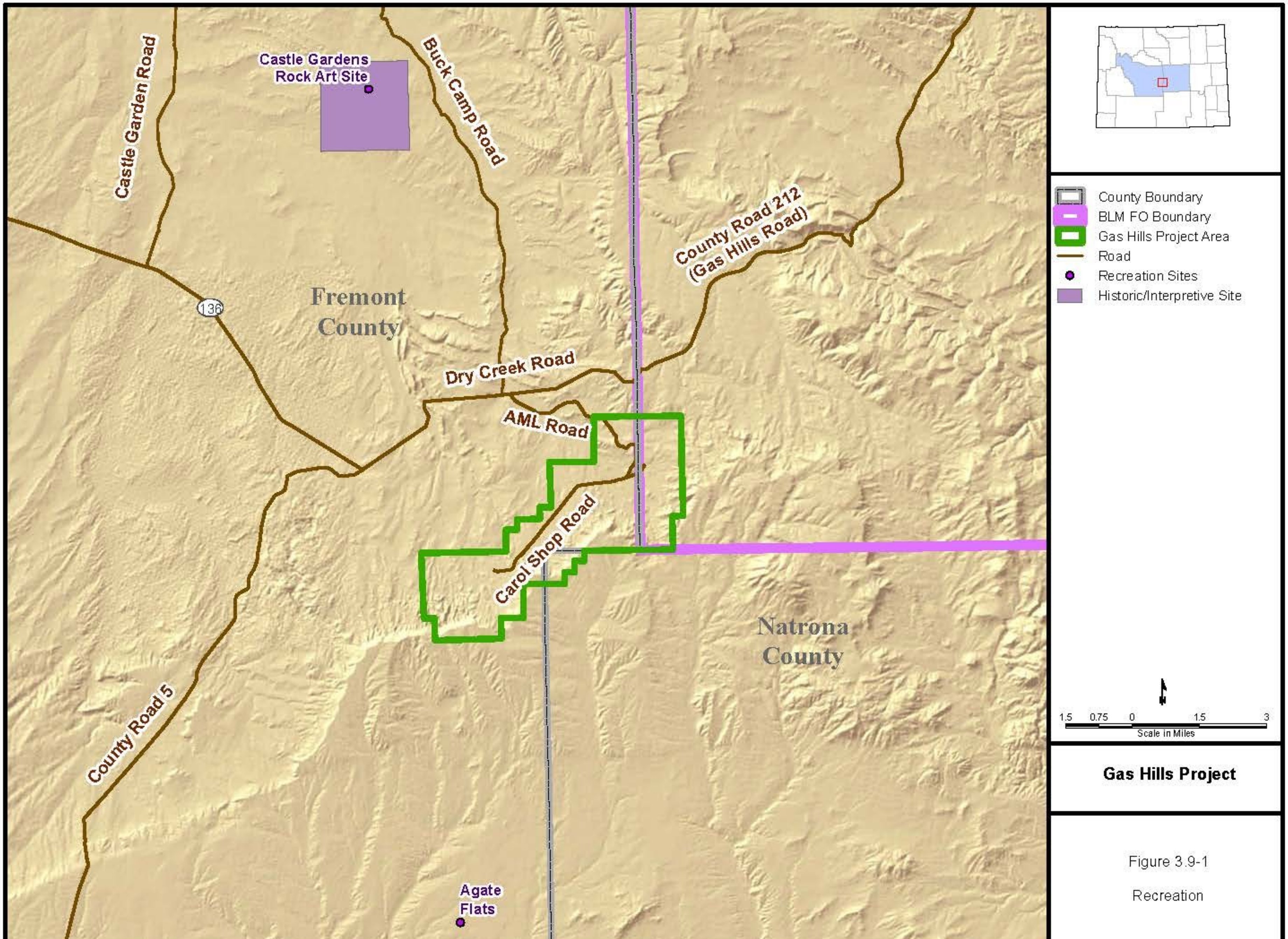
Table 3.9-1 Mule Deer Hunting Statistics

Hunt Area Statistics/Year	Total Mule Deer Harvest	Total Hunters	Hunter Days/Harvest
Muskrat[a]			
2005	49	61	6.7
2006	39	54	5.9
2007	73	64	5.8
2008	87	102	6.2
2009	90	118	7.8
Sweetwater Rocks[b]			
2005	***150***	***308***	***6.9***
2006	***255***	***409***	***4.5***
2007	***270***	***448***	***5.7***
2008	***280***	***481***	***5.9***
2009	***345***	***636***	***4.9***

[a] 1 percent of the total Hunt Area is within the GHPA.

[b] Less than 1 percent of the total Hunt Area is within the GHPA.

Source: WGFD 2009b, 2008, 2007, 2006, 2005.



Gas Hills Project

Figure 3.9-1

Recreation

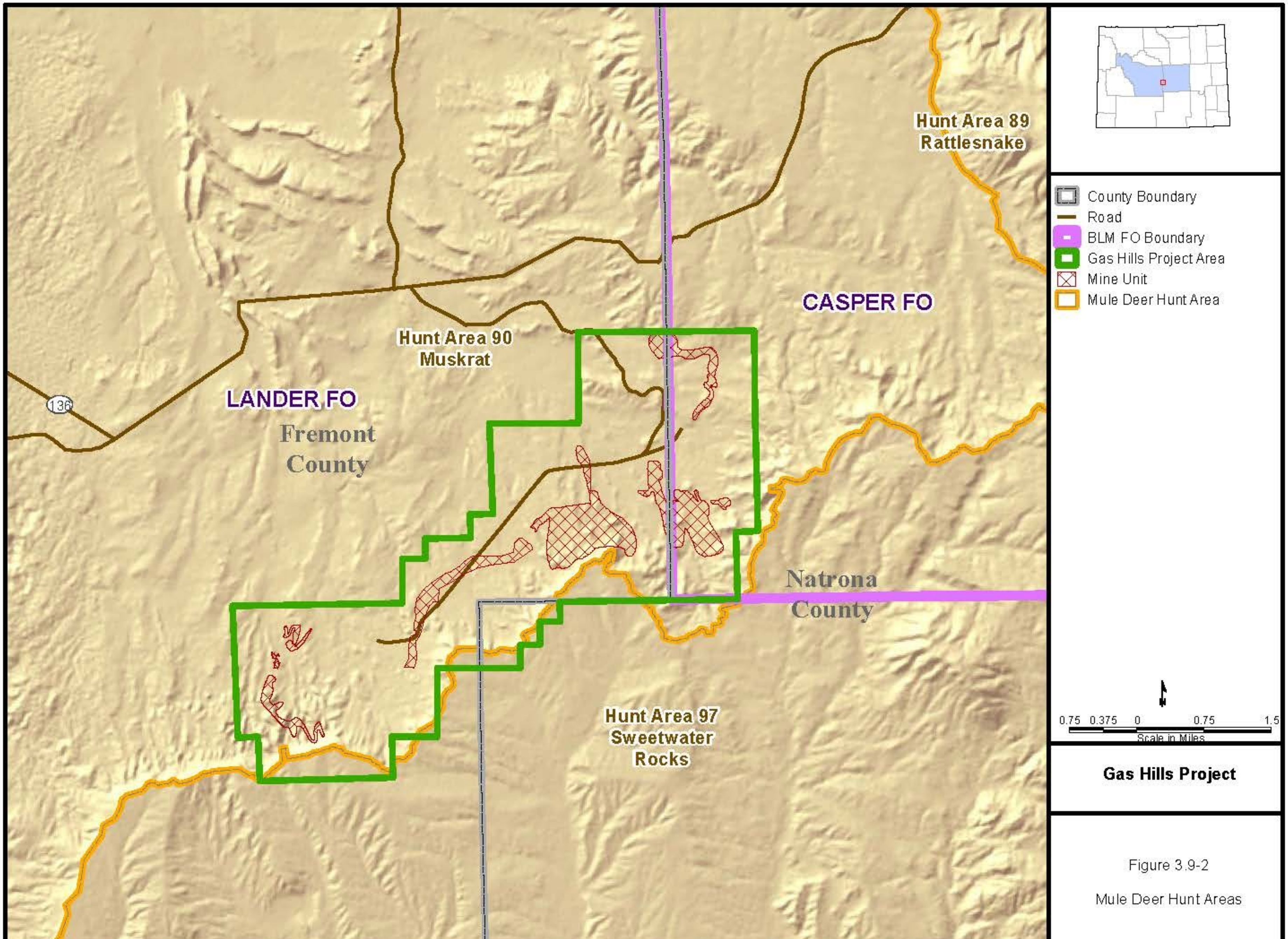


Figure 3.9-2

Mule Deer Hunt Areas

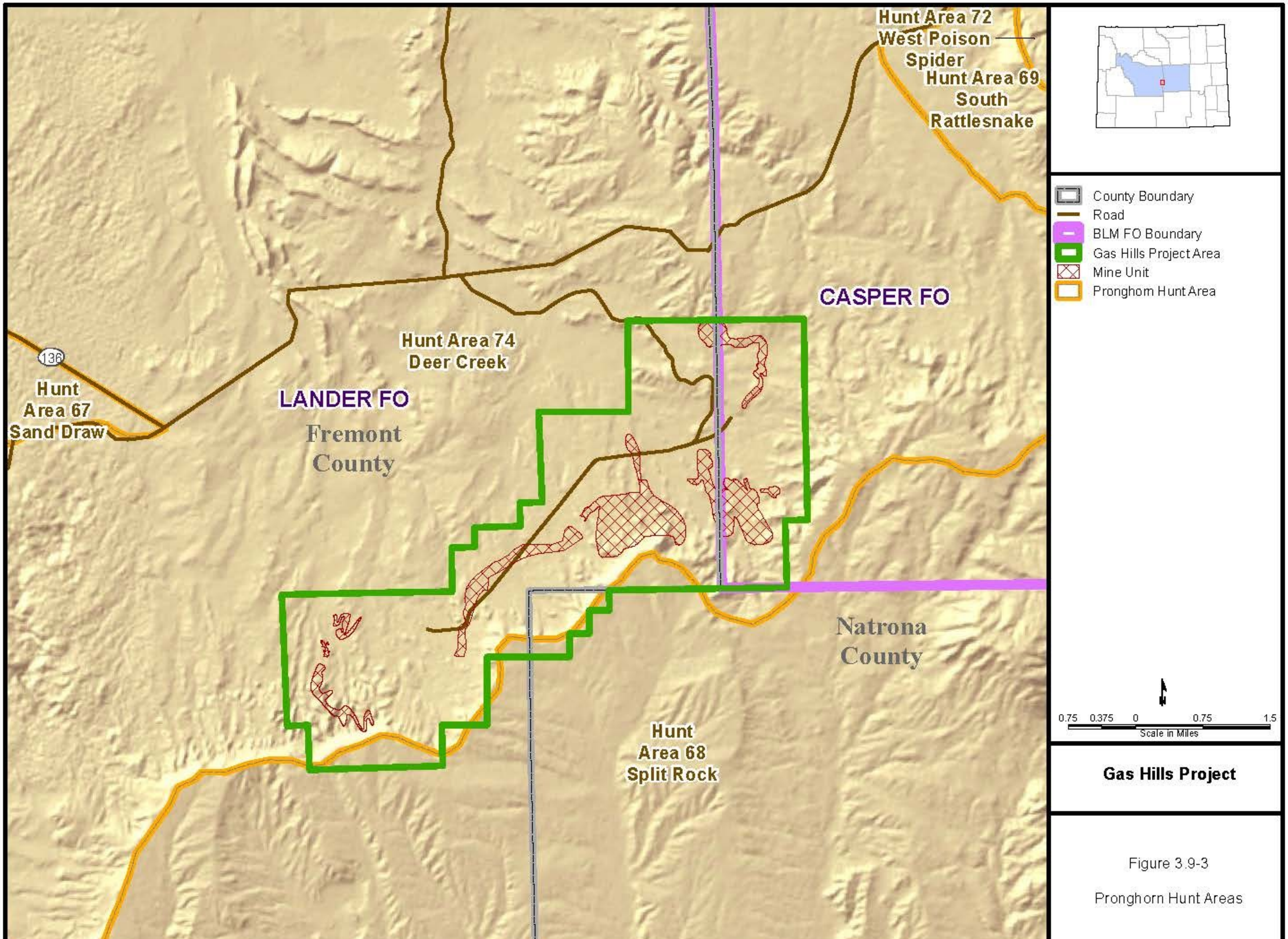


Figure 3.9-3

Pronghorn Hunt Areas

Table 3.9-2 Pronghorn Hunting Statistics

Hunt Area Statistics/Year	Total Pronghorn Harvest	Total Hunters	Hunter Days/Harvest
Split Rock[a]			
2005	216	207	2.5
2006	330	337	2.9
2007	420	438	3.1
2008	388	426	3.3
2009	528	551	3.1
Deer Creek[b]			
2005	157	147	2.7
2006	203	194	3.5
2007	313	285	3.1
2008	314	302	2.5
2009	378	668	2.8

[a] 1.6 percent of the total Hunt Area is within the GHPA.

[b] 2.7 percent of the total Hunt Area is within the GHPA.

Source: WGFD 2009b, 2008, 2007, 2006, 2005.

3.10 Socioeconomics

The study area and cumulative impact study area (CISA) for social and economic values includes Fremont and Natrona counties, and extends into Converse County. The Project is located on the Fremont-Natrona county line with approximately 80 percent of the Project on the Fremont County side of the line. The GHPA is approximately midway between Lander and Casper, which together with Riverton, comprise the 3 largest cities in the area and the most likely to be affected by any potential employment and population effects of the Project. Casper and Riverton are major trade centers for central Wyoming, providing a major portion of the industrial services for the region. These 3 communities would provide labor, services, and supplies and also would house and provide public facilities and services to workers coming into the area to work on the Project. Western Converse County is included in the study area because ore from the Project would be processed into yellowcake at the existing Smith Ranch-Highland facility, located in Converse County, approximately 35 miles northeast of Casper. Effects of the Project on Converse County are expected to be minor**;** however, because between 6 to 8 employees would be added there, and economic and community resources in nearby Casper are much more substantial than Converse County communities offer. Consequently, the primary focus of this analysis is on Natrona and Fremont counties.

3.10.1 Population and Demography

Wyoming and the 3 study area counties had dramatic increases in population from 1970 to 1980 stimulated largely by energy development. The state and the 3 counties all lost population in the following decade and had only modest annual average growth rates from 1990 to 2000 (**Table 3.10-1**). By 2010, 30 years after the 1980 peaks, Fremont and Natrona counties had recovered and exceeded their 1980 population levels, but Converse County's population still lagged behind its 1980 level by a small margin.

Table 3.10-1 Population Characteristics

Area	1980	1990	2000	2010	Average Annual Percent Change 1980-1990	Average Annual Percent Change 1990-2000	Average Annual Percent Change 2000-2010
Converse County	**14,069**	**11,128**	**12,052**	**13,833**	**(2.3)**	**0.8**	**1.4**
Glenrock	2,736	2,153	2,231	2,576	(2.4)	0.4	1.4
Fremont County	**38,992**	**33,662**	**35,804**	**40,123**	**(1.5)**	**0.6**	**1.1**
Lander	7,867	7,023	6,867	7,487	(1.1)	(0.2)	0.9
Riverton	9,562	9,202	9,310	10,615	(0.4)	0.1	1.3
Natrona County	**71,856**	**61,226**	**66,533**	**75,450**	**(1.6)**	**0.8**	**1.3**
Bar Nunn	NA	835	936	2,213	NA	1.1	9.0
Casper	51,016	46,742	49,644	55,316	(0.9)	0.6	1.1
Evansville	2,335	1,403	2,255	2,544	(5.0)	4.9	1.2
Mills	2,139	1,574	2,591	3,461	(3.0)	5.1	2.9
Wyoming	**469,557**	**453,588**	**493,782**	**563,626**	**(0.3)**	**0.9**	**1.3**

Source: U.S. Census Bureau 2010; Wyoming Department of Administration and Information 2010.

Natrona County, with a 2010 population of 75,450, is the largest of the 3 study area counties by a substantial margin. The county and its largest city, Casper, comprise the major population and economic locus of central Wyoming.

State forecasters predict growth for the next 2 decades for all 3 study area counties and all of the communities in the study area (Wyoming Economic Analysis Division [WEAD] 2012). Notably, the state's forecasts were prepared in 2007 and proved to be too conservative in the short-term; the state, all of the counties, and all of the communities tabulated for the study area experienced higher population levels in the 2010 census counts than the WEAD had forecast for 2010.

The study area counties generally are less racially and ethnically diverse than the State of Wyoming as a whole (**Table 3.10-2**). The only notable exception to this is Fremont County, which contains a large portion of the Wind River Indian Reservation. Fremont County's population is 20 percent Native American.

Table 3.10-2 Percent Race and Ethnicity by County

	Converse County	Fremont County	Natrona County	Wyoming
White Not of Hispanic Origin	91.3	71.5	89.1	85.9
Black Not of Hispanic Origin	0.3	0.2	0.8	0.8
American Indian, Eskimo or Aleut Non-Hispanic	0.6	20.0	0.8	2.1
Asian or Pacific Islander Non-Hispanic	0.3	0.4	0.6	0.9
Other or 2 or More Races Non-Hispanic	1.1	2.3	1.7	1.6
Hispanic Origin of Any Race	6.3	5.6	6.9	8.9

Note: Discrepancies in totals are due to rounding.

Source: U.S. Census Bureau 2010.

3.10.2 Economy and Employment

The economy of central Wyoming is supported to a large extent by natural resource development. Much of this reliance on natural resources in Fremont, Natrona, and Converse counties derives from oil and natural gas production and processing, but uranium was a notable contributor in the past and is again becoming more important as demand has increased. There also are notable components of agriculture, recreation and tourism, and government at all levels. Converse County produces coal, much of which is used to generate electric power both locally and nationally. These economic activities are considered to be contributors to the "economic base" of the area because they export goods and services that bring money into the local economy from other areas of the state, nation, and world.

Despite their proximity to each other, each of the 3 study area counties has a different emphasis in its employment base. Converse County is heavily weighted toward the natural resources and mining with more than double the state's percentage of employment working in that sector (**Table 3.10-3**). Converse County is the second highest producer of surface coal in the state. It is Wyoming's only producer of uranium, ranks in the top 10 for both crude oil and stripper oil, and also produces natural gas.

Table 3.10-3 2010 Nonagricultural Wage and Salary Employment by Sector

	State of Wyoming		Converse County		Fremont County		Natrona County	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Goods Producing - Private								
Natural Resources and Mining	27,507	10.1	1,147	21.1	859	5.2	3,298	8.7
Construction	22,352	8.2	521	9.6	976	5.9	2,623	6.9
Manufacturing	8,713	3.2	71	1.3	260	1.6	1,601	4.2
Subtotal	**58,572**	**21.6**	**1,739**	**32.0**	**2,095**	**12.7**	**7,522**	**19.8**
Service Providing - Private								
Trade, Transportation and Utilities	49,301	18.2	862	15.9	2,722	16.6	8,132	21.4
Information	3,881	1.4	63	1.2	233	1.4	490	1.3
Financial Activities	10,792	4.0	178	3.3	686	4.2	1,892	5.0
Prof. and Business Services	17,192	6.3	174	3.2	662	4.0	2,820	7.4
Educational and Health Services	24,940	9.2	271	5.0	2,208	13.4	5,663	14.9
Leisure and Hospitality	32,622	12.0	559	10.3	1,540	9.4	3,970	10.5
Other Services	7,926	2.9	144	2.6	501	3.0	1,701	4.5
Subtotal	**146,654**	**54.1**	**2,251**	**41.4**	**8,552**	**52.0**	**24,668**	**65.0**
Subtotal - Private	**205,226**	**75.7**	**3,990**	**73.4**	**10,647**	**64.8**	**32,190**	**84.8**
Service Providing - Public								
Federal Government	8,077	3.0	78	1.4	495	3.0	764	2.0
State Government	13,339	4.9	135	2.5	873	5.3	696	1.8
Local Government	44,510	16.4	1,235	22.7	4,426	26.9	4,288	11.3
Subtotal - Public	**65,926**	**24.3**	**1,448**	**26.6**	**5,794**	**35.2**	**5,748**	**15.2**
Total	**271,152**	**100.0**	**5,438**	**100.0**	**16,441**	**100.0**	**37,938**	**100.0**

Fremont County is notable for its unusually high percentage of government employment, particularly local government employment. Fremont County is the 5th highest producer of crude oil among the state's 23 counties and ranks in the top 10 for stripper oil and natural gas production. Nevertheless, the percentage of jobs in the natural resources and mining sector is only about half the state average.

Natrona County employment is heavily weighted toward private sector services, particularly in the trade, transportation, and utilities sector and the education and health services sector. This is to be expected as Casper is the largest city in central Wyoming and is concomitantly a major commercial and service center for the region. Natrona County also is the state's highest producer of stripper oil and ranks 10th for natural gas production.

The combined labor force in the study area counties currently is estimated at 66,729, approximately 62,647 of whom are employed. The remaining 4,082 unemployed individuals represent a 6.1 percent unemployment rate (**Table 3.10-4**). This level is only slightly lower than the 6.2 percent statewide unemployment rate and is notably lower than the national rate, estimated at approximately 9.0 percent for the comparable time period (Wyoming Department of Workforce Services [WDWS] 2011). Two of the 3 counties are below the 6.1 percent aggregate unemployment rate, while Fremont County's rate is somewhat higher (**Table 3.10-4**). Unemployment rates for all 3 counties and the state have improved from the prior month, from a year earlier and from their peak levels in 2009. Although they are all more than 1.0 percent lower than the year earlier period, they are more than double the rates from 2007, except for Converse County where the rate is approximately 66 percent above the 2007 rate. A potentially important consideration regarding unemployment rates is the effect on availability of workers for any new jobs related to the Project.

Table 3.10-4 April 2011 Labor Force, Employment and Unemployment

	Labor Force	Employed	Unemployed	Unemployment Rate
Converse County	7,301	6,950	351	4.8
Fremont County	18,959	17,634	1,325	7.0
Natrona County	40,469	38,063	2,406	5.9
County Totals	**66,729**	**62,647**	**4,082**	**6.1**
Wyoming	290,411	272,493	17,918	6.2

Source: WDWS 2011.

3.10.3 Income

Personal incomes for study area counties are variable compared with the Wyoming level. The average per capita personal income in Fremont County ($38,105 in 2009) is substantially lower than for Converse County ($44,283), or Natrona County ($53,361) and is below the state average of $44,861 (**Table 3.10-5**). The pattern holds largely true for median household incomes as well, except that Converse County leads in that metric. The median household income for the state in 2010 was $53.802. Converse County's median household income was 1.5 percent higher at $54.599, Natrona County's was 5.3 percent lower at $50,936, and Fremont County's was substantially (13.8 percent) lower at $46,397 (**Table 3.10-5**).

Table 3.10-5 Income Levels by County

	Converse County	Fremont County	Natrona County	Wyoming
Per Capita Personal Income (pcpi)	$44,283	$38,105	$53,361	$44,861
Median Household Income	$54,599	$46,397	$50,936	$53,802
Percent in Poverty	7.7	14.0	8.4	9.8

Source: Bureau of Economic Analysis (BEA) 2011.

As noted previously, natural resource development, particularly oil and gas extraction, is a major contributor to the economy of the study area. The mining sector, which includes oil and gas extraction, is the largest contributor to earned income in Converse County (19 percent of total income) and in Natrona

County (16.9 percent of total personal income). The mining sector is the second largest contributor to earned income in Fremont County, at 5.3 percent of total personal income. Government at all levels combined was the largest contributor to total personal income in Fremont County (21.2 percent), second largest in Converse County (13.3 percent), and third largest in Natrona County (9.5 percent, closely following the health care and social assistance sector).

Total personal income includes non-labor income as well as earned wage income. Non-labor income includes sources such as dividends, interest, and rent, as well as personal transfers such as retirement, disability, insurance, Medicare, and welfare income. Non-labor income sources are significant contributors to personal income in the study area. They provided 31.7 percent, 46.4 percent, and 35.6 percent of total personal income for Converse, Fremont, and Natrona counties, respectively, in 2009 (BEA 2011).

The natural resources and mining sector, which includes oil and gas extraction, is a major contributor to wages in the state and in each of the 3 study area counties. The sector provided nearly 22 percent of total wages in Wyoming with just over 10 percent of total employment. Average annual pay for the sector ranged from 51 percent above the average annual pay for all sectors in Converse County to 82 percent above the average annual pay for all sectors in Fremont County. Construction or federal and state government sectors typically were the sectors with the second highest level of average annual pay, although they lagged well behind the natural resources and mining sectors.

Poverty rates in the study area counties tracked household income levels to a large degree (see Section 3.10.8, Environmental Justice). Figures for 2009 indicate 9.6 percent of state residents had incomes below the poverty level. Rates for Converse, Fremont, and Natrona counties were 6.8 percent, 14.1 percent, and 9.6 percent, respectively.

3.10.4 Housing

The 2010 census found 58,006 housing units in the 3-county study area; 33,807 units, or 58 percent, were in Natrona County; 17,796 units were in Fremont County; and 6,403 units were in Converse County (**Table 3.10-6**). At the time of the census, 51,744 of the housing units were occupied, leaving 6,262 (10.8 percent) vacant. The overall vacancy rate can be misleading; however, as some portion of the vacant units were for seasonal, recreational, or occasional use and not available for people seeking housing. In Natrona County, 30,616 units were occupied and 3,191 (9.4 percent) were vacant. Discounting the seasonal, recreational, and occasional use units, vacancy rates were at a low 1.7 percent in homeowner units, and a more generous 9.1 percent in rental units (U.S. Census Bureau 2010). Vacancy rates were fairly consistent throughout the study area. The vacancy rates for just homeowner units ranged from 1.5 percent in Fremont County to 2.2 percent in Converse County; the overall rate was 1.7 percent for the 3 counties. The vacancy rate for rental units was 8.5 percent for the 3-county area.

Table 3.10-6 2010 Housing Vacancy Rates

	Housing Units				Vacancy Rate by Type (%)	
Geographic Area	Total	Occupied	Vacant	Vacancy Rate (%)	Homeowner Units	Rental Units
Converse County	6,403	5,673	730	11.4	2.2	7.3
Fremont County	17,796	15,455	2,341	13.2	1.5	7.6
Natrona County	33,807	30,616	3,191	9.4	1.7	9.1
Total	58,006	51,744	6,262	10.8	1.7	8.5

Short-term housing opportunities in the study area are available in the major communities. Casper is home to 33 motels and hotels hosting over 2,000 rooms. There are 15 mobile home parks, recreational vehicle parks and campgrounds in the Casper vicinity, several of which are on BLM-administered lands. Riverton has approximately 11 motels and hotels with several hundred rooms, and 2 recreational vehicle parks or campgrounds.

3.10.5 Public Facilities and Services

Law enforcement in the vicinity of the Project is provided by the Fremont County Sheriff's Department, based out of Riverton, and by the Natrona County Sheriff's Department, based out of Casper.

The GHPA is served by emergency response organizations for fire suppression, emergency medical, and ambulance service. Agencies responsible for fighting fires include the Lysite and Battalion No. 1 Volunteer Fire Departments in Fremont County, the Natrona County Fire Department, based in Casper, and the BLM for wildland fires. Ambulance services serving the area include the Fremont County Emergency Medical Service in Riverton and the Wyoming Medical Center Ambulance Service in Casper. Hospitals are located in Riverton and Casper.

3.10.6 Education

There are 11 county school districts in the 3 study area counties. The largest, with an enrollment of 11,772 in the fall of 2010, is Natrona County District No. 1, the only district in Natrona County and the second largest district in the state. Enrollment in the district has varied by only a few percent from year to year in the last 10 years, peaking at 11,835 in 2001 and dropping as low as 11,408 in 2005. Converse County has 2 districts, the nearest to the GHPA being District No. 2 in Glenrock with a 2010 enrollment of 690. Enrollment in the district has fallen gradually from its peak of 792 in 2001.

Fremont County has 8 school districts. The largest are District No. 25 in Riverton, with 2,474 students in 2010, and District No. 1 in Lander, with 1,707 students. Enrollment in District No. 25 has been very consistent over the past 10 years. Enrollment in District No. 1 declined gradually from its peak of 1,933 in 2001 to 1,670 in 2009 before rebounding modestly in 2010. Enrollments in Fremont County's other districts are much lower, ranging from 195 in Dubois' District No. 2 to 563 in Ethete's "Wyoming Indian Schools" District No. 14.

3.10.7 Public Finance

Mineral production in Wyoming, including uranium production, is taxed 2 ways: by a state severance tax and by county ad-valorem property taxes. The Wyoming Department of Revenue (WDR) determines and certifies the taxable value of mineral production for each mineral and each county based on the market value of the mineral minus certain qualifying production costs such as processing and transportation costs (Sachse 2011). Severance taxes are levied on uranium production at the rate of 4 percent of the taxable value (WDR 2010). The taxable value also is certified to the producing county, which collects the ad valorem tax based on the county's mill levy. The mill levy is set by the county each year through its budget process.

Converse County was the only producer of uranium in Wyoming in 2009. A total of 1.9 million pounds of uranium was produced in 2009 with a taxable value of $22.7 million (WDR 2010). This was approximately 0.2 percent of the taxable value of all minerals produced in Wyoming in 2009. Surface-mined coal, along with oil and natural gas, provide the largest taxable mineral valuation in the state. Taxes on the 2009 uranium production included ad valorem taxes of $1.4 million and severance taxes of $0.9 million.

All 3 study area counties produce substantial amounts of crude oil, stripper oil, and natural gas. Converse County also is the second highest producer of surface-mined coal in Wyoming, albeit production from the county is less than 7 percent of the largest producer, Campbell County.

Severance taxes on mineral production in Wyoming are distributed according to a legislatively approved formula. A substantial majority of the revenues are transferred to the state general fund, the state's budget reserve account, and the Permanent Wyoming Mineral Trust Fund (WDR 2010). Approximately $20.9 million was distributed among the state's cities, towns, and counties in fiscal year 2009.

Fremont County adopted a budget of $38.9 million for 2011-2012, $11.4 million of which is planned to come from ad valorem taxes based on a levy of 12.0 mills. Fremont County's total assessed valuation for 2010 was $764.6 million, including both taxable value of minerals and the value of other properties in the county. Natrona County has adopted a 2011-2012 budget of $49.9 million, anticipating ad valorem tax revenue of $13.9 million. Natrona County's total assessed valuation for 2010 was $1,034.6 million.

3.10.8 Environmental Justice

Since publication of EO 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" in the *Federal Register* on February 11, 1994 (59 *Federal Register* 7629), federal agencies have been developing a strategy for implementing the order. Currently, federal agencies rely on "Environmental Justice: Guidance Under the National Environmental Policy Act" (guidance), prepared by the CEQ (1997), in implementing EO 12898.

EO 12898 "is intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment. As required by EO 12898, the Project must be evaluated for any disproportionately high and adverse human health or environmental effects on minority communities and low-income populations.

The environmental justice study area is the same 3-county area as the socioeconomic analysis study area.

3.10.8.1 Minority Populations

EO 12898 defines minority groups as: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic/Latino origin; or Hispanic/Latino. CEQ guidelines for evaluating potential adverse environmental justice effects indicate minority populations should be identified when either: 1) a minority population exceeds 50 percent of the population of the affected area; or 2) a minority population represents a "meaningfully greater increment" of the affected area population than the population of some appropriate larger geographic unit, as a whole.

Majorities of the total populations of both Fremont and Natrona counties classify themselves as White in response to census questions. The largest minority population for Natrona County is Hispanic or Latino, followed by those who identify themselves as being of 2 or more races. Both of these populations were effectively at or below state averages. Blacks represent 0.8 percent of Natrona County's population, the same as the statewide 0.8 percent of the population. Fremont County recorded a 2010 American Indian population of 20.0 percent of the county population, well above the Wyoming state average of 2.1 percent. This would be considered a "meaningfully greater increment" of the Fremont County population for environmental justice concerns. The large American Indian population can be attributed to the Wind River Indian Reservation, most of which lies in Fremont County. The GHPA is not located within the boundaries of the Reservation, the nearest portion of which is situated approximately 30 miles northwest of the GHPA. The next largest minority population in Fremont County is Hispanic or Latino, which, at 5.6 percent of the population, is less than the state average. Converse County is 91.3 percent white; all other racial and ethnic categories represent smaller percentages of the county population than state averages. **Table 3.10-7** summarizes the racial composition and low-income populations of the 3 study area counties.

3.10.8.2 Low-Income Populations

Low-income populations are those communities or sets of individuals whose median income is below the current poverty level of the general population. In identifying low-income populations, agencies may consider a community as either a group of individuals living in geographic proximity to each other, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure.

Approximately 14.0 percent, 8.4 percent, and 7.7 percent of households fall below the poverty level in Fremont, Natrona, and Converse counties, respectively (**Table 3.10-7**). The percentage of Fremont County's population with incomes below the poverty level was much greater than the state average of 9.8 percent, while the percentages of Natrona and Converse counties' populations below the poverty level were notably lower than the state average. Fremont County also had median household income that was nearly 14 percent lower than the state average. Natrona County's median household income was slightly below the state average while Converse County's was slightly above the state average. The presence of the Wind River Indian Reservation influences the low median household income and higher level of poverty in Fremont County.

Table 3.10-7 Racial Composition and Low-Income Populations, 2010

County/State	White Not Hispanic (%)	Black Not Hispanic (%)	American Indian/ Alaska Native Not Hispanic (%)	Asian Not Hispanic (%)	Native Hawaiian/ Pacific Islander Not Hispanic (%)	Other or Two or More Races (%)	Hispanic or Latino of Any Race (%)	Below the Poverty Level (%)	Median Household Income ($)
Wyoming	85.9	0.8	2.1	0.8	0.1	1.6	8.9	9.8	53,802
Converse County	91.3	0.3	0.6	0.3	0.0	1.1	6.3	7.7	54,599
Fremont County	71.5	0.2	20.0	0.4	0.0	2.3	5.6	14.0	46,397
Natrona County	89.1	0.8	0.8	0.6	0.0	1.7	6.9	8.4	50,936

Source: U.S. Census Bureau 2010.

3.11 Soils

A variety of data sources were used to identify the baseline soil characteristics in the GHPA. Information on Major Land Resource Areas and Soil Types was obtained from ***USDA-***NRCS literature or databases, including the Land Resource Regions and Major Land Resource Areas of the ***U.S.***, the Caribbean, and the Pacific Basin ***USDA*** Handbook 296 (USDA-NRCS 2006) and the Soil Survey Geographic Database (SSURGO). Soil baseline characterization for the Proposed Action and alternatives is based on SSURGO database review and analyses. SSURGO is the most detailed level of soil mapping done by the USDA-NRCS (USDA-NRCS 2011).

SSURGO soils maps generally are grouped for mapping into units known as soil complexes and soil associations. The primary difference between an association and a complex is scale. An association or complex consists of 1 or more major soils and some minor soils. A soil complex has a characteristic pattern that is so intricately mixed or small in size that it is not practical to separate the soils at the standard mapping scale. A soil association has a characteristic pattern of soils on the land surface, largely determined by relief, drainage, slope aspect or other soil-determining factors. Soil characteristics may vary between each component in a complex or association and are listed separately for greater accuracy.

3.11.1 Major Land Resource Areas

The GHPA lies entirely within Major Land Resource Area (MLRA) 34A, the Cool Central Desertic Basins and Plateaus (USDA-NRCS 2006). This area is surrounded on most sides by mountains with elevations ranging from 5,200 to 7,500 feet. Soils were formed in slope alluvium or residuum derived from shale or sandstone. Soils that formed in stream- or river-deposited alluvium are near the major waterways. Generally, the soils are well drained and calcareous. The dominant soil orders in this MLRA are aridisols and entisols. Aridisols form in an arid or semi-arid climate, and are well developed soils that have a very low concentration of organic matter. In contrast, Entisols are considered recent soils that lack soil development because erosion or deposition rates occur faster than the rate of soil development. The average annual precipitation in this MLRA generally is 7 to 12 inches, but ranges from 7 to 32 inches with a freeze-free season of 45 to 160 days.

Soil characteristics such as the susceptibility to erosion and the potential for revegetation are important to consider when planning for construction activities and stabilization of disturbed areas. These hazards or limitations for use are a function of many physical and chemical characteristics of each soil, in combination with the topography, aspect, climate, and vegetation. **Table 3.11-1** summarizes some important soil characteristics to be considered when evaluating the effects of surface-disturbing activities. Explanations of the meanings of each column follow the table.

3.11.2 Soil Types and Constraints

A variety of soils occur across the GHPA. This soil variability stems primarily from a variety of parent materials as influenced by topography, aspect, elevation, vegetation, and differential rates of mineral weathering. GHPA soils formed from alluvium, residuum, slope alluvium, and eolian parent materials derived from sandstones and shales. Soil depths range from shallow to very deep and slopes range from 1 to 70 percent. The pH of surface soils across the analysis area ranges from neutral (7.0) to moderately alkaline (8.4). Several revegetation limitations are listed for the soil map units overlying the analysis area. These limitations include alkalinity, salinity, sodicity, water holding capacity, soil depth, stoniness, and invasive plant competition.

The GHPA consists of approximately 409 acres of disturbed, approximately 894 acres of previously disturbed but reclaimed, and undisturbed soils (PRI 2009, Hayden-Wing Associates [HWA] 2011a). Much of the existing soil disturbance is related to previous mining or exploration. However, disturbance

Table 3.11-1 Soil Characteristics in the GHPA

Wind Erodible	Water Erodible	LRP [a]	Hydric	Compaction Prone	Shallow Bedrock	Stony Rocky	Droughty	Total Acres
Fremont County								
0	3,021	2,973	0	2,980	0	610	264	6,468
Natrona County								
0	687	231	0	321	183	681	20	2,051
Total GHPA Acres								
0	3,708	3,204	0	3,301	183	1,291	284	8,518

[a] LRP = Limited Reclamation Potential.

Note: No soils within the GHPA are classified as Prime Farmland. Discrepancies in calculated acreages may occur due to rounding.

related to recreation (hunting and OHV use) also has contributed to soil disturbance in the GHPA. Disturbed soils can consist of compacted soils, eroded soils lacking topsoil, and soils that have been salvaged and replaced (resulting in soil mixing). The soil quality and productivity of these sites has been negatively altered compared to an undisturbed state. The extent of the degradation of soil quality and productivity depends on the type of disturbance and the biological, physical, and chemical condition of the soil. Previously reclaimed areas have been seeded, but may be revegetated with a non-native grass species and may have been reclaimed with a single species instead of a diverse native plant community.

Several piles of topsoil, originally developed for eventual reclamation of the Carol Shop facility and main roads, are distributed throughout the GHPA and occupy approximately 3 acres. Topsoil excavation, transport, storage, and redistribution modify existing soil structure, generating adverse impacts relative to aeration and permeability. It is likely that some mixing of textural zones has occurred, as well as mixing of saline and/or alkaline materials with relatively salt-free materials. This mixing may create adverse chemical impacts to soil quality for seedbeds. Currently existing microbial populations are likely to have decreased during storage.

Water erosion is the detachment and movement of soil by water. Natural erosion rates depend on inherent soil properties, slope, soil cover, and climate. Approximately 44 percent of the soils within the GHPA are highly erodible to water. Wind erosion is the physical wearing of the earth's surface by wind. Wind erosion removes and redistributes soil. Small blowout areas may be associated with adjacent areas of deposition at the base of plants or behind obstacles, such as rocks, shrubs, fence rows, and roadbanks (Soil Quality Institute 2001). Soils susceptible to wind erosion are not present within the GHPA (**Figure 3.11-1**). However, exposed or loose soils may be prone to wind erosion even if they are not erosion prone.

LRP soils consist of soils that have been identified singly or in combination as saline, sodic, or strongly alkaline or acidic. As stated above, these chemical characteristics can severely limit the plant growth. Typically, vegetation that is tolerant or adapted to the soil chemical characteristics is necessary for reclamation. Approximately 38 percent of the GHPA is characterized as having limited revegetation potential soils (**Figure 3.11-2**).

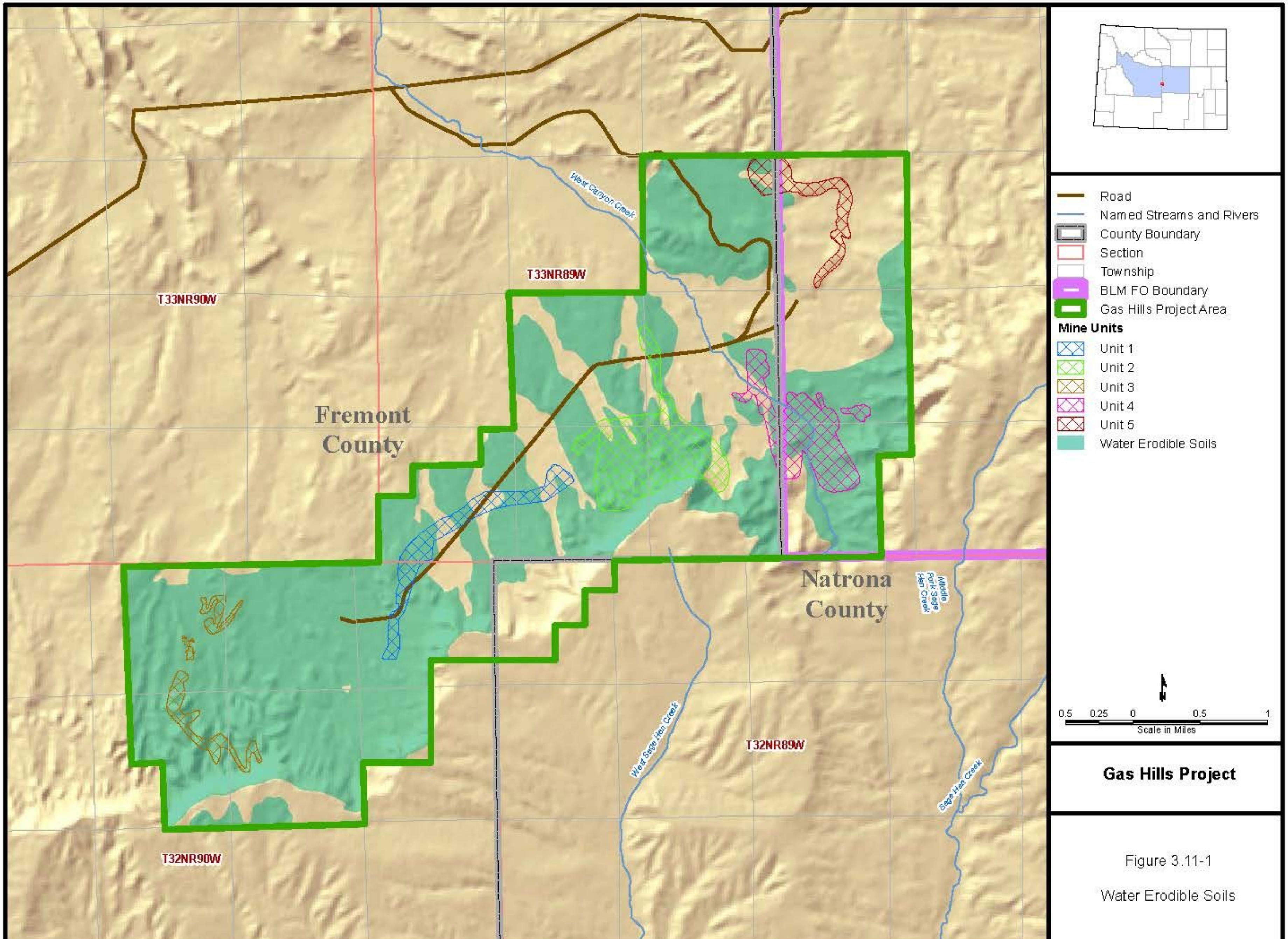


Figure 3.11-1

Water Erodible Soils

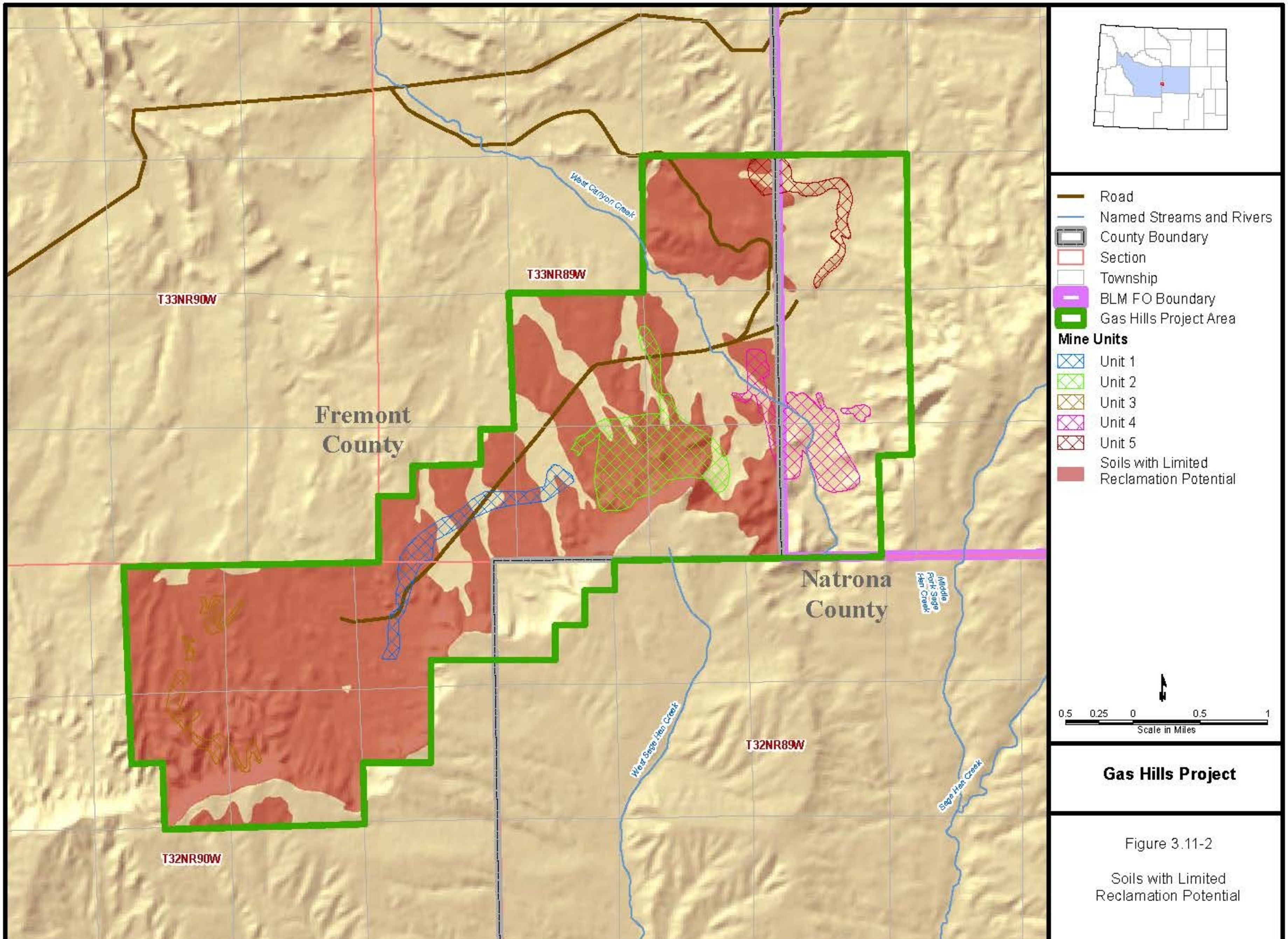


Figure 3.11-2

Soils with Limited Reclamation Potential

Hydric soils are soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper portion. These soils commonly are associated with floodplains, lake plains, basin plains, riparian areas, wetlands, springs, and seeps. No hydric soils are mapped within the GHPA; however, due to the scale of mapping, small areas of hydric soils may not be captured.

The USDA-NRCS (2012a) defines prime farmland as land that has the best combination of physical and chemical characteristics for producing 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. No soils within the GHPA are classified as prime farmland.

Compaction prone soils were identified by identifying component soil series in SSURGO with a surface texture of sandy clay loam or finer. In general, fine textured soils with a high moisture content have low soil strength and are most susceptible to compaction or rutting (**Figure 3.11-3**).

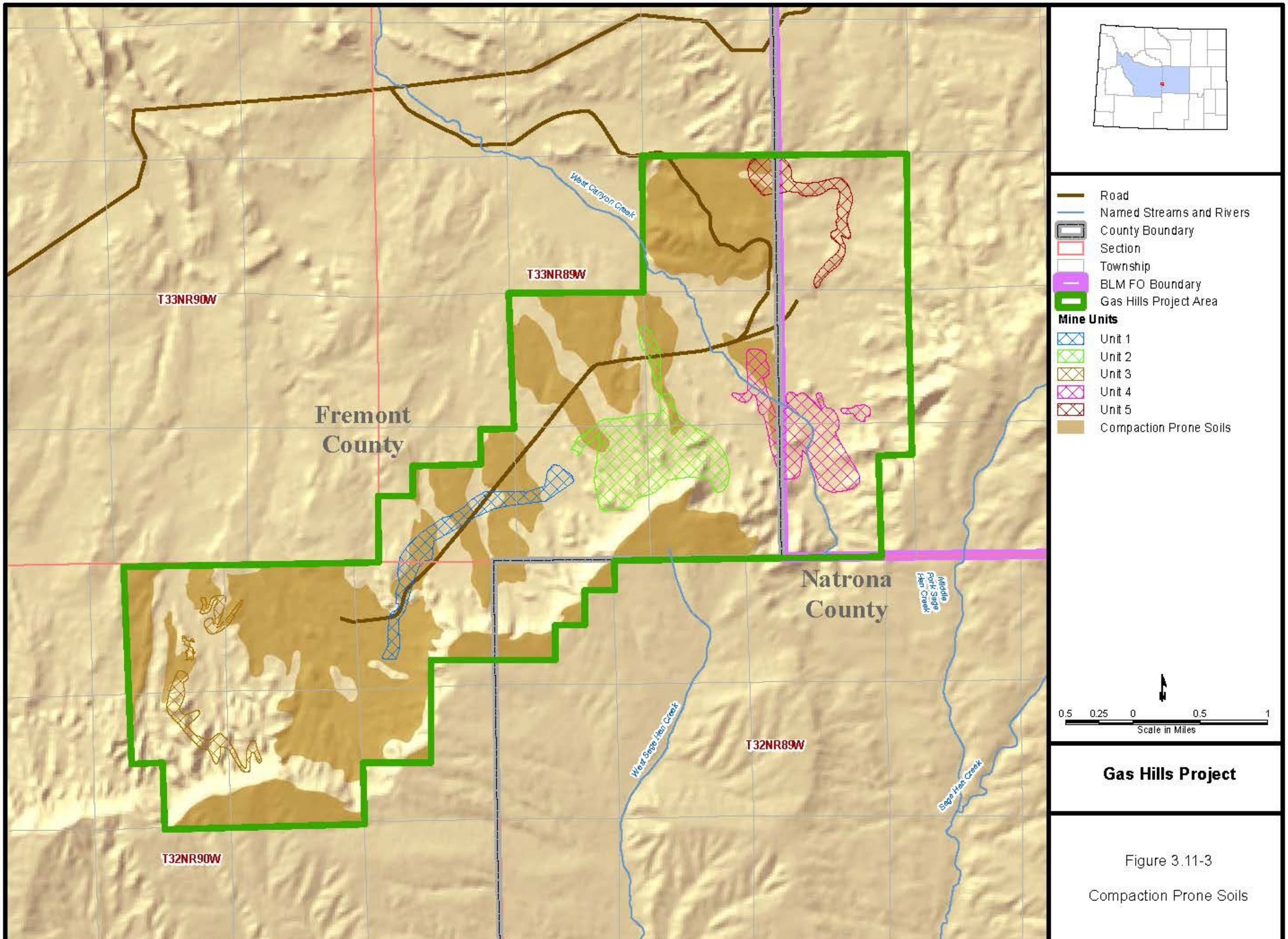
Shallow-to-bedrock soils were identified by soil series with a lithic (hard) bedrock contact listed above 60 inches in depth. The analysis focused on depth hard bedrock which could inhibit pipeline construction related to trenching or spider-plowing.

Stony-rocky soils were identified because they can inhibit pipeline construction and reduce reclamation potential. Soils with significant quantities of stones in the surface were identified by soil series with either: 1) a cobbley, stony, bouldery, gravelly, or shaly modifier to the textural class of the surface layer; or 2) have a surface layer that contains greater than 5 percent (weight basis) stones larger than 3 inches.

Droughty soils were identified by a soil series with a surface texture of sandy loam or coarser and are moderately well to excessively drained. These soils have a low water holding capacity and can be difficult to revegetate and stabilize.

Biological soil crusts are considered an important component in dry arid ecosystems. They provide soil stability, prevent erosion, fix nitrogen, increase infiltration rates, and may reduce noxious weed migration. Biological soil crusts occur throughout the arid west. No site-specific data are available on soil crust coverage in the study area; however, research shows that biological soil crusts do best where sedimentary parent materials are found (Belnap et al. 2003) such as are found in the GHPA.

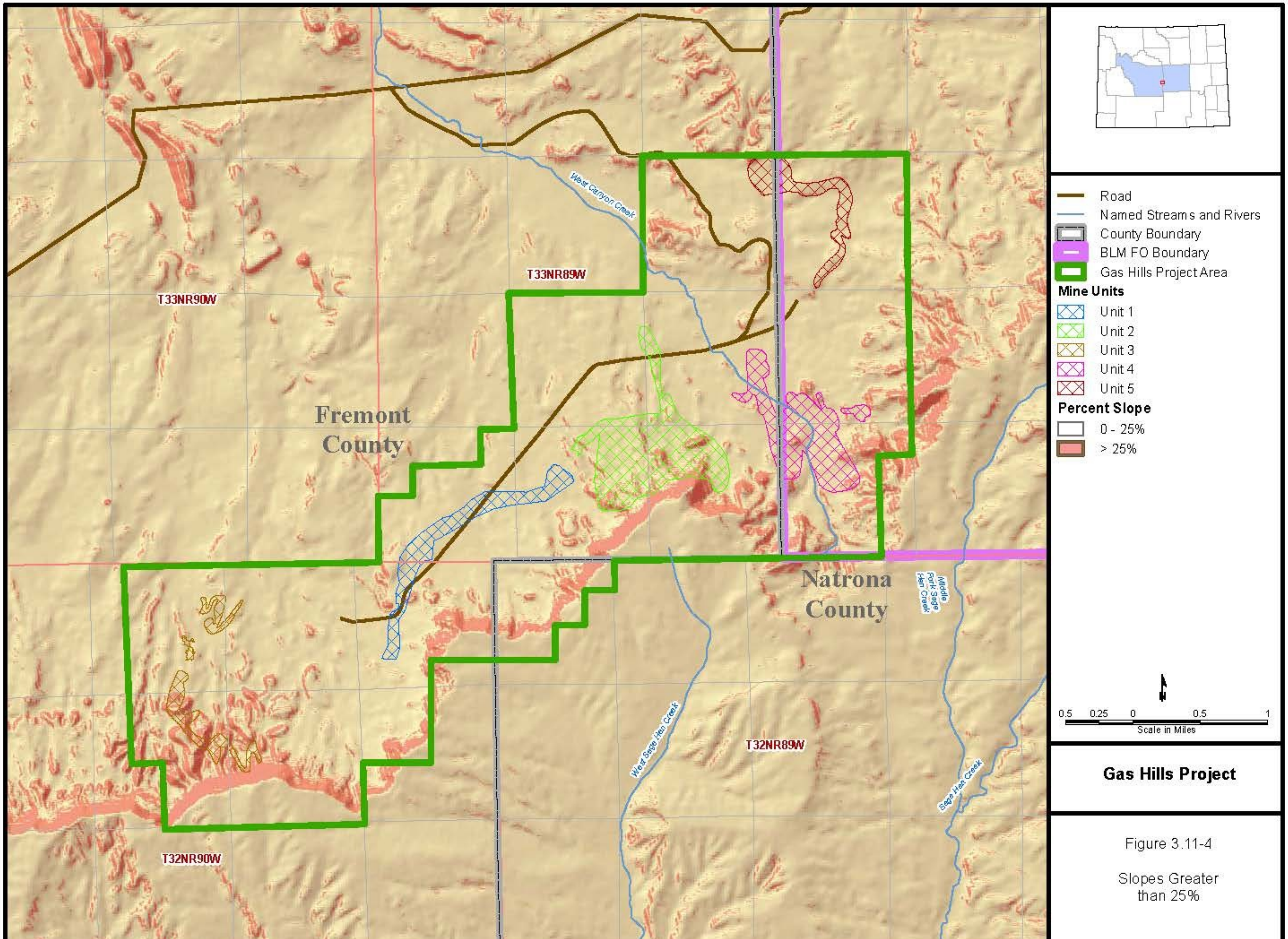
A soil's stability is greatly affected by the slope on which it occurs. In general, the greater the slope, the greater the potential is for slumping, landslides, and water erosion. Approximately 12 percent (1,047 acres) of the GHPA has slopes of 25 percent or more. Slopes greater than 25 percent are illustrated in **Figure 3.11-4**.



Gas Hills Project

Figure 3.11-3

Compaction Prone Soils



Gas Hills Project

Figure 3.11-4

Slopes Greater than 25%

3.12 Transportation

The study area for transportation and access is the GHPA plus regional, county, state, and U.S. highways, as well as the transportation route to the Smith Ranch-Highland facility. The GHPA is located approximately 22 miles south of U.S. Highway 20/26 (**Figures 2-4** and **3.12-1**). As depicted in **Figure 3.12-1**, access to the GHPA is primarily by Wyoming State Route 136, which initiates south of Riverton and terminates just west of the GHPA where it turns into the Ore Road (County Road [CR] 5). Access to the GHPA from the north is via the Castle Garden Road (CR 507), Buck Camp Road (CR 508), and Gas Hills Road (CR 212), all originating from U.S. Highway 20/26. Access to the GHPA from the south is via Ore Road (CR 5), originating from U.S. Highway 287/789.

Transportation routes to the Smith Ranch-Highland facility from the GHPA also are a part of the study area for transportation and access. **Figure 2-5** portrays the Project transportation routes, stretching from Riverton in the west to the Smith Ranch-Highland facility in the east. As depicted in **Figure 2-5**, access to the existing Smith Ranch-Highland facility from Interstate 25 would be primarily by Wyoming 95/93 and Highland Loop Road.

All of the roads within the GHPA are unpaved, and are either BLM or county-maintained, non-maintained public roads, or private. There are approximately 50 miles of roads within the GHPA currently. The majority of the roads in the area are rural and receive light use during Project operation, all of the roads used for the Project in the GHPA would be maintained by Cameco. A summary of traffic counts for roads in the vicinity of the GHPA are provided in **Table 3.12-1**. U.S. Highway 20/26 and State Route 136 recorded increases in traffic from 2000 to 2010 of 39 and 60 percent, respectively. U.S. Highway 287 and State Route 135 (south from Riverton) recorded more modest increases in traffic. The nearest railroad is a Burlington Northern Santa Fe line, approximately 26 miles north of the northern edge of the GHPA.

Under the 1986 Lander RMP, there are areas within the GHPA where OHV travel is designated as either limited, open, or closed to OHV travel. “Limited” OHV areas limit off-road vehicles to existing roads and vehicle routes. As noted in **Figure 3.12-1**, all of the BLM-administered land within the GHPA has been designated as being limited to existing roads and vehicle routes.

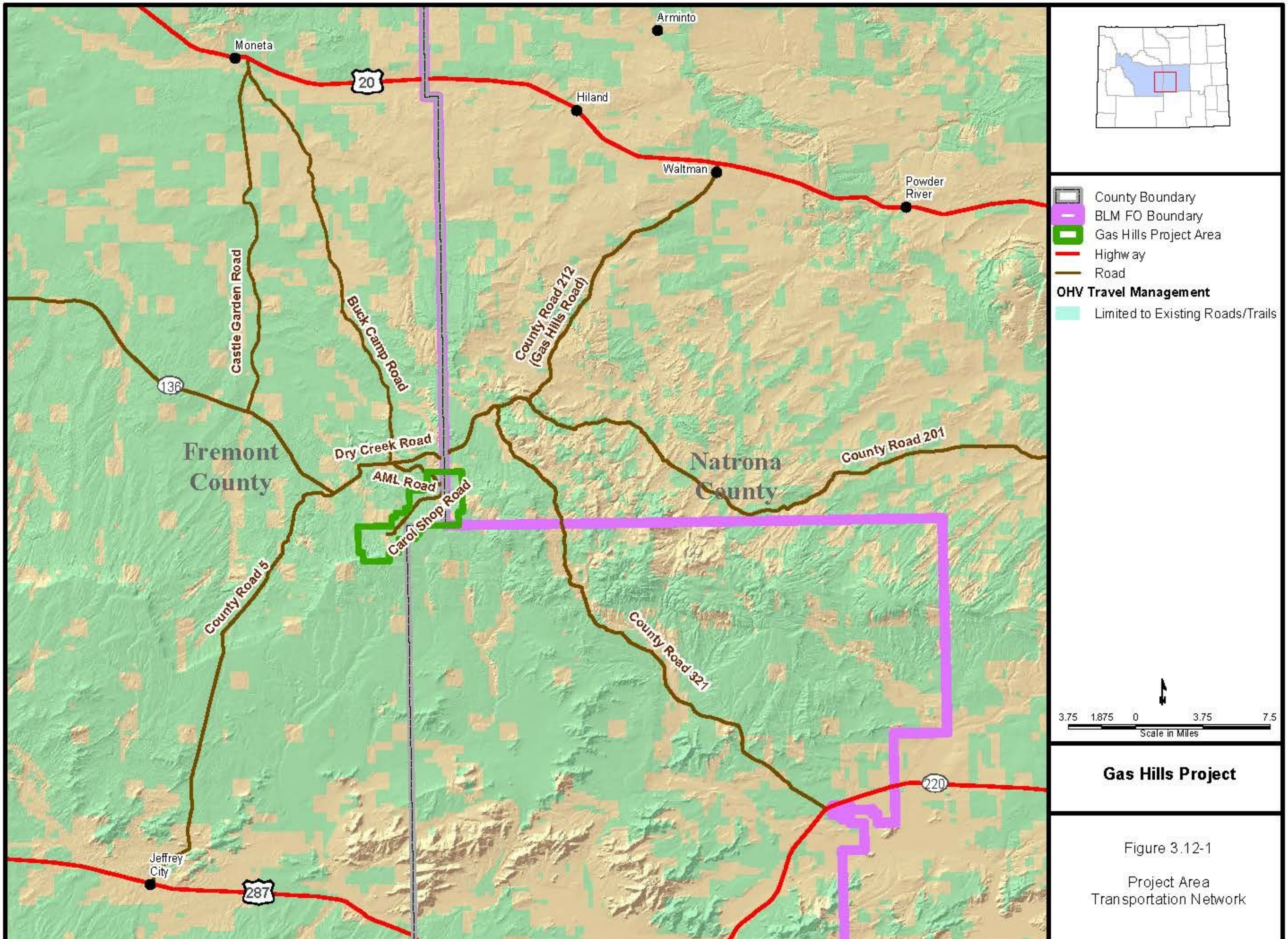


Figure 3.12-1

Project Area Transportation Network

Table 3.12-1 Summary of Current Traffic Volume Near the GHPA

Route	2000 All Vehicles	2000 Trucks	2009 All Vehicles	2009 Trucks	2010 All Vehicles	2010 Trucks	% Change 2000-2010 All Vehicles	% Change 2000-2010 Trucks
U.S. 20/26 at Moneta	2,000	300	2,662	427	2,781	404	39	35
U.S./WY-287/789 east side of Jeffrey City	900	120	1,072	140	1,072	141	19	18
WY-135 MP 17.6 – 34.6	520	70	577	80	570	95	10	36
WY-136 at CR 507 North	130	20	211	20	208	35	60	75

Source: WYDOT 2010.

3.13 Vegetation

The study area for vegetation resources, including general vegetation, noxious weeds, and invasive species, and special status plant species is defined as the GHPA. The following section presents the affected environment for general vegetation resources, noxious weeds and invasive species, and special status plant species within the study area.

3.13.1 General Vegetation

The study area is located in the Wyoming Basin ecoregion. The Wyoming Basin extends from southern Montana into northern Colorado, and includes portions of northeast Utah and southeast Idaho. The arid basin is broad and drained by 3 major river systems; the Green River, the Wind-Bighorn River, and the North Platte. The basin is dominated by grasslands and shrublands surrounded by mountains (Chapman et al. 2004). Common land uses in the ecoregion include livestock grazing, mining, and natural gas and petroleum production (Chapman et al. 2004). The GHPA historically has been mined and is heavily disturbed. Many of the disturbances from historic mining activity are in various stages of reclamation. In these locations vegetation can often be sparse or non-existent, resulting in unstable soils and active erosion. The previously disturbed mine sites are described in more detail under Reclaimed Areas. Non-native grass species common in the GHPA include crested wheatgrass (*Agropyron cristatum*) and cheatgrass (*Bromus tectorum*). Crested wheatgrass was a species commonly used in the reclamation that occurred in the area. Cheatgrass is a prolific seed producer that can invade native communities, displace native plants, and alter the species composition (Colorado State University 2011). Cheatgrass promotes more frequent fires by increasing the biomass and horizontal continuity of fine fuel allowing fire to spread evenly across landscapes where fire was previously restricted to isolated patches (Zouhar 2003).

The topography in the GHPA varies from rolling plains in the north to steep ridges with deep ephemeral drainages in the south (PRI 2009).Vegetation communities were mapped by PRI 2009 Addendum D8 and HWA in 2010. Mapping methodology was based on sampling procedures in the WDEQ-LQD, Rules and Regulations, Guideline 2 and through consultation with the WDEQ (PRI 2009 Addendum D-8). Vegetation communities were delineated based on visual characteristics such as dominant plant species, estimated vegetation cover, landscape position, and major land use. Small vegetation inclusions in larger vegetation communities were not mapped.

There are 8 vegetation communities and land use types mapped in the study area. These vegetation communities and land use types include bottomland sage, mixed sagebrush grassland, rough breaks, reclaimed areas, wetlands, reservoirs, upland grass, and disturbed land. **Table 3.13-1** summarizes the acreages for each vegetation cover type within the GHPA. The dominant cover types are mixed sagebrush grassland and rough breaks.

Descriptions of the plant communities for each vegetation cover type are provided in the following text. Community characterizations were compiled based on vegetation community descriptions from survey reports developed by Intermountain Resources in 1994; BKS Environmental Associates in 2008 and 1997; and HWA in 2011. Additional vegetation community characterizations were provided by NatureServe (2011) and the planning documents for the Casper and Lander FO (BLM 2007a, **2013**). Species nomenclature is consistent with the USDA-NRCS Plants Database (USDA-NRCS 2012b), the Wyoming Natural Diversity Database (WYNDD 2007), and the Wyoming State Noxious Weed List (Wyoming Department of Agriculture [WDA] 2011). **Figure 3.13-1** illustrates the vegetation cover types present within the GHPA.

Table 3.13-1 Vegetation Communities

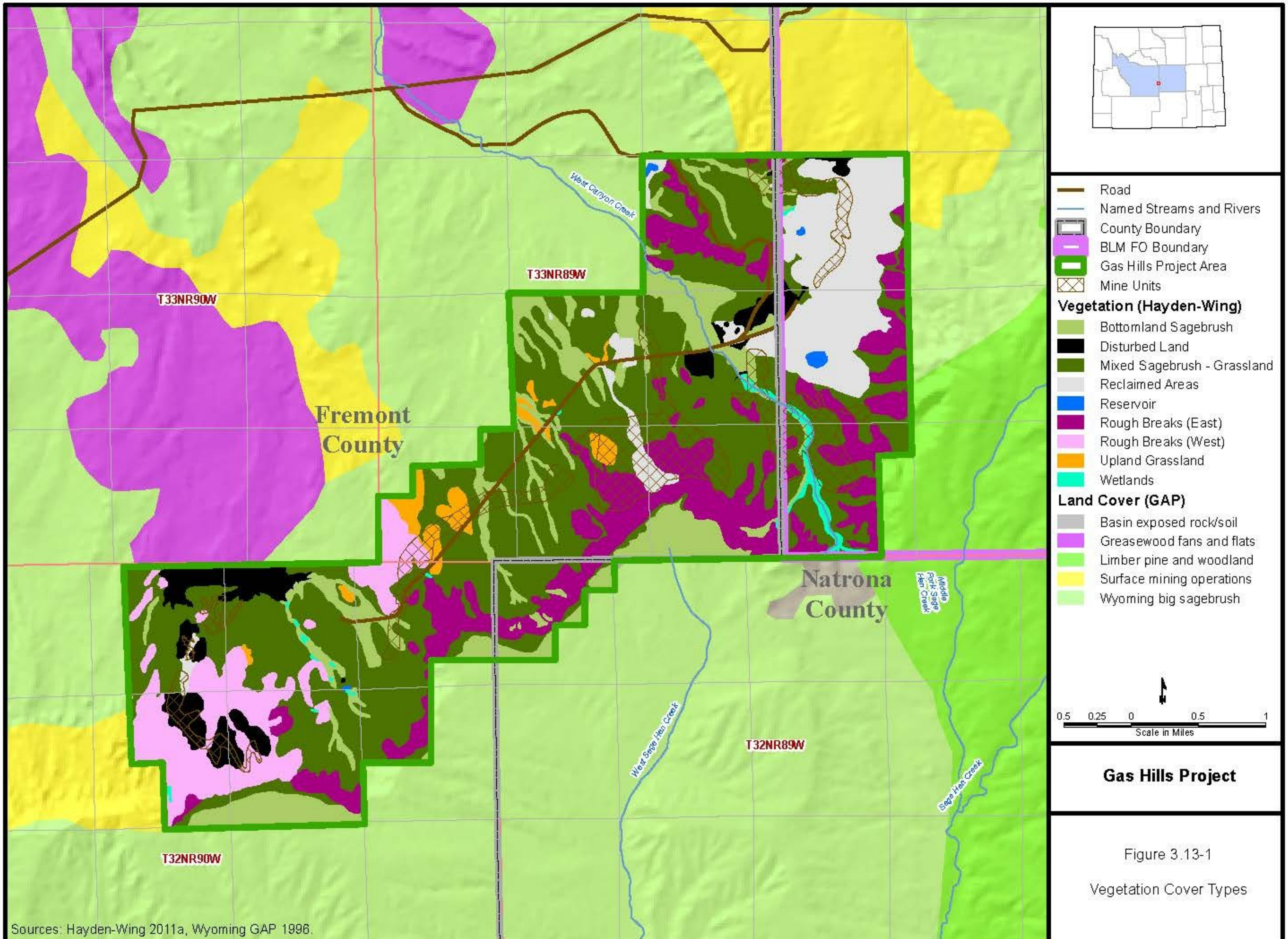
Vegetation Communities/ Land Use Types	Acres	Percent of Study Area
Mixed Sagebrush Grassland	3,898	46
Rough Breaks	1,990	24
Bottomland Sagebrush	1,091	13
Reclaimed Areas	894	10
Disturbed Land	409	5
Upland Grass	151	2
Wetlands	71	1
Reservoirs	15	<1
Total	**8,518**	**100**

Note: Discrepancies in totals are due to rounding.

Mixed Sagebrush Grassland is the dominant vegetation community in the GHPA comprising almost half of the GHPA (46 percent). The vegetation community is found on a variety of topographies ranging from slight draws to upland sloped areas on moderately deep to deep, loamy soils, or shallow rocky sites. The vegetation, composed of a mosaic of shrubs and grasses, is diverse. Dominant species include big sagebrush (*Artemisia tridentata*), thickspike wheatgrass (*Elymus lanceolatus*), and threadleaf sedge (*Carex filifolia*). Other common shrubs include rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), and mountain snowberry (*Symphoricarpos oreophilus*). Other grass and forb species include bluebunch wheatgrass (*Pseudoroegneria spicata*), Western wheatgrass (*Pascopyrum smithii*), Sandberg bluegrass (*Poa secunda*), phlox (*Phlox* spp.), and milkvetch (*Astragalus* spp.).

The Rough Breaks vegetation community is found on approximately 24 percent of the GHPA on upland, relatively steep sloped areas, rock outcrops, bare slopes, ridges, hilltops, sideslopes, and draws. The substrate is shallow, rocky, or gravelly soils. Dominant vegetation is sparse. Vegetation provides approximately 50 percent cover, and bare soil and rocks occupy approximately 40 percent of the total cover. The vegetation community is comprised of 2 sub vegetation communities: Rough Breaks East and Rough Breaks West. Rough Breaks East is found primarily along the area of draws and slopes along the Beaver Rim, while Rough Breaks West is primarily found in the southwest portion of the GHPA. The dominant vegetation in the Rough Breaks East sub-community consists of big sagebrush, threadleaf sedge, and thickspike wheatgrass, while in Rough Breaks West, dominant species consist of bluebunch wheatgrass, big sagebrush, and thickspike wheatgrass. In the higher elevations of the GHPA, such as the vegetation community atop of Beaver Rim and east towards the Rattlesnake Hills, there are small stands of juniper and limber pines.

The Bottomland Sagebrush vegetation community comprises 13 percent of the GHPA and is found within drainages and upland areas where deeper soil and moisture are present. Species composition is similar to the Mixed Sagebrush Grassland vegetation community, but there is greater shrub cover (approximately 30 percent) and the overall vegetative cover is greater. Dominant species include big sagebrush, Cusick bluegrass (*Poa cusickii*), and thickspike wheatgrass. Other associated species include Western wheatgrass, bluebunch wheatgrass, thistles (*Cirsium* spp.), and milkvetch.



Gas Hills Project

Figure 3.13-1

Vegetation Cover Types

Reclaimed areas cover 10 percent of the GHPA and consist of areas that were previously disturbed but are currently in various stages of succession. Most of the reclaimed areas are found in the northeast portion of the GHPA. Reclamation on these areas was conducted either by the mining companies responsible for the disturbance, or under the Wyoming AML ***(Abandoned Mine Lands)*** Program. ***Reclamation activities were conducted utilizing the applicable standards and practices at the time they occurred.*** The dominant species are wheatgrasses (*Agropyron* spp., *Pseudoroegnena* spp.), but Indian ricegrass (*Achnatherum hymenoides*) also is common. Non-native grasses and forbs also can be found in these areas. Wheatgrasses, especially crested wheatgrass, were commonly used in seed mixes for reclamation on the areas disturbed by mining. As stated in the Mine Permit Application, quantitative cover information for reclaimed areas located in the proposed disturbed areas would be submitted to the WDEQ-LQD 6 months prior to disturbance. Specific vegetation information was not collected at the time of surveys due to the dynamic nature of reclaimed areas.

Disturbed land comprises 5 percent of the GHPA and consists of areas devoid of vegetation or with limited vegetation due to the development of mining facilities in the area. Mining-related infrastructure and disturbance in the area consists of existing mine pits, topsoil stockpiles, spoil piles, buildings, power lines, and roads.

Upland Grass comprises 2 percent of the GHPA and is found in upland flat areas within the Mixed Sagebrush Grassland that contains somewhat saline soil conditions. Grasses are 30 percent of the total cover, while shrubs are only about 10 percent. Dominant species include threadleaf sedge, birdfoot sage (*Artemisia pedatifida*), and thickspike wheatgrass. Other common shrubs include big sagebrush, rubber rabbitbrush, broom snakeweed (*Gutierrezia sarothrae*), and winterfat (*Krascheninnikovia lanata*).

Reservoirs are less than 1 percent of the GHPA and range in size from small stockponds to large mine impoundments. Several small stock ponds are located in the central and northwest portions of the GHPA, and a small reservoir is located in the southern portion of the GHPA. Vegetation adjacent to reservoirs ranges from seeded grass species to hydrophilic vegetation.

Wetlands are 1 percent of the GHPA and are predominantly found along WCC, which runs northwest to southeast in the eastern portion of the GHPA. The remaining wetlands are found in scattered patches throughout the GHPA. Wetland and riparian communities are areas having persistent water or obligate vegetation (e.g., sedges, rushes, willows) due to the availability of surface or groundwater. Although wetlands and riparian areas comprise a very small percentage of the vegetation communities in the western U.S., their importance to the surrounding ecosystems and associated species is disproportionately great in relation to their size. Most wildlife species use riparian areas at some point in their life cycles and some depend almost entirely on the health of these systems (e.g., many migratory birds during breeding season and amphibians). Riparian areas are the transition between water sources and uplands, and often are rich in vegetation diversity and structure. Riparian and wetland areas act as water purifiers, supply for groundwater recharge, aid in flood control, and in addition to providing food, water, and shade they also may provide cover to wildlife and livestock. Wetlands species in the GHPA include willows (*Salix* spp.), cottonwoods (*Populus* spp.), and boxelders (*Acer negundo*).

3.13.2 Noxious Weeds and Invasive Species

Noxious weeds and invasive species have become a growing concern in the western U.S. based on their ability to increase in cover relative to surrounding native vegetation and exclude native plants from an area. The spread of noxious weeds has resulted in impacts to endangered native species, available forage for livestock and wildlife, and economic resources. They impact the ability of the BLM to manage for multiple uses, contribute to the loss of rangeland productivity, cause increased soil erosion, reduce native species diversity, cause loss of wildlife habitat and, in some instances, are hazardous to human and animal health and welfare. The Federal Plant Protection Act of 2000 (formerly the Noxious Weed Act of 1974) and EO 13112 of February 3, 1999, requires cooperation with state, local, and other federal agencies in the application and enforcement of all laws and regulations relating to the management and control of noxious weeds. Recognizing these regulations, the BLM has established a goal that NEPA documents consider and analyze the potential for the spread of noxious weed species and provide preventative rehabilitation measures for each management action involving surface disturbance.

The State of Wyoming defines noxious weeds as weeds, seeds, or other plant parts that are considered detrimental, destructive, injurious or poisonous, either by virtue of their direct effect or as carriers of diseases or parasites that exist within the state, and are on the designated list (Wyoming Status, Title 11, Chapter 5, Section 102.a.xi). Noxious and invasive weeds are a threat to native ecosystems and biological diversity based on their ability to increase in cover relative to surrounding vegetation and exclude native plants from an area. In addition to the state designated list of noxious weeds, Fremont and Natrona county have declared weeds of concern specific to each county under the authority of the Wyoming Weed and Pest Control Act (WDA 2011). **Table 3.13-2** provides a list of designated noxious weed species and priority species as identified by the State of Wyoming, as well as Fremont and Natrona counties.

Table 3.13-2 Noxious Weeds Potentially Occurring in the GHPA

Common Name	Scientific Name	State of Wyoming Designated Noxious Weed List[a]	On Fremont (F) or Natrona (N) County Noxious Weed Lists[b]	Observed in the GHPA
Common burdock	*Arctium minus*	X		
Showy milkweed	*Asclepias speciosa*		N	
Cheatgrass/downy brome	*Bromus tectorum*		N	
Hoary cress (whitetop)	*Cardaria draba* & *Cardaria pubescens*	X		X
Plumeless thistle	*Carduus acanthoides*	X		
Musk thistle	*Carduus nutans*	X		
Diffuse knapweed	*Centaurea diffusa*	X		
Spotted knapweed	*Centaurea maculosa*	X		
Russian knapweed	*Centaurea repens*	X		
Yellow starthistle	*Centaurea solstitialis*		N	
Ox-eye daisy	*Chrysanthemum leucanthemum*	X		
Canada thistle	*Cirsium arvense*	X		X
Field bindweed	*Convolvulus arvensis*	X		
Houndstongue	*Cynoglossum officinale*	X		
Russian olive	*Elaeagnus angustifolia*	X		
Leafy spurge	*Euphorbia esula*	X		
Skeletonleaf bursage	*Franseria discolor* Nutt.	X		

Table 3.13-2 Noxious Weeds Potentially Occurring in the GHPA

Common Name	Scientific Name	State of Wyoming Designated Noxious Weed List[a]	On Fremont (F) or Natrona (N) County Noxious Weed Lists[b]	Observed in the GHPA
Wild licorice	*Glycyrrhiza lepidota*		N	X
Curlycup gumweed	*Grindelia squarrosa*		N	
Halogeton	*Halogeton glomeratus*		N	
Foxtail barley	*Hordeum jubatum*		N	
Black henbane	*Hyoscyamus niger*		N	
Common St. Johnswort	*Hypericum perforatum*	X		
Dyers woad	*Isatis tinctoria*	X		
Perennial pepperweed (giant whitetop)	*Lepidium latifolium*	X		
Dalmatian toadflax	*Linaria dalmatica*	X		
Yellow toadflax	*Linaria vulgaris*	X		
Purple loosestrife	*Lythrum salicaria*	X		
Black medic	*Medicago lupulina*		N	
Scotch thistle	*Onopordum acanthium*	X		
Buffalobur	*Solanum rostratum*		N	
Perennial sowthistle	*Sonchus arvensis*	X		
Swainsonpea	*Sphaerophysa salsula*		F	
Saltcedar	*Tamarix* spp.	X		
Common tansy	*Tanacetum vulgare*	X		
Puncturevine	*Tribulus terrestris*		N	

[a] Source: WDA 2011.

[b] N = Natrona County; F = Fremont County.

For the BLM, while the primary concerns are noxious weeds of concern identified by the State of Wyoming (BLM 2011b), a secondary concern is the control of invasive species (e.g., halogeton, henbane, and cheatgrass) that can impede successful reclamation and impact management of livestock, wildlife, and human activities. Weed treatment on public land is conducted by the land agencies in conjunction with the county weed and pest control districts (Wyoming State Weed Team 2003). These districts develop programs that include private landowners, other local entities and agencies, tribes, state and federal agencies, as well as collaborate which offers the best chance to protect natural resources from noxious plant invasions and improves the efficiency of their programs.

Within the GHPA, Canada thistle, hoary cress (whitetop), and wild licorice have been observed. Approximately 300 acres of the GHPA have been documented as being infested with Canada thistle. Hoary cress and wild licorice have each been mapped in 1 location within the GHPA. BLM personnel also have observed black henbane, Canada thistle, and Russian knapweed along the ***AML*** Road (BLM 2010***a***). In the vicinity of the GHPA, black henbane, Russian knapweed, perennial pepperweed, Russian olive, saltcedar, and Scotch thistle also have been documented (PRI 2009).

3.13.3 Special Status Plant Species

Special status plant species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the ESA or are considered as candidates for such listing by the USFWS, species that are state listed as threatened or endangered, and BLM sensitive species.

In accordance with the ESA, the lead agency in coordination with USFWS must ensure that any federal action to be authorized, funded, or implemented would not adversely affect a federally listed, threatened, or endangered species or its critical habitat. Special Status Species Management Policy 6840 requires the BLM to manage and protect BLM sensitive species, which include: species listed or proposed for listing under the ESA; species requiring special management consideration to promote their conservation and reduce the likelihood and need for future listing under the ESA; species designated as BLM sensitive by the State Director; and all federal candidate species, proposed species, and delisted species in the 5 years following delisting. This policy requires the BLM to manage and protect BLM sensitive species to prevent the need for future federal listing as threatened or endangered.

Based upon data obtained from agency websites and agency contacts, 19 special status plant species were identified by the USFWS and BLM as potentially occurring within the GHPA (BLM 2011***a***; HWA 2011a,b; PRI 2009). These species, their scientific names, status, associated habitats, and their potential for occurrence within the GHPA are summarized in **Appendix *H***. Occurrence potential was evaluated for each of these species based on their habitat requirements and/or known distribution. Based on these evaluations, 13 special status plant species have been eliminated from detailed analysis as their known range is outside of the GHPA, and/or there is no suitable habitat for these species. The species eliminated from detailed analysis are Meadow pussytoes (*Antennane corymbosa*), Laramie columbine (*Aquilegia laramiensis*), Porter's sagebrush (*Artemisia porteri*), Dubois milkvetch (*Astragalus gilviflorus* var. *purpureus),* Many-stemmed spider flower (*Cleome multicaulis*), Owl Creek Miner's candle (*Cryptantha subcapitata),* Williams' Wafer parsnip (*Cymopterus williamsii),* Fremont's bladderpod (*Lesquerella fremontii),*Blowout penstemon (*Penstemon haydenii*), Shoshonea (*Shoshonea pulvinata*), Laramie false sagebrush (*Sphaeromeria simplex*), Ute ladies'-tresses orchid (*Spiranthes diluvialis*), Barneby's clover (*Trifolium barnebyi),* and Desert yellowhead (*Yermo xanthocephalus*). Further detail on why these species were eliminated from detailed analysis is included in **Appendix *H***. The remaining 5 species that have the potential to occur within the GHPA are discussed in the following text. Species information was compiled based on the HWA biological field survey report (HWA 2011a,b), the Casper RMP Final EIS (BLM 2007a), NatureServe (2011), and the WYNDD (2011) species accounts. Additional sources are identified in the following text.

HWA conducted field surveys in 2010 for each of the 5 species identified as potentially occurring within the GHPA (**Appendix *H***). Survey protocols followed the Cameco Resources Gas Hills Project Wildlife Monitoring Plan approved by the regulatory agencies in 2009 and as requested by the BLM Lander FO.

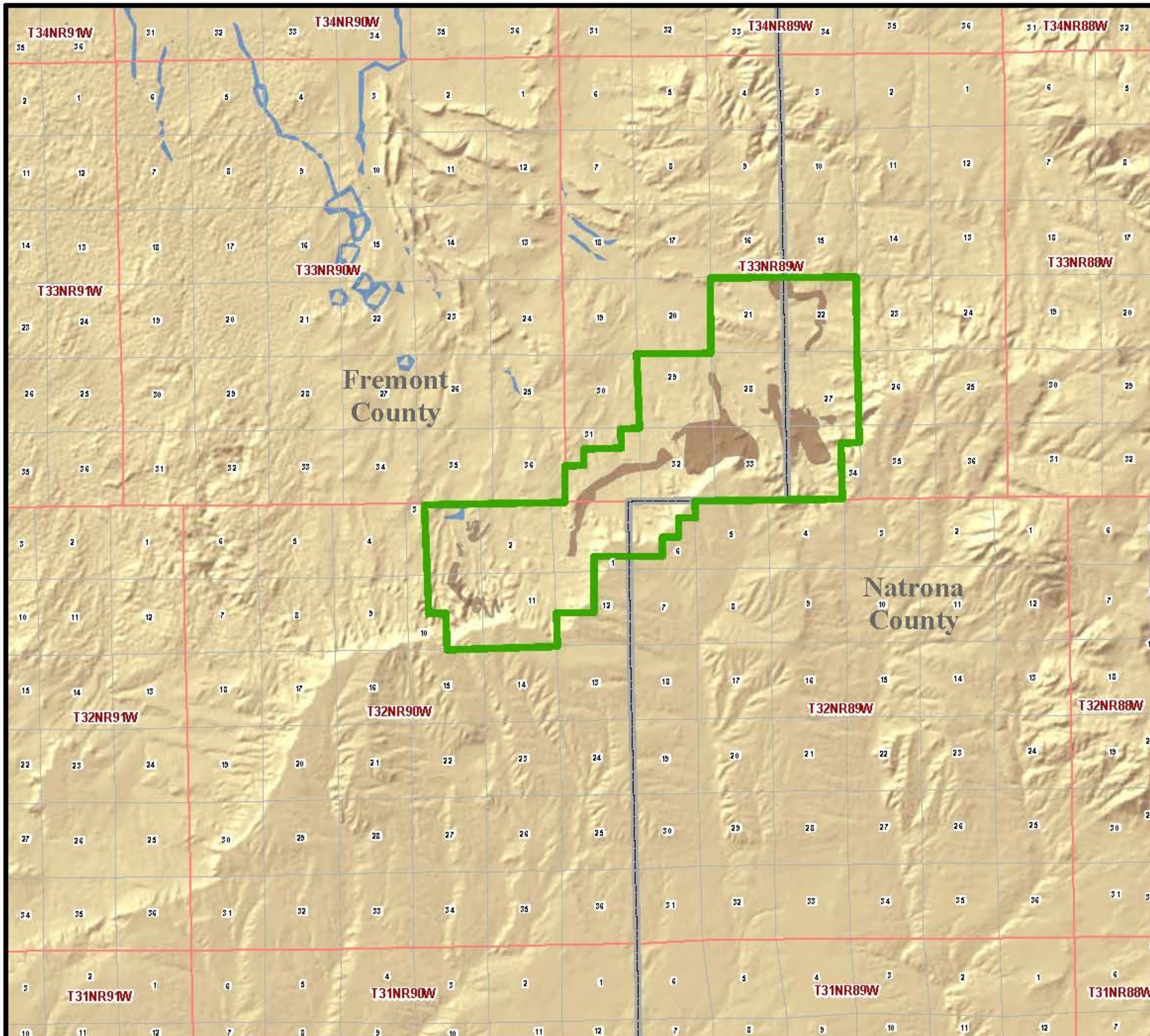
Surveys to identify suitable habitat for the ***3*** ESA-listed species (Ute ladies'-tresses, blowout penstemon, and desert yellowhead) were conducted in 2009 and 2010. No designated critical habitat for these species occurs in the GHPA. Surveys were conducted again in 2010 for the Ute ladies'-tresses when the nearest known specimen in the vicinity of the GHPA of this species was observed as flowering. Based on these surveys, no suitable habitat was identified in the GHPA.

For the BLM sensitive plant species, surveys were conducted in areas identified as potential habitat for each species based on potential distribution models provided by the WYNDD (HWA 2011a,b). Surveys were conducted in mid to late June 2010 for the BLM sensitive species, near the peak flowering and fruiting periods. Survey sites were randomly distributed throughout the GHPA and were located both in and outside of the modeled habitat areas. At each survey site, meandering pedestrian surveys were conducted within 200 meters of the survey site center-point.

Persistent sepal yellowcress (*Rorippa calycina*) is a Wyoming BLM sensitive species and regional endemic currently only known from the North Platte River drainage, and Bighorn, Great Divide, Green River, and Wind River basins in Albany, Big Horn, Carbon, Fremont, Park, Sweetwater, and Washake counties. Persistent sepal yellowcress is a rhizomatous perennial herb with pubescent stems and foliage, yellow petals, and pubescent ovoid to nearly globose fruits. The species flowers from late May to August, but under favorable circumstances blooming may extend into October. Habitat for the species is primarily found in areas that have periodic flooding such as the high-water line of moist sandy to muddy banks of streams, stock ponds, and man-made reservoirs, high plain swales that evaporate, and along creeks. The species is found from 3,660 to 6,800 feet amsl. There are 28 occurrences in Wyoming, with total populations estimated as ranging from 15,000 to 25,000 plants. Threats to the species mainly result from changes in water management that reduces the periodicity of flooding, but also include invasion of noxious weeds, herbicide spraying, trampling by livestock, recreation use, and coal mining. Potential habitat for the species was modeled as occurring north of Mine Unit 3 (**Figure 3.13-2**). Suitable habitat was observed along the ***Dry Creek*** Road. No individuals or populations were identified as occurring in the GPHA during surveys.

Cedar Rim thistle (*Cirsium aridum*) is a Wyoming BLM sensitive species and regional endemic that is restricted to the Green River Basin, Sublette County; Beaver Rim area, Fremont, County; Sweetwater River Valley, Carbon County; and highlands east of Flaming Gorge, Sweetwater County. A perennial, taprooted herb with lavender flowers, and brown streaked, cream-colored fruits, it flowers and produces fruit from June to July. Habitat is in sparsely vegetated openings within Wyoming big sagebrush grasslands on barren slopes, fans, and draws. Substrates are sandstone, chalk, tufaceous colluviums, or clay substrates derived from the Split Rock, White River, Wagon Bed, Wind River, Green River, and Wasatch formations. The species is found from 5,800 to 7,500 feet amsl. Populations are estimated to be 40,000 to 50,000+ individuals. Threats to the species include weed management activities for invasive thistles including herbicide spraying, and biocontrol insects (BLM 2011b). Potential habitat was modeled as occurring in the GHPA and southwest and northeast of the GHPA (**Figure 3.13-3**). Suitable habitat for the species was found in the clay slopes and fans within stands of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and grasslands close to the Beaver Rim. No individuals or populations were identified as occurring in the GPHA during surveys. There is a known population of Cedar Rim thistle 2 miles southwest of the GHPA boundary and within the modeled habitat.

Beaver Rim Phlox (*Phlox pungens*) is a Wyoming BLM sensitive species and local endemic in the Wind River and Green River basins extending to the Beaver Rim and southeastern foothills of the Wind River Range in Fremont, Lincoln, Rock Springs, and Sublette counties, Wyoming. There are 2 forms ("typical," and "Ross Butte morph") that are split geographically. The typical form is found in Fremont County, and the Ross Butte morph is mainly in the Green River Basin. The species is a leafy perennial forb that forms loose mats of prostrate or short, erect stems and flowers from May to June. Habitat is found on sparsely vegetated slopes on substrates of sandstone, siltstone, or limestone in the Wind River Basin and clays and shales in the Green River Basin. The elevation range is 6,000 to 7,400 feet amsl. There are 31 known occurrences in Wyoming, with populations of 200,000 to 300,000 in the Beaver Rim



County Boundary
Township
Section
Gas Hills Project Area
Mine Units

Modeled Habitat based on WYNDD Distribution Model Persistent Sepal Yellowcress

Likely Habitat

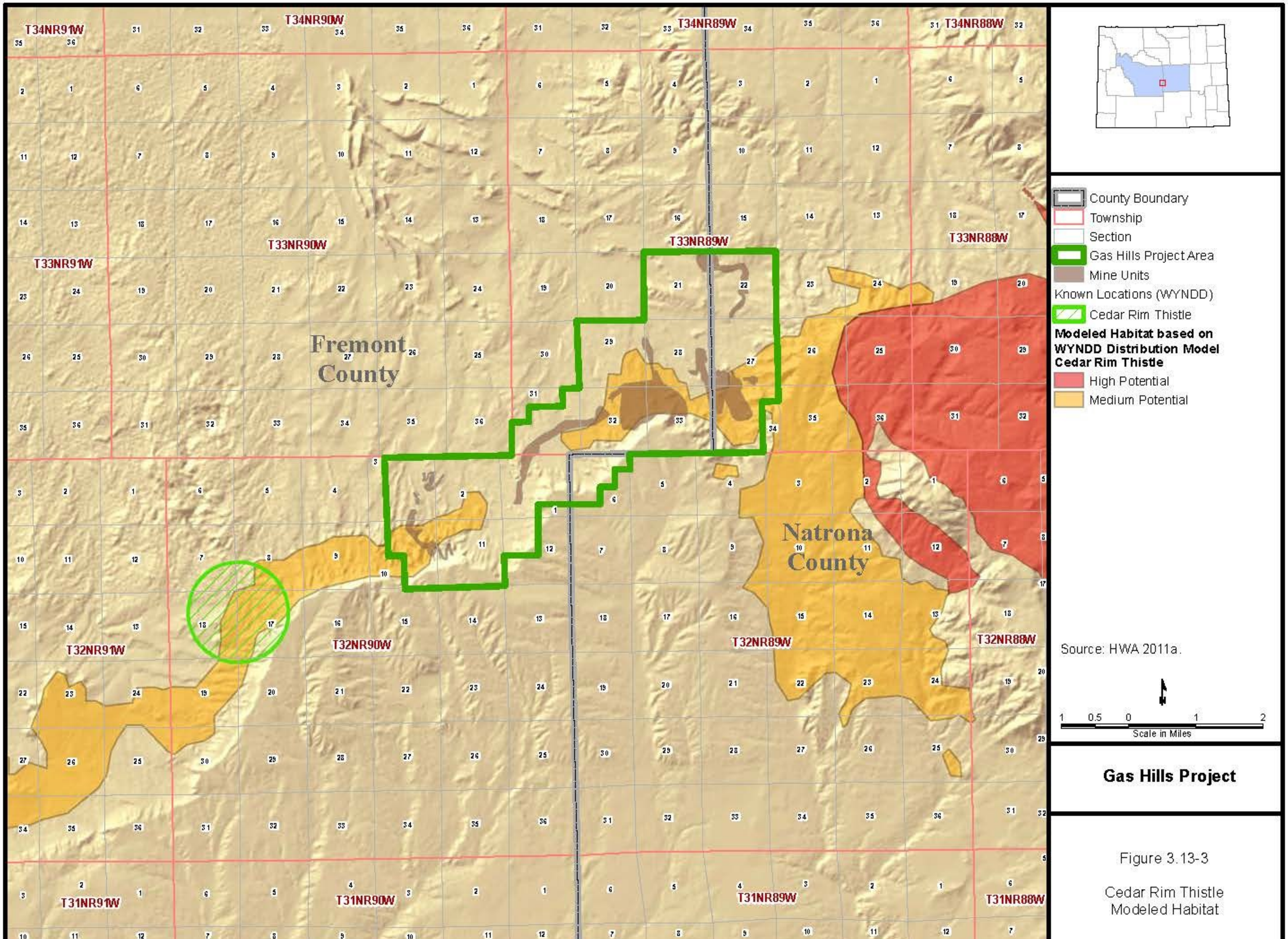
Source: HWA 2011a.

1 0.5 0 1 2
Scale in Miles

Gas Hills Project

Figure 3.13-2

Persistent Sepal Yellowcress Modeled Habitat



Gas Hills Project

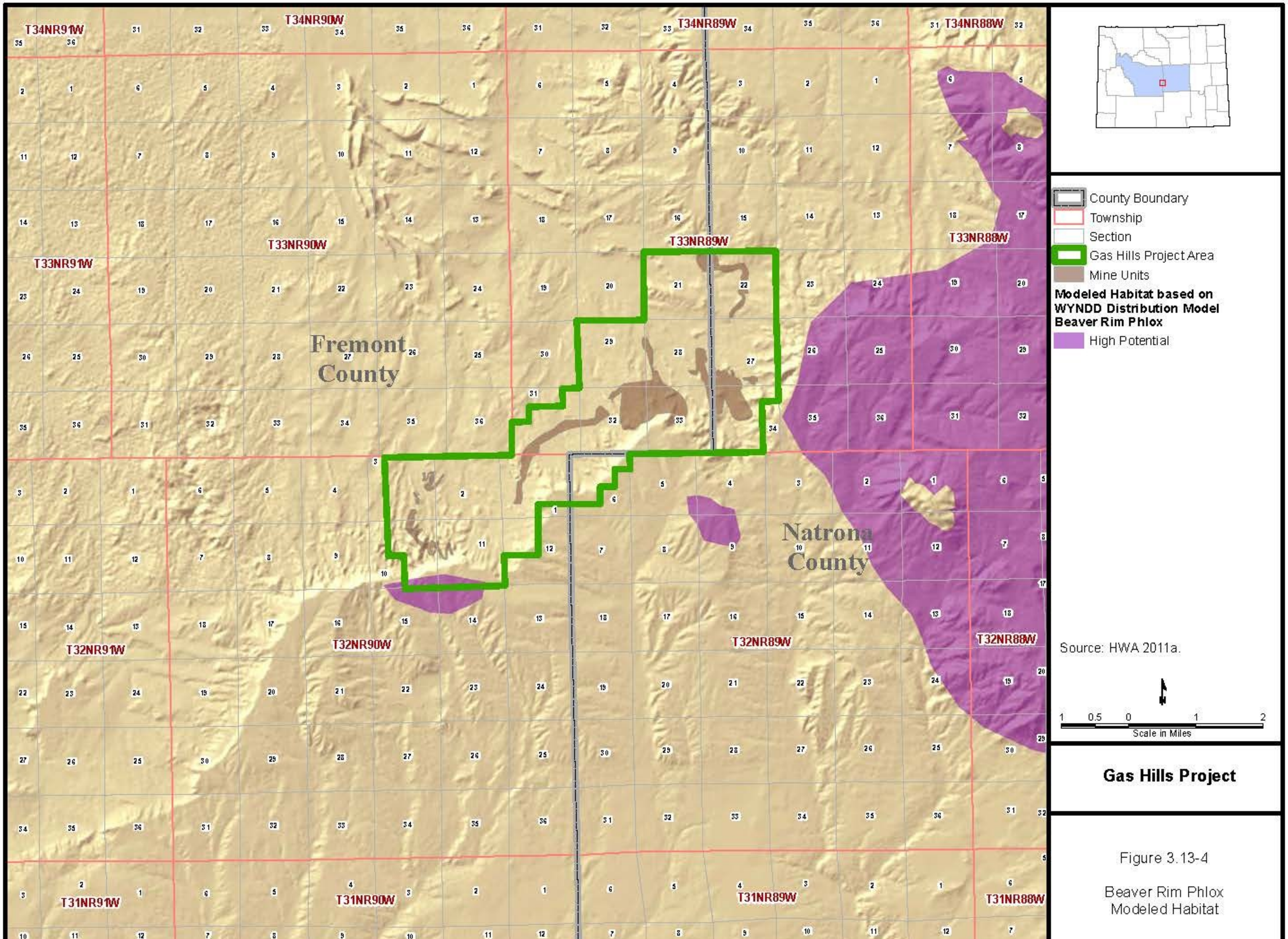
Figure 3.13-3

Cedar Rim Thistle Modeled Habitat

area and Green River Basin, respectively. Threats to the species include surface disturbance associated with oil and gas development, pipeline and highway construction, off-road vehicle use, and the spread or establishment of noxious weeds and invasive species. Potential habitat was modeled as occurring in the GHPA and south and east of the GHPA (**Figure 3.13-4**). Suitable habitat for the species was found on the slopes and top of the Beaver Rim where there were gaps in the Wyoming big sagebrush. There are no known populations of Beaver Rim phlox in the vicinity of the GHPA. No individuals or populations were identified as occurring in the GPHA during surveys.

Rocky Mountain twinpod (*Physaria saximontana* var. *saximontana*) is a Wyoming BLM sensitive species and state endemic for Fremont, Hot Springs, Carbon, and Park counties. In these counties, the species is found in the southern Bighorn and Wind River basins, and in the foothills of the Wind River and Absaroka ranges. The species is a perennial herb with a basal rosette of gray, green, long-petiole leaves, yellow flowers, and prostrate and decumbent flowering stems. Flowering is from May to late June. Fruits are gray-hairy, inflated, deeply notched at the top and are present from late June to August. Habitat is sparsely vegetated slopes on substrates of sandy, gravelly soils, or talus of limestone, red sandstone, or clay. The elevation range is 5,200 to 8,300 feet amsl. There are 18 occurrences of the species in Wyoming, with populations varying from small and sparse to locally abundant depending on the habitat. Threats to the species include road and pipeline construction or off-road vehicle activity. Potential habitat was modeled as occurring in the GHPA, and southwest, northwest, and east of the GHPA (**Figure 3.13-5**). Suitable habitat for the species was found on the sparsely vegetated portions of the north slope of the Beaver Rim in substrates of clay and gravelly soil. Two known populations of Rocky Mountain twinpod are found in the modeled habitat southwest of the GHPA. No individuals or populations were identified as occurring in the GPHA during surveys.

Limber pine (*Pinus flexilis*) is a recent Wyoming BLM sensitive species which is found from Alberta and British Columbia south to California, Arizona, and New Mexico. A long-lived, slow growing tree species, it is rarely taller than 50 feet and often grows in an irregular or multi-stem growth form (Johnson 2001). Flower buds develop late April to late June, while pine cones ripen from August to September. The resulting seeds are dispersed from September to October. Habitat for the tree is typically in dry, rocky sites in forested regions on mesic sites in low density, open areas. In Wyoming, it is usually found with Rocky Mountain lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), whitebark pine (*Pinus albicaulis*), Rocky Mountain Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), Rocky Mountain juniper (*Juniperus scopulorum*), and common juniper (*Juniperus communis*). While specific elevation ranges for Wyoming are not available, elevation range for the species throughout its range is 4,000 to 12,500 feet amsl. Threats to the species include mountain pine beetle infestations, white pine blister rust infections, and climate change (BLM 2010b). Due to the recent listing of this species, habitat modeling and surveys were not conducted for this species. However, the vegetation surveys conducted for the site observed stands of limber pine in the eastern portion of the GHPA.



Gas Hills Project

Figure 3.13-4

Beaver Rim Phlox Modeled Habitat

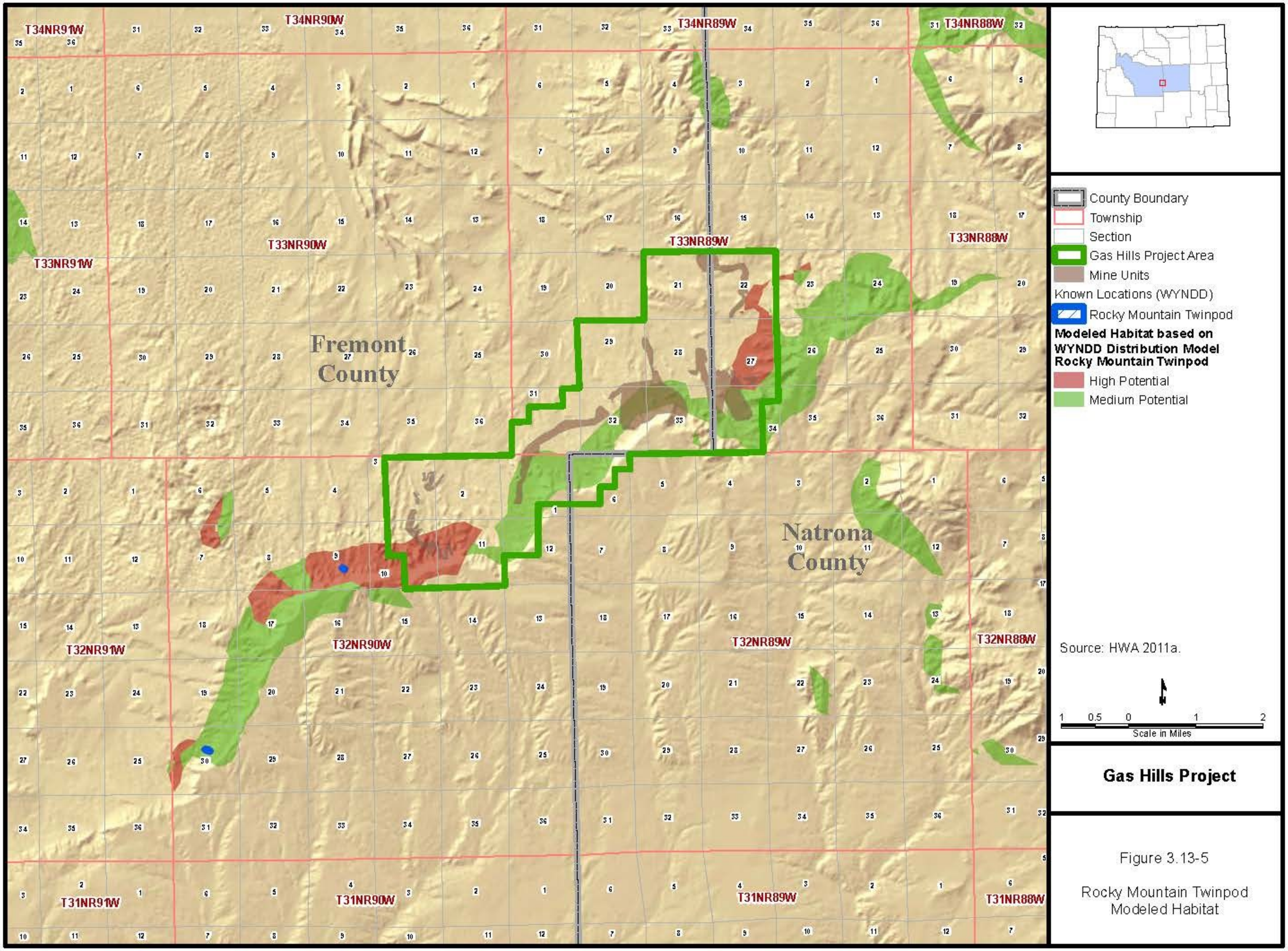


Figure 3.13-5

Rocky Mountain Twinpod Modeled Habitat

3.14 Visual Resources

The visual resources study area encompasses the area from which the Project would be visible (viewshed) within approximately 5 miles of the Project boundary.

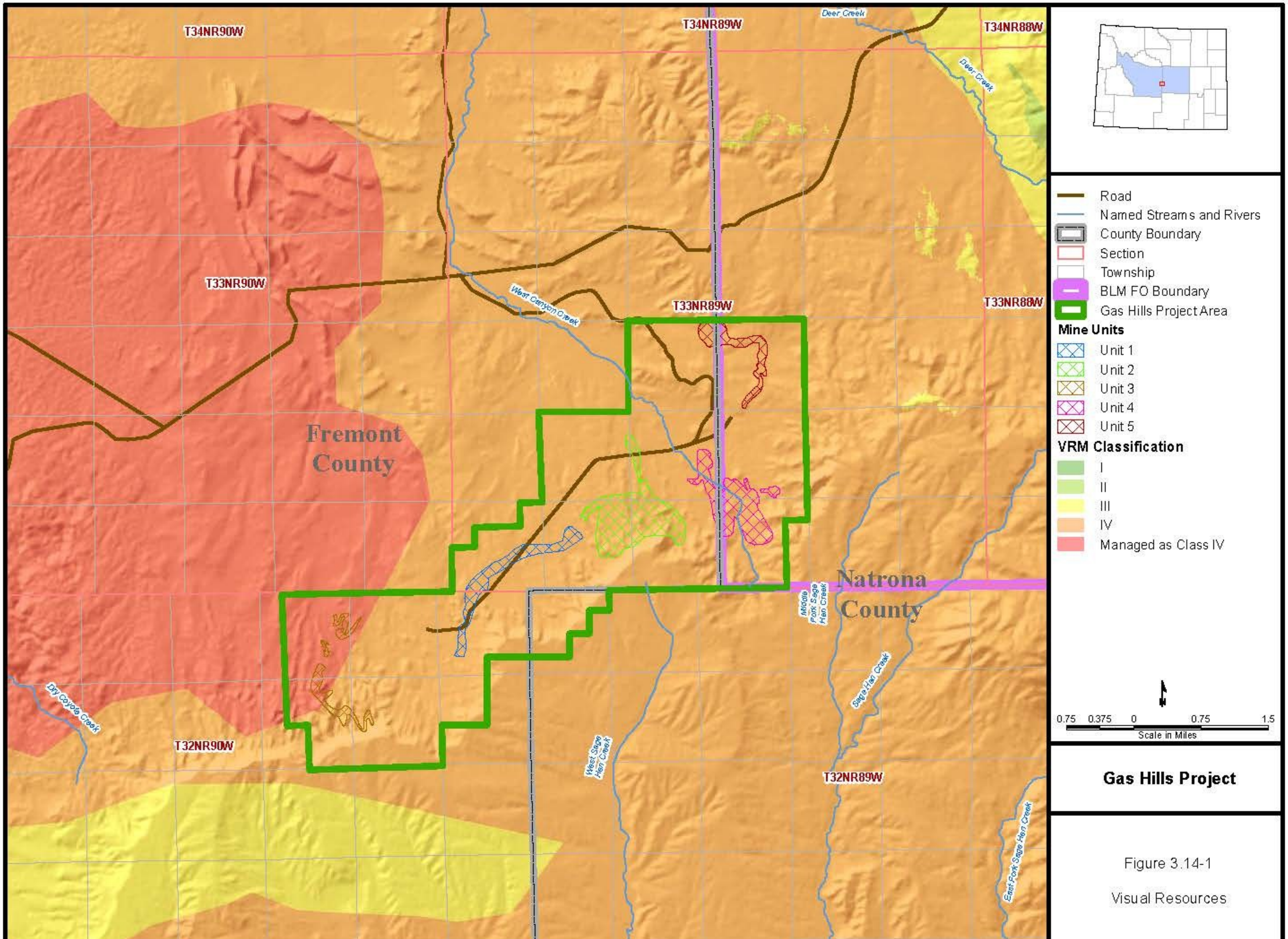
The BLM is responsible for identifying and protecting scenic values on public lands under several provisions of FLPMA and NEPA. The BLM Visual Resource Management (VRM) system was developed to facilitate the effective discharge of that responsibility in a systematic, interdisciplinary manner. The VRM system includes an inventory process, based on a matrix of scenic quality, viewer sensitivity to visual change, and viewing distances, which leads to classification of public lands and assignment of visual management objectives. Four VRM classes have been established, which serve 2 purposes: 1) as an inventory tool portraying relative value of existing visual resources; and 2) as a management tool portraying visual management objectives for each classification. Areas not meeting the objectives of the VRM class established through the inventory and RMP processes for reasons such as being excessively disturbed by previous activities are identified as "rehabilitation areas." This designation indicates the area needs improvement to comply with visual objectives. **Table 3.14-1** shows the minimum management objectives for each class, based on BLM Handbook H-8410-1, Visual Resource Inventory.

Table 3.14-1 BLM Visual Resource Management Class Objectives

Class I Objective	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II Objective	The objective of this class 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 (design) elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III Objective	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV Objective	The objective of this class is to provide for management activities, which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic (design) elements.

The VRM system also includes a "contrast rating" procedure for evaluating the potential visual effects on the landscape of a proposed project or management activity in the context of other activities that have occurred or may occur in the area in the reasonably foreseeable future.

The viewshed for the Project generally follows drainages to the northwest, including most notably WCC, Fraser Draw, and Willow Springs Draw. The viewshed is interrupted at a distance of approximately 3 miles to the northwest by the Gas Hills. It is truncated by terrain of the Beaver Divide ridge, which runs along the southeast boundary of the GHPA, and by the Rattlesnake Hills approximately 3 miles to the northeast of the permit boundary.



Gas Hills Project

Figure 3.14-1

Visual Resources

Under the VRM system, the affected environment for visual resources is characterized using an inventory and evaluation process that addresses scenic quality, viewer sensitivity, and distance between viewers and any proposed modification to the landscape. The results of the 3-step inventory process are used to determine which of 4 possible VRM classes should be assigned to BLM-managed public lands by applying a standard matrix to combine the inventory data. Each VRM class has specific objectives giving guidance as to how the visual environment may be managed on lands so designated (**Table 3.14-1**). Landscape characteristics contributing to the inventory process for the GHPA are described below, followed by VRM class designations for the visual area of influence.

The GHPA is located in the Wyoming Basin physiographic province, as defined by Fenneman (1931), which is a landscape defined by horizontal layers of sedimentary bedrocks, often of multiple colors. Some of these areas have striking eroded formations (called "badlands") interspersed between areas of low, rolling terrain and flat-topped hills. The landform in the Project vicinity is generally low, rolling hills cut in places by drainages. The terrain broadens out and flattens to the northwest, beyond the low Gas Hills. The most notable landform in the area is the Rattlesnake Hills ridge to the northeast, which rises to nearly 8,000 feet amsl.

Regional vegetation tends to be shrubby and sparse, dominated by sagebrush, greasewood, and saltbush. Higher elevations have patches of conifer and aspen. There also are cottonwood groves along some larger drainages. There are no major water features in the study area of sufficient quality or scale to have a notable effect on the visual environment.

Colors in the landscape vary seasonally. Although spring infuses the area with brighter greens in wet years, the most dominant colors are muted grey-greens and tans, with some darker browns and muted reds where soils or rock outcrops are prominent. There are no landscape features in the visual study area that are rare or unique to the Wyoming Basin physiographic province.

The most prominent modifications in the vicinity are remnants of prior uranium mining activities. Previous mining employed primarily surface mining methods, which produced pits and waste rock piles. There also is a network of roads, the most prominent of which are State Route 136 to Riverton, Gas Hills Road (CR 212) to U.S. Highway 20/26, and CR 5 (Ore Road), originating from U.S. Highway 287/789 to Jeffrey City. Other roads in the area are mostly primitive 2-track roads, some of which were exploration access roads. Ranching and agriculture have introduced modifications such as fence lines, corrals, and stock tanks.

Viewer sensitivity to the visual environment in the study area is considered to be low. There are no developed recreation areas to attract recreational viewers and none of the major historic trails across Wyoming pass near the study area. There are no residences in the vicinity. There are no major travel corridors within viewing distance of the visual study area that would bring large numbers of travelers near the Project. Consequently, the number of viewers in the vicinity is small and most viewers in the area are there for work activities related to energy development or ranching. Work related viewers are generally not considered to be highly sensitive to visual resource conditions.

The BLM has conducted visual inventories of the GHPA under the VRM system and established VRM classes in the study area (BLM 2007c,d, 2003) (**Figure 3.14-1**). The Rattlesnake Hills are designated Class III primarily because of better than average scenic quality for the area resulting from more interesting terrain and vegetation. The remainder of the study area is designated VRM Class IV (BLM 2007a). The Lander FO is in the process of revising its RMP. Until that process is complete, the 1987 Lander RMP provides management guidance. The current Lander RMP (BLM 1987) identifies a portion of the visual study area as Class V, however, the BLM Manual Handbook 8410-1 eliminated the Class V designation and areas previously designated Class V are managed as Class IV areas. Class IV areas typically lack distinctive visual qualities and some are highly modified from previous development activities. The scenery is typical of the Wyoming Basin physiographic province described above.

3.15 Water Resources

This section summarizes the surface water and groundwater resources currently found in the GHPA. The area has an arid climate with approximately 9.3 inches of average annual precipitation according to 45 years of record at the Gas Hills 4E NWS station. The University of Wyoming's Water Resources Data System online mapper estimates that the higher elevations in the GHPA may receive an average of 11 inches of precipitation annually (University of Wyoming 2011). The months of April, May, and June see nearly half the average annual precipitation, while approximately only 30 percent of the average annual precipitation falls from October through March (WRCC 2011). The NWS estimates that average annual free water (pond) evaporation in this area is approximately 42 inches (Farnsworth et al. 1982).

3.15.1 Surface Water Resources

According to the Watershed Boundary Dataset, the majority of the GHPA is located in the Upper Canyon Creek-Deer Creek and Fraser Draw Hydrologic Unit Code (HUC-12) subwatersheds within the Big Horn Basin, with a small portion in the West Sage Hen Creek and Upper Diamond Springs Draw subwatersheds within the North Platte Basin (USDA-NRCS et al. 2010). These subwatersheds are not known to contain any USEPA, state, or locally designated surface water protection areas (USEPA 2011b; WDEQ 2004). The boundaries and names of subwatersheds within and near the GHPA are depicted in **Figure 3.15-1** and acreages of the GHPA within each subwatershed are tabulated in **Table 3.15-1**.

Table 3.15-1 GHPA Location and Acreage According to the Watershed Boundary Dataset

Region	Sub-region	Basin	Subbasin	Watershed	Sub-watershed (HUC-12)	Sub-watershed Acreage	Acres within GHPA
Missouri	Big Horn	Big Horn	Lower Wind	Upper Poison Creek	Upper Canyon Creek-Deer Creek (100800050301)	21,810	5,522
			Muskrat	Upper Muskrat Creek	Fraser Draw (100800040103)	39,558	2,550
	North Platte[a]	North Platte	Sweetwater	Sage Hen Creek	West Sage Hen Creek (101800060704)	23,815	300
				Sweetwater River- Crooks Creek	Upper Diamond Springs Draw (101800060605)	27,212	145

[a] No Project-related disturbance is planned within the North Platte Basin.

Surface drainage within the Upper Canyon Creek-Deer Creek Subwatershed flows toward WCC. WCC is a tributary to Canyon Creek, which is a tributary to Deer Creek, which is a tributary to Poison Creek. Poison Creek empties into Boysen Reservoir on the Wind River.

Surface drainage within the Fraser Draw Subwatershed is toward 2 tributaries within the GHPA named East and West forks of Fraser Draw. Fraser Draw is a tributary to Muskrat Creek; surface flow in West

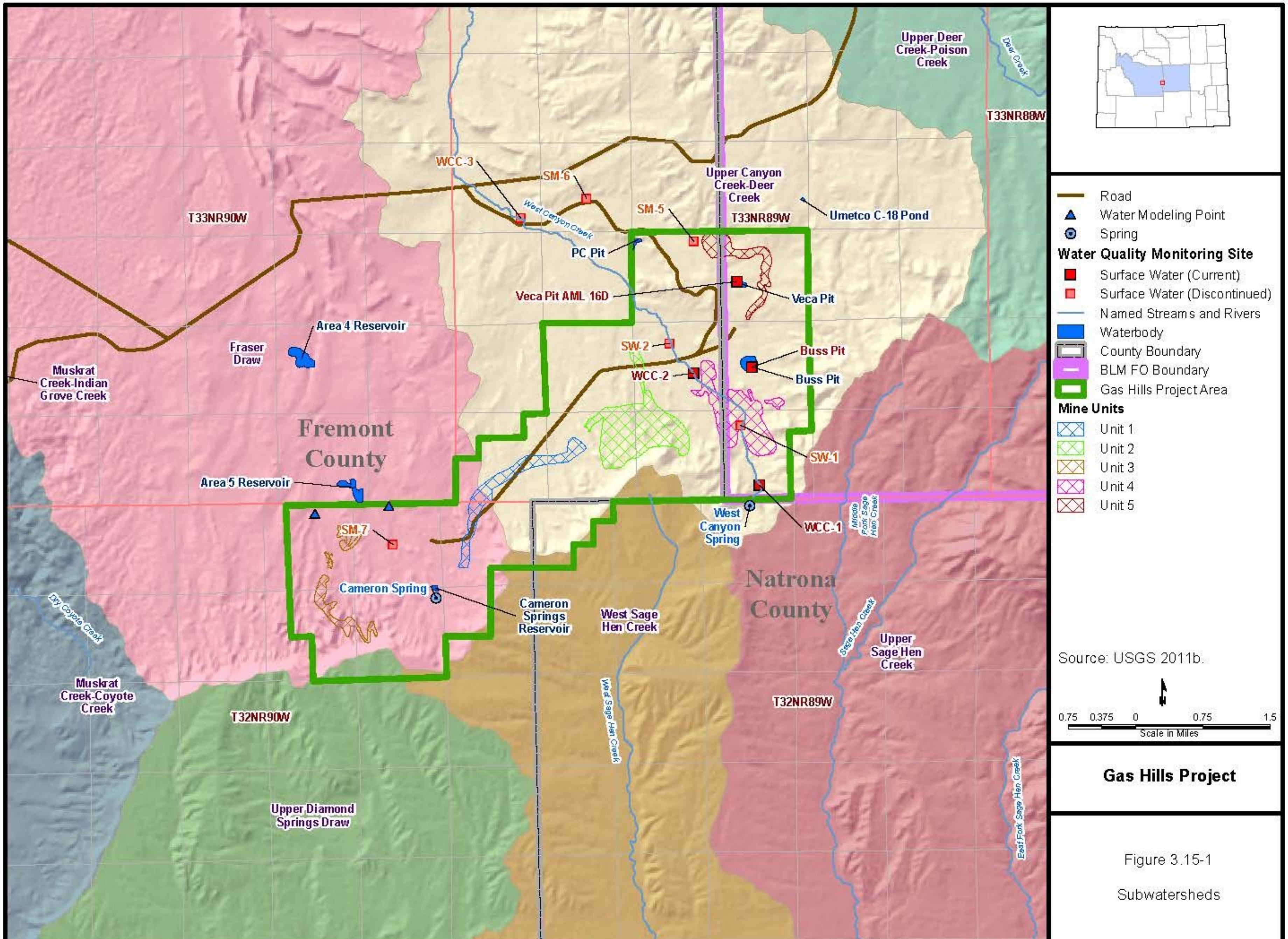


Figure 3.15-1

Subwatersheds

Fork of Fraser Draw is captured by the ***Area 5 reservoir on Area 4 reservoir,*** which ***are*** part of Pathfinder Mine's operations. Upon Pathfinder's reclamation, runoff from East Fork of Fraser Draw also will be captured by this waterbody.

No Project development would occur in the North Platte Basin (Sweetwater subbasin).

The general drainage of the GHPA is towards the northwest from headwaters located along the Beaver Rim, which runs along the southeastern boundary of the GHPA. Stream channels in the area typically are incised, with active headcutting and gully erosion occurring due to a combination of past mining disturbance, minimal vegetative cover, steep basin slopes, and non-cohesive medium- to fine-grained sand bed materials (PRI 2009).

Streams in the GHPA are classified by the National Hydrography Dataset (USGS 2011b) as all being intermittent; however, evidence through literature review and field reconnaissance indicates these waterways are generally ephemeral in nature, only flowing in response to precipitation events. Exceptions to this are associated with the upper 1.7 miles of WCC and the headwaters of the East Fork of Frasier Draw, where intermittent or perennial flows are exhibited through seasonal or year-round contributions from springs (PRI 2009). Additional stream flow information is included in the following Section 3.15.1.1, Surface Water Quantity.

Waterbodies within the GHPA include mine pits (the Buss Pit, Veca Pit, and the PC Pit), all in the Upper Canyon Creek-Deer Creek subwatershed. Neither the Buss Pit nor the PC Pit are located on stream channels; however, the Veca Pit is located at the headwaters of the East Fork of WCC. Cameron Springs impoundment also is located in the GHPA within the Fraser Draw Subwatershed and on the East Fork of Fraser Draw.

Several surface water monitoring locations have been established in the GHPA as depicted in **Figure 3.15-1**. Permanent stations have been established on WCC consisting of combination v-notch/ cipoelletti weirs; WCC-1 is located in the perennial reach downstream of the spring, and WCC-2 is where the stream becomes ephemeral. Discharge from Cameron Spring in the East Fork of Fraser Draw has been monitored by way of a 3-inch Parshall flume. Monitoring results are discussed below in the subsections on surface water quantity and quality.

Other mapped locations that have been sampled do not have permanent stations because they are located on ephemeral reaches. These locations include WCC-3 which is downstream from the northern GHPA boundary on WCC where the drainage encompasses the portion of the GHPA within the Upper Canyon Creek-Deer Creek Subwatershed. Historic sampling has occurred at numerous sites (i.e., SW-1, SW-2, SM-5, SM-6, SM-7, Buss Pit, and PC Pit) which are reported in this mine's WDEQ Mine Permit Application (PRI 2009) as well as other mine permits. Sites SM-5 and SM-6 are located on the East Fork of WCC, with SM-6 located downstream of the northern Project boundary. Sites SW-1 and SW-2 are located on WCC between WCC-1 and WCC-2, and downstream of WCC-2, respectively. Site SM-7 is located on the East Fork of Fraser Draw.

3.15.1.1 Surface Water Quantity

The upper reaches of WCC exhibit perennial flow due to spring discharge just south of the GHPA in Section 4 of T32N, R89W. Discharge from this spring was measured in 1996 at 9 gallons per minute (gpm), and perennial flow was predicted at the spring.

The headwaters of the East Fork of Fraser Draw contain Cameron Springs, where discharge has been measured at 2 to 3 gpm. The Matador Cattle Company has a permitted water right and the Cameron Springs impoundment directly downstream of this spring captures all discharge (PRI 2009). Section 3.15.3, Water Use, presents additional information on groundwater use.

All other stream reaches in the GHPA are ephemeral in nature and, therefore, only flow in direct response to precipitation events. Several hydrologic analysis points have been established and include the WCC-3 sampling location, along with sites WFD and EFD which are on the downstream GHPA boundaries of the West and East Forks of Fraser Draw, respectively. These points have been evaluated as key surface water discharge locations from the GHPA and flood volumes have been estimated based on methods for estimating stream discharge in ungauged watersheds. **Table 3.15-2** contains a tabulation of calculated stream discharge and flood volumes at the hydrologic analysis points for specific design storms (e.g., 100-year storm event).

Table 3.15-2 Flood Volumes and Stream Discharge of Recurrence Interval Design Storms

	10-Year		25-Year		50-Year		100-Year	
Analysis Point	**Volume (acre-feet)**	**Discharge (cfs)[a]**	**Volume (acre-feet)**	**Discharge (cfs)**	**Volume (acre-feet)**	**Discharge (cfs)**	**Volume (acre-feet)**	**Discharge (cfs)**
WFD	18.3	266.4	27.8	389.5	35.7	490.4	44.8	602.8
EFD-1	21.5	308.3	32.4	448.2	41.4	561.3	51.7	686.8
EFD-2	16.8	246.6	25.5	359.7	32.7	452.0	40.9	554.6
WCC-3	64.0	835.6	101.2	1,269.5	135.3	1,655.5	175.1	2,095.4
WCC-1	17.0	248.8	23.6	335.9	28.7	401.7	34.2	471.3
WCC-2	22.5	321.5	33.4	460.3	42.4	572.7	52.4	696.2

[a] cubic feet per second.

Source: PRI (2009) based on Craig and Rankl ***1977*** method.

3.15.1.2 Surface Water Quality

The Clean Water Act (CWA), Section 303(c), requires each state to review, establish, and revise water quality standards for all surface waters within the state. ***Water quality standards are the overall water quality goals set by the state for specific waterbodies. The standards consist of 3 parts: designated uses, narrative or numeric water quality criteria for specific parameters to protect the designated uses, and antidegradation policies to protect water quality.***

As noted above, surface water use classifications are established by WDEQ in compliance with the CWA. Surface waters within the GHPA are classified as 3B – Other aquatic life ***other than fish***, recreation, wildlife, agriculture, industry, scenic value. Section 303(d) of the CWA requires states to list all streams that do not meet***, or are threatened to not meet, any of their designated uses***, and are therefore considered impaired streams. None of the ***waters*** within the GHPA are listed in the 201***2*** State of Wyoming 303(d) list as a threatened or impaired stream (***WDEQ-WQD 2012***).

Surface water quality in the GHPA is acceptable for livestock and wildlife consumption. TDS concentrations are consistently below 5,000 mg/L. Wyoming's surface water standards do not limit TDS for livestock use; however, the groundwater regulations limit TDS to 5,000 mg/L for livestock use (WDEQ-WQD 2005). Metal concentrations often are below detectable limits, and otherwise generally do not exceed livestock water standards. Uranium and radium 226 occasionally have exceeded 5 mg/L and 5 pCi/L, respectively (PRI 2009). USEPA's drinking water standard for uranium and radium 226 are 0.03 mg/L and 5 pCi/L, respectively (USEPA 2001); however, because the waters in the GHPA are not classified with a drinking water use, these limits do not apply. For Class 3B waters in Wyoming, no numeric criteria for uranium are established, and the limit for radium 226 is 60 pCi/L (WDEQ-WQD 2007a).

The upper reaches of WCC, where flow is perennial, have been characterized in Cameco's mine permit documents (PRI 2009) as a high quality, calcium-bicarbonate type water that exhibits little variation during base flow conditions between up- and downstream monitoring locations or over time. TDS has ranged from 186 to 337 mg/L (USEPA drinking water secondary standard of 500 mg/L) and the mean of measured pH values is 8.1. Metals have been below detectable levels with the following exceptions; arsenic has been detected in most samples ranging from 0.004 to 0.020 mg/L (human health limit of 0.001 mg/L, not applicable to Class 3B waters [WDEQ-WQD 2007b]). Uranium concentrations have ranged from 0.01 to 0.08 mg/L. Radium 226 concentrations generally have been less than 5 pCi/L, although higher concentrations have been recorded. Cameron Spring is reported to have TDS ranging from less than 200 to a maximum of 786 mg/L and pH of 7.5 to 8.0. Site SM-7 is reported to be similar to Cameron Springs (PRI 2009).

Ponds and reservoirs in the GHPA that have recorded water quality data include the Buss Pit, Veca Pit, and PC Pit. These are all located in the northern GHPA in the Upper Canyon Creek-Deer Creek subwatershed and all contain calcium-sulfate type water with low concentrations of trace metals, some below the detection limit. The Buss Pit has recorded TDS concentrations exceeding 3,000 mg/L and pH of 3.83 standard units (s.u.) (Wyoming criteria range for Class 3B is between 6.5 and 9 s.u.). The Veca Pit has recorded TDS concentrations ranging from 547 to 1,185 mg/L, uranium concentrations ranging from 0.10 to 0.22 mg/L, and radium 226 concentrations ranging from 1.0 to 2.6 pCi/L. The PC Pit has recorded TDS concentrations ranging from 1,303 to 2,796 mg/L, uranium concentrations ranging from 0.20 to 0.56 mg/L, and radium 226 concentrations ranging from 0.9 to 2.1 pCi/L (PRI 2009).

Collection of water quality data during runoff events is scarce, but shows extreme variability. Sites SM-5 and SM-6 have TDS concentrations ranging from less than 100 to over 2,400 mg/L, with pH ranging from 3.3 to 7.6. Uranium concentrations have ranged from 0.006 to 3.2 mg/L at these sites (PRI 2009).

Radium 226 in runoff is reported to show significant variation that is not correlated to mine disturbance. Concentrations have generally been below 5 pCi/L, with 1 anomalous maximum concentration of 372 pCi/L measured at SM-7. The current monitoring sites have yielded concentrations generally below 1 pCi/L, with a high of 17.1 pCi/L measured at WCC-1 (PRI 2009).

3.15.2 Groundwater Resources

3.15.2.1 Regional Groundwater Resources

The Wind River Basin is a northwest-southeast trending structural basin bounded on the east by the Paleozoic rocks of the Casper Arch, on the west by the Precambrian rocks of the Wind River Range, on the north by the Paleozoic and Mesozoic rocks of the Owl Creek Range and the Tertiary rocks of the Absaroka Range, and on the south by the Beaver Rim and the Granite Mountains (Whitcomb and Lowry 1968). Along its axis, the Wind River Basin contains up to 30,000 feet of downfolded and faulted sedimentary rocks ranging in age from Cambrian to recent (Jensen 1972). During the Eocene, high energy streams from the Granite Mountains on the south and the bordering highlands on the west and east formed coalescing alluvial fan deposits that eventually filled the basin. The primary stratigraphic unit formed from these deposits is the Wind River Formation, which contains the uranium deposits within the GHPA.

Groundwater flow in the Wind River Formation Aquifer (Wind River Aquifer) in the south central part of the Wind River Basin (where the GHPA is located) is northwestward toward the Wind River (Whitcomb and Lowry 1968). Groundwater elevations in the south central to southeastern part of the basin range from about ***6,850*** feet amsl ***in*** the ***Gas Hills*** to 4,800 feet amsl along the Wind River. Recharge to groundwater in the Wind River Aquifer is from precipitation and mountain-front runoff from the adjacent bordering highlands of the basin. Discharge is to the Wind River and its major tributaries, the Little Wind River, and the Popo Agie River, which act as groundwater sinks for the Wind River Aquifer.

Groundwater in the Wind River Aquifer occurs under both water table (unconfined) and artesian (confined) conditions (Whitcomb and Lowry 1968). Artesian groundwater conditions are found in the Tertiary and older geologic units, while water table conditions are found in the Quaternary alluvium and in the areas of exposure of older units along the flanks of the basin.

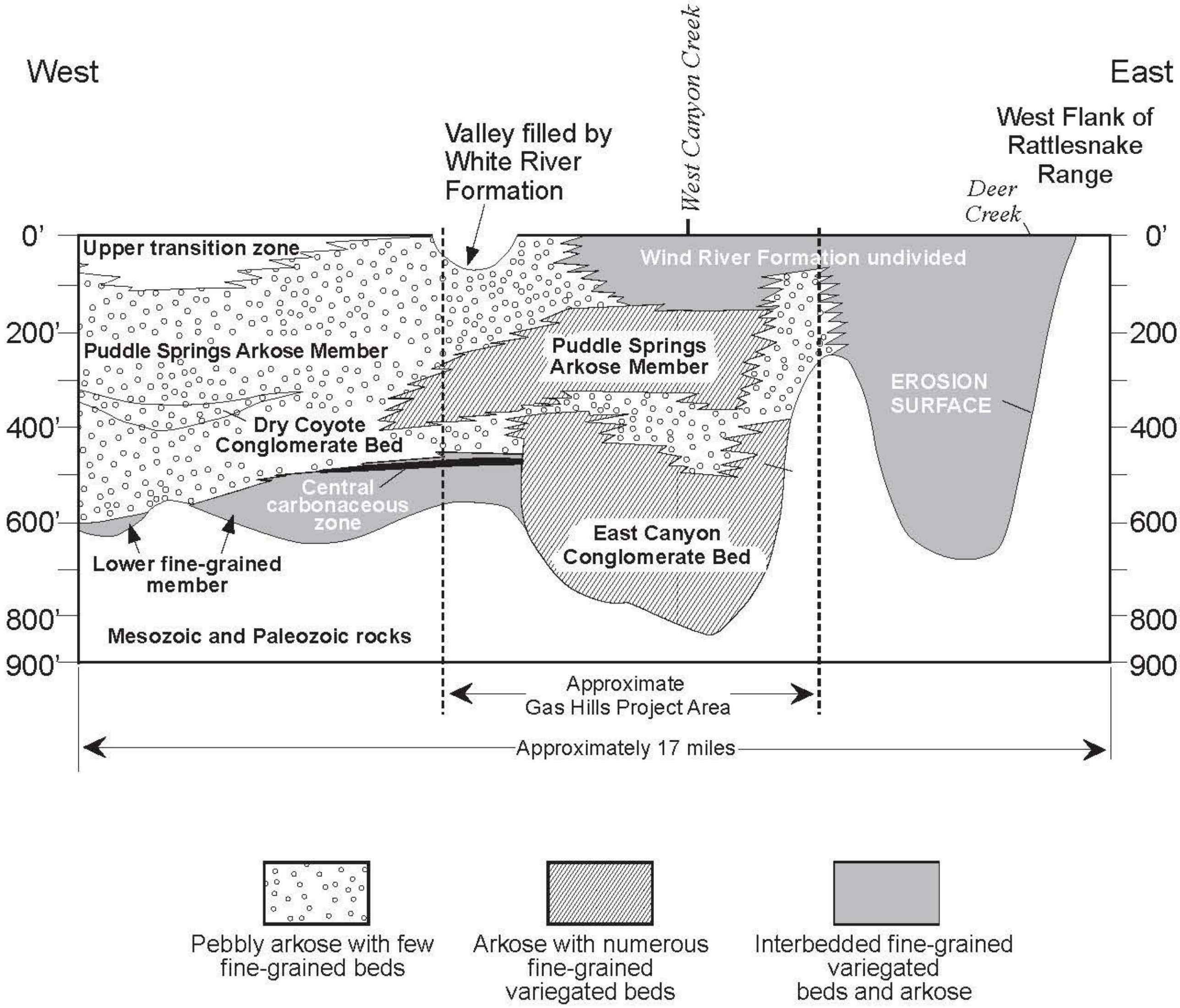
Regional water quality patterns over the Wind River Basin are presented by Whitcomb and Lowry (1968) based on sampling of springs and wells available during their evaluation of the basin. Alluvial aquifers along the Wind River, the Little Wind River, and the Popo Agie River are major sources of water in the basin. Bedrock aquifers in the Wind River Formation can yield substantial water at depths of less than 500 feet. Near the margins of the basin, Cretaceous and pre-Cretaceous units are exposed, and, thus are shallow enough for access by wells for groundwater use, depending on the well yields. In areas of fracturing, these deeper units can provide sufficient water for domestic and agricultural use. Formations that have yielded water are the Park City, Nugget, Tensleep Sandstone, and the Chugwater Formation. Water quality in all geologic units, including the alluvial aquifers, varies considerably throughout the Wind River Basin from groundwater with TDS below 1,000 mg/L to waters with elevated TDS and high sodium and sulfate.

3.15.2.2 Hydrogeology of the GHPA and Vicinity

The GHPA is located in the south central part of the Wind River Basin just north of the Sweetwater Plateau and the Beaver Rim, as shown in **Figure 3.3-1**. The uranium mined historically and the uranium to be mined under the Proposed Action are located in the Eocene Wind River Formation. This formation consists of alluvial fan deposits shed northward into the subsiding Wind River Basin as a result of erosion from the Granite Mountain highlands. This section discusses the geology and hydrogeology of the GHPA and vicinity in general.

Figure 3.3-2 illustrates the geology of the GHPA and vicinity based on mapping completed by Soister (1968) and also compiled from previous mapping in the south central part of the Wind River Basin. The Wind River Formation overlies many older formations and was deposited on these formations after considerable erosion during the Paleocene that formed deeply incised valleys. Subsequent erosion has exposed these underlying geologic units in highland areas to the north and east of the GHPA. Folding that preceded the deposition of the Wind River Formation is evident in the older units exposed in these highlands (e.g., the Gas Hills). Faulting associated with the uplift of the Sweetwater Plateau is observed south of the GHPA, and faulting associated with basin development and subsidence is evident north of the GHPA. The uranium deposits in the Wind River Formation are located, as indicated, by the numerous historic mine workings visible in **Figure 1-1**, within and just north of the GHPA.

In the GHPA and vicinity the Wind River Formation consists of 3 members: 1) a lower grayish-green to gray fine-grained siltstone and sandstone unit with carbonaceous shale and coal; 2) the Puddle Springs Arkose consisting of massive to coarse-grained conglomeratic arkosic sandstone and granite boulder conglomerate; and 3) an upper transition zone that grades into the overlying Wagon Bed Formation and contains numerous beds of tuffaceous and bentonitic mudstone (Soister 1968). **Figure 3.15-2** shows an interpretive geologic cross section along the northern boundary of the GHPA prepared by Soister (1968) based on compiled geologic mapping of the Wind River Basin. The cross section is oriented as shown in **Figure 3.3-1**, and illustrates the relationship of the lower fine-grained member and the uranium-bearing Puddle Springs Arkose. This member is up to 130 feet thick and has carbon-rich (carbonaceous) zones 5 to 15 feet in thickness.



Modified from Soister (1968).

Interpretive cross-section showing the geology of the Gas Hills District along an east-west transect, as indicated in Figures 3.3-1 and 3.3-2.

Gas Hills Project

Figure 3.15-2

Schematic Geologic Cross Section

The Puddle Springs Arkose is 400 to 800 feet thick and consists of a massive, coarse-grained conglomeratic arkosic sandstone (coarse sandstone formed by the disintegration of granite) with a granite boulder conglomerate and thin beds of feldspathic sandstone (sandstone derived from granitic-type, primary crystalline, rocks), siltstone, claystone, and carbonaceous shale. Cementing agents include clay, gypsum, limonite, calcite, jarosite, pyrite, black manganese oxides, silica, fluorapatite, and minerals containing selenium arsenic, molybdenum, and uranium (Soister 1968). The arkose is oxidized and grayish yellow above the water table, but blue, green, or gray below the water table. The Puddle Springs is host to all the uranium deposits in the GHPA and vicinity, including those to be mined under the Proposed Action. The upper transition member grades into the overlying Wagon Bed Formation and is 50 to 100 feet in thickness.

Groundwater in the Wind River Aquifer in the south central part of the Wind River Basin flows north to northwestward from the ***area just north of the*** Beaver Rim into the central part of the basin, to eventually discharge into the Wind River. In the vicinity of the GHPA, groundwater elevations in the Wind River Aquifer range from around 6,800 to 6,900 feet amsl ***just north of*** the Beaver Rim to 6,200 feet amsl north of the GHPA (**Figure 3.15-3**). This indicates that groundwater in the Wind River Aquifer flows ***northward from a recharge area north of*** the Beaver Rim to the central part of the Wind River Basin, and discharges to the Wind River and its tributaries.

3.15.2.3 Geology of the Mine Units

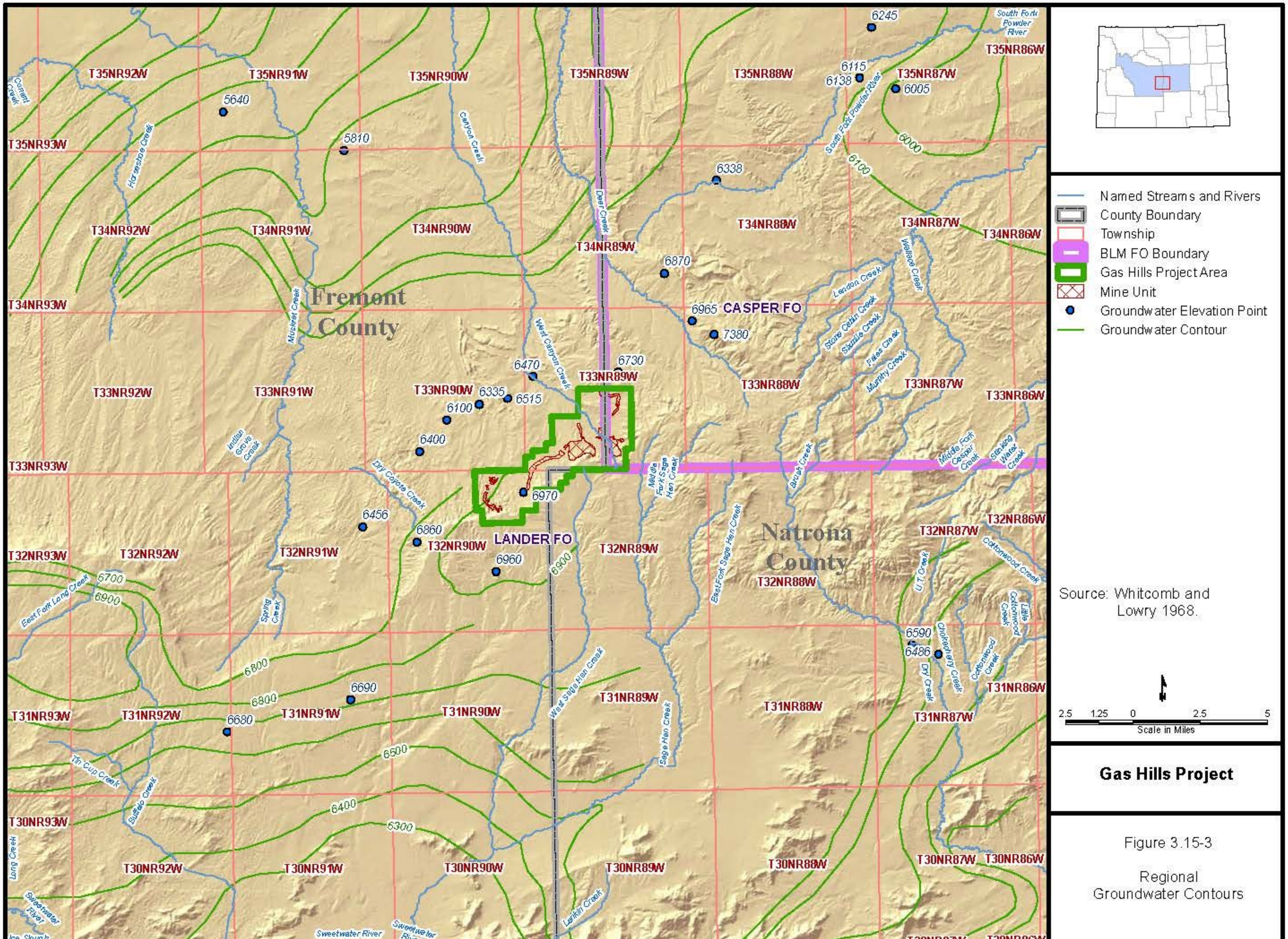
The GHPA and vicinity contains 4 separate alluvial fan depositional systems in the Wind River Formation, as shown in **Figure 3.3-4** and discussed in Section 3.3.4.1, Uranium, that contain the uranium deposits mined in the area. The uranium to be mined under the Proposed Action is located in the Puddle Springs member of the Wind River Formation, within interbedded sand and shale units. The sands are numbered in even increments of 10 and represent dark gray to greenish-gray arkosic sands with interbedded granite pebble to boulder conglomerates (PRI 2009). The sands are moderately to poorly sorted and locally contain clay and silt fractions as well as clay and siltstone interbeds. The shale units are dark gray to brownish gray and represent zones of fine-grained sandstone, claystone, and mudstone. Contacts between the sand and shale units can be sharp or gradational. Under the Proposed Action, the 30 Sand, 40 Sand, 50 Sand, 60 Sand, 70 Sand, and 80 Sand would be mined in 5 mineable units, which are discussed in more detail in the following subsections.

<u>Mine Unit 1 (Muskrat Deposit)</u>

The target for production in this ***mine unit*** is the 70 Sand, which is part of the Coyote Creek fan system. The ore zone is located in a single sand horizon with no traceable faults in the area (PRI 2009). The ore zone is located in a medium to coarse grained arkosic sand ranging in thickness from 20 to 80 feet. The mineralized sand is confined by an overlying shale unit 55 to 150 feet in thickness and an underlying shale unit 20 to 50 feet in thickness. The 50 Sand lies below the underlying confining shale unit. The 70 Sand is separated from underlying pre-Tertiary units by as much as 200 feet of Wind River Formation (PRI 2009). Two faults, the Jasper Fault and the HBow Fault, are located south of this deposit (**Figure 3.15-4**). The potentiometric surface (water level or the surface to which groundwater rises in a well that penetrates an aquifer) in the Muskrat Deposit is above the confining shales, making the mineable sand a confined aquifer.

<u>Mine Unit 2 (Bountiful Deposit)</u>

This deposit is located in multiple sands within the Canyon Creek alluvial fan depositional system: (see **Figure 3.3-4**) specifically, the 40, 50, 60, 70, and 80 Sand horizons. The sands are medium to coarse grained arkosic sandstones with cobble to boulder conglomerate interbeds. The individual sands are up to 100 feet in thickness and are separated by shale units 5 to 20 feet thick. The individual shale units separating the mineralized sands are reasonably continuous within the area to be mined but disappear east of the ***mine unit.*** The upper confining units in Mine Unit 2 consist of siltstones and claystones ranging from 75 to 400 feet in thickness. The lower confining unit, the Triassic Chugwater Formation, is



Source: Whitcomb and Lowry 1968.

Gas Hills Project

Figure 3.15-3

Regional Groundwater Contours

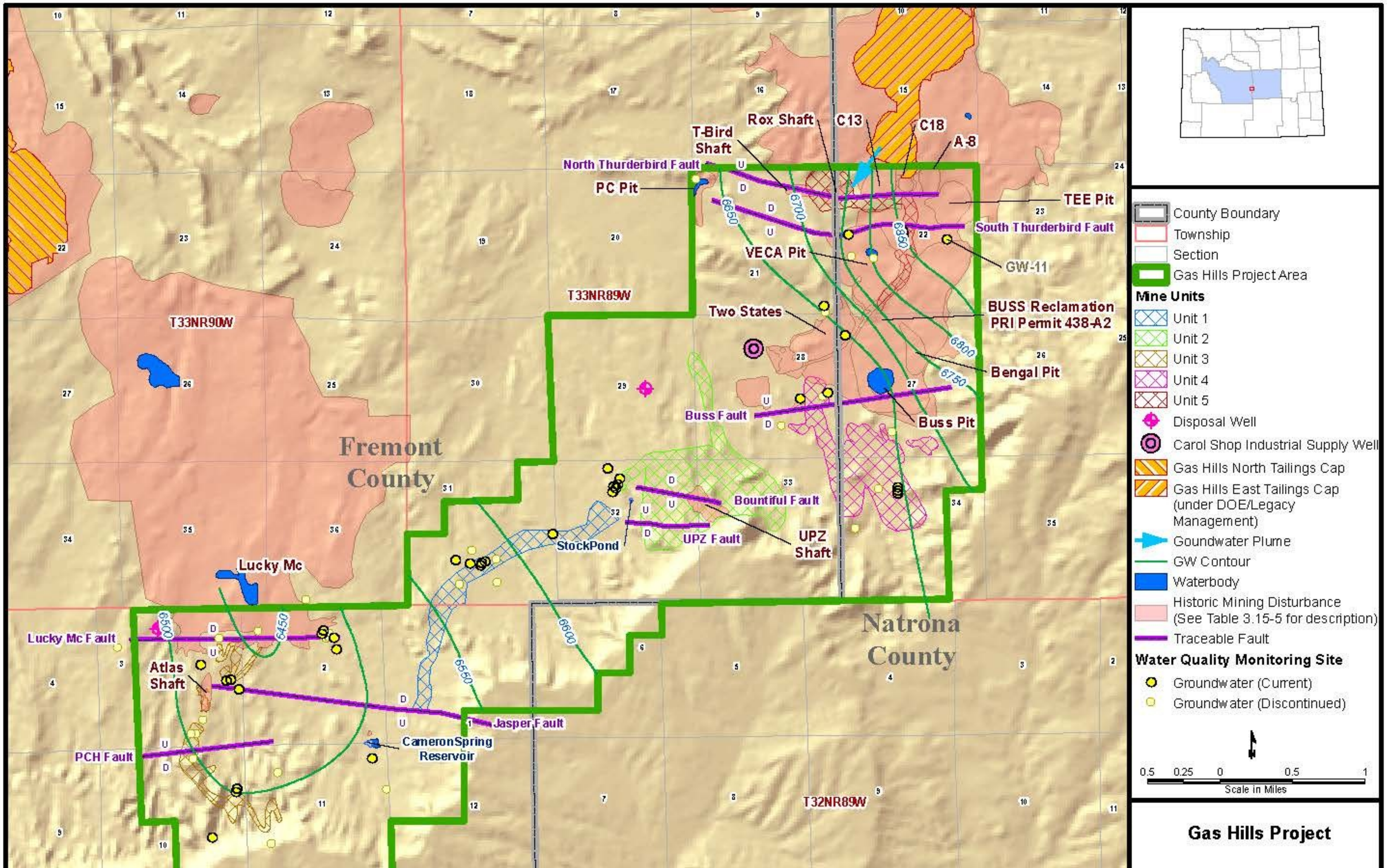


Figure 3.15-4

Groundwater Conditions and Historic Mining Sites within the GHPA dominantly shale and siltstone in the GHPA (PRI 2009). The mineable sands are part of a confined aquifer system (an aquifer in which the water is under pressure because of an impermeable layer above it that keeps it from seeking its level) with the potentiometric surface above the upper confining shales.

Two traceable faults, the Bountiful Fault and the Uranium Point Zone (UPZ) Fault, are located within this proposed ***mine unit*** (**Figure 3.15-4**). The Bountiful Fault has 40 to 50 feet of displacement, while the UPZ Fault has up to 50 feet of displacement and is known to be a groundwater flow path along part of its length (PRI 2009).

The Bountiful Deposit area has been mined historically. The UPZ shaft is located on the southern edge of this deposit. Construction on this shaft began in 1979 and was halted in 1983 by TVA. In 1983, the shaft was 14 feet in diameter and 880 feet deep with a 1-foot thick concrete liner. Pump stations to dewater the shaft were constructed at 250 and 495 feet bgs as well as a station and loading pocket located between 742 and 780 feet bgs. The pump stations are 8 feet by 8 feet by 20 feet deep and believed to be cut into siltstone and claystone confining layers (aquitards). The loading pocket and station are approximately 41 feet vertically by 12 feet wide by 40 feet deep connecting the 50 Sand with the 40 Sand (PRI 2009). The shaft was filled with broken concrete in 1991.

<u>Mine Unit 3 (Peach Deposit)</u>

This deposit is located in the western part of the GHPA in the Coyote Creek alluvial fan depositional system (see **Figure 3.3-4**) within multiple sand units. Dewatering of the Lucky Mc pit over the years has lowered the potentiometric surface in the northern part of this ***mine unit*** (PRI 2009). The ***mine unit*** contains 2 traceable faults, the PCH and the Jasper faults, and the abandoned Atlas underground mine.

The uranium deposits are located in the 30, 40, 50, and 60 Sands. The Sands are separated by confining claystones and siltstones that can range up to 30 feet thick. The 30 through 70 Sands coalesce along the northwest side of the ***mine unit*** to form a single sand horizon. The 60 Sand is not currently targeted for mining because of insufficient hydrostatic head, but this may change as groundwater recovers in the Lucky Mc open pit mine (PRI 2009). The upper confining unit is a claystone, 5 to 40 feet thick, that is reasonably continuous over the area to be mined. The lower confining units are either claystones or mudstones of the Wind River Formation, or shales of the pre-Tertiary units. The Morrison, Cloverly, Thermopolis, Muddy, Mowry, and Frontier formations make up the pre-Tertiary units, but only the Cloverly is considered an aquifer and is separated from the production sand by confining units in the Wind River Formation. The potentiometric surface in this ***mine unit*** is partially within some of the sands, making the aquifer in the sands confined to partially confined.

The Jasper Fault was evaluated with a pumping test in 1996 and shown to have a zone of high transmissivity (groundwater flow) within the ***mine unit.*** The Lucky Mc Fault, located north of the ***mine unit,*** may represent a hydrologic barrier. The Atlas underground mine, developed in the 1960s and reclaimed in the 1980s, is located in the western portion of the GHPA and involves the 30, 40, and 50 Sands. The planned injection pattern has been adjusted to exclude the Atlas Mine workings.

<u>Mine Unit 4 (Buss Deposit)</u>

The Mine Unit 4 deposit is located in multiple sand horizons in the eastern part of the GHPA. The partially reclaimed Buss Pit, an historic open pit mine, is located to the northeast and has lowered the potentiometric surface in portions of this ***mine unit.*** Sands to be mined are the 50 through 80 Sands south of the Buss Fault and the 50, 60, and possibly the 70 Sand north of the fault. The 70 and 80 Sands range in thickness from 30 to 100 feet and are separated by mudstone or siltstone interbeds, and are not always contiguous and frequently disappear allowing for coalescence of the sand units. The uppermost confining unit south of the Buss Fault ranges in thickness from 10 to 100 feet. The confining unit north of the Buss Fault is a shale above the 60 Sand that ranges from 10 to 20 feet in thickness. The 70 and 80 Sands are not confined north of the Buss Fault. The confining unit below the 50 Sand throughout this ***mine unit*** ranges from 5 to 30 feet in thickness and separates the 50 Sand from the East Canyon

Conglomerate (PRI 2009). The potentiometric surface is within the sands north of the Buss Fault, making the aquifer in the sands partially confined to unconfined. South of the Buss Fault the potentiometric surface is above the confining shales, making the aquifer in the sands confined.

Pre-Tertiary formations are not well defined in this ***mine unit*** due to lack of lithologic logs (also known as a well log) in drill holes that have penetrated the pre-Tertiary (PRI 2009). The lowest sand to be mined, the 50 Sand, rests on a confining unit above the East Canyon Conglomerate or a shale that uncomfortably overlies the Jurassic Sundance Formation.

The Buss Pit mine was partially reclaimed in 1995 and is located northeast of the planned development for this ***mine unit.*** The Buss Pit Mine extracted ore from the 60, 70, 80, and 90 Sands, and was reclaimed as a reservoir that intersects the local water table. This reservoir is fed by groundwater inflow from the Wind River Aquifer and has affected water quality in this area. The 80 and 90 Sands were mined in pits above the water table. Other open pit mines in the area, such as the Cap, Bengal, and Mars mines, have been backfilled above the water table (PRI 2009).

Mine Unit 5 (Pix Deposit)

The Mine Unit 5 deposit is located within the 50 Sand in the northeastern part of the GHPA. The reclaimed Veca open pit mine, located west of this ***mine unit,*** is backfilled above the water table. Water quality in the vicinity of the Veca pit has been affected by historic mining. The Thunderbird Mine and Rox Mine is located within the northern part of this ***mine unit.*** The potentiometric surface lies within the sands in the Pix Deposit, making the aquifer in the sands partially confined to unconfined.

The 50 Sand ranges in thickness from 50 to 70 feet and is a medium to coarse grained arkosic sand. The 60 Sand interfingers with the 50 Sand in the Pix Deposit. The upper confining unit is 15 to 40 feet in thickness while the lower confining unit ranges from 20 to 40 feet in thickness and separates the 50 Sand from the East Canyon Conglomerate. One or more faults marking the southern side of the Thunderbird Graben are located within this ***mine unit.***

This ***mine unit*** is near several historic open pit mines and reclaimed areas within the GHPA (see **Figure 2-1**) as well as an area with capped uranium tailings (Gas Hills East) (PRI 2009). The Rox and Thunderbird underground mines are located within the Thunderbird Graben and were reclaimed in the 1980s. The Pix Deposit is an area of complex faulting and past historic mining. Historic mining operations have resulted in impacts to groundwater within the GHPA, typically, elevated TDS.

3.15.2.4 Hydrogeology of the Mine Units

Groundwater in the GHPA is found mainly within the Wind River Aquifer. Of the overlying units, only the Miocene Split Rock Formation carries water and serves as an aquifer south of the Beaver Rim and outside of the GHPA (PRI 2009). Geologic units below the Wind River that serve as aquifers are the Cretaceous Cloverly, the Jurassic Nugget, and the Pennsylvanian Tensleep formations. The Cloverly and the Nugget are recharged north of the GHPA in the Dutton Basin Anticline.

Aquifer Characteristics

Within the Wind River Aquifer in the GHPA, the mineralized sands act as local water-bearing units, or local aquifers. With few exceptions, these sands serve as confined aquifers with potentiometric surfaces above the top of the sand. Cameco completed aquifer testing with single well and multi-well pumping tests in the main sand units to be mined (PRI 2009). These pumping tests were run at rates up to 20 to 25 gpm for periods up to about 40 hours. In the Muskrat Deposit, the 70 Sand was tested as well as an overlying non-mineralized sand. In the Bountiful Deposit, the 70 Sand and the underlying 50 Sand were tested along with faults in the area and a confining clay zone. For the Peach Deposit, the 30 Sand and 40 Sand were tested. In the Buss Deposit, the 50 Sand and 60 Sand were tested, and in the Pix Deposit, the 40, 50, and 60 Sands were tested because they can act as 2 aquitards. The results of the aquifer testing are summarized in **Table 3.15-3**.

Table 3.15-3 Results of Aquifer Testing

Mine Unit	Transmissivity Range (feet^2/minute)	Aquifer Thickness Range (feet)	Hydraulic Conductivity Range (feet/minute)
1	5.51×10^{-2} to 1.84×10^{-1}	57 to 65	9.67×10^{-4} to 2.83×10^{-3}
2	3.13×10^{-2} to 2.23×10^{-1}	48	6.52×10^{-4} to 4.65×10^{-3}
3	9.10×10^{-3} to 3.7×10^{-1}	30-170	5.35×10^{-5} to 6.4×10^{-3}
4	1.70×10^{-3} to 2.48×10^{-1}	45 to 287	9.2×10^{-6} to 2.76×10^{-3}
5	4.88×10^{-4} to 5.37×10^{-2}	23-170	2.87×10^{-6} to 7.16×10^{-4}

Aquifer testing also showed that in most of the mineable units, the potentiometric surface in overlying non-mineralized units is higher than the potentiometric surface in the mineable sands, indicating a downward hydraulic gradient. In the Peach Deposit, the 30, 40, and 50 Sands may be hydraulically connected to the 60 and 70 Sands. In the Buss Deposit, the 70 Sand is hydraulically connected to the 80 and 90 Sands and the 50 Sand interfingers with the East Canyon Conglomerate. In the areas where the aquifer thickness is around 100 feet or greater, the 30, 40, 50, and 60 Sands act as a single hydraulic unit. Near faults and near the Buss and Veca pits, aquifer testing is affected by these boundary conditions. In the Peach Deposit, the faults impede or constrict groundwater flow. In the Buss Deposit, leakage from faults or confining units affected the aquifer testing results. In the Pix Deposit, the overlying confining unit showed a response to pumping in the mineralized sands, suggesting hydraulic connection. This was not observed in the other mineable units (PRI 2009).

<u>Groundwater Flow in the GHPA</u>

Groundwater elevations within the mineralized zones in the GHPA suggest groundwater flow from northeast to southwest across the GHPA and approximately parallel to the Beaver Rim. The potentiometric surface ranges from 6,800 feet amsl in the Pix Deposit in the northeast portion of the GHPA to 6,200 feet amsl in the southwestern part of the GHPA. Cameco interpreted this potentiometric gradient to suggest that groundwater flows from northeast to southwest across the GHPA (PRI 2009).

Regional flow in the Wind River Aquifer is south to north with discharge at the Wind River (Whitcomb and Lowry 1968; see **Figure 3.15-3**). When potentiometric levels in the GHPA are compared with those in Whitcomb and Lowry (1968) which show potentiometric levels of 6,200 feet amsl north of the GHPA, then it becomes apparent that groundwater flows to the northwest from the GHPA. Also, groundwater flow in the Wind River Aquifer north of the GHPA discharges to Fraser Draw and WCC. Groundwater flow in the GHPA also is affected by historic mine pits that are refilling with water, such as the Veca Pit and the Buss 1 Pit. Groundwater flows into the pits ***from all directions*** and evaporates ***as*** the pit ***lake rises. These pit***s act as ***terminal sinks for*** groundwater ***due to evaporation from the pit lakes.*** Historic mine pits that were developed below the water table were subsequently reclaimed by backfilling above the water table, such as the TVA Bengal Pit, the FHP Tee Pit, and the Umetco B2/B3 and C3/C4 Pits (**Figure 3.15-4)**. ***These pits act as flow-through pits where the groundwater*** flows through the pit backfill ***and can react*** with the oxidized mine spoils used for pit backfill (PRI 2009).

<u>Groundwater Quality</u>

Groundwater quality in the Wind River Aquifer within the GHPA and vicinity varies depending on past historic mining, hydraulic communication between stratigraphic units, and hydraulic interaction between surface ***water*** and groundwater. **Table 3.15-4** presents the average values for constituents in groundwater by mine unit. ***Generally, the water quality would meet Wyoming Class III standards for livestock or agricultural use; however, radium*** concentrations above the Standards (5 pCi/L) make this water unsuitable for ***any use other than industrial.***

Table 3.15-4 Average Concentrations in Background Groundwater by Mining Unit, Upper Wind River Aquifer, Fall 1996-Fall 1997

Constituent	Units	Wyoming Class III Standards[a]	Mine Unit 1	Mine Unit 2	Mine Unit 3	Mine Unit 4	Mine Unit 5
Alkalinity	mg/L	--[f]	231	245	172	184	187
Ammonium	mg/L	--[f]	0.2	0.2	0.3	0.1	0.1
Bicarbonate	mg/L	--[f]	282	293	197	225	228
Calcium	mg/L[b]	--[f]	69	69	64	129	408
Carbonate	mg/L	--[f]	0.1	3.8	5.1	0.1	0.1
Chloride	mg/L	2,000	18	11	20	7	61
Conductivity	µmhos/cm[c]	--[f]	943	881	1,278	879	2,088
Fluoride	mg/L	--[f]	1	1.1	0.8	1	1
Magnesium	mg/L	--[f]	15	13	14	25	74
Manganese	mg/L	--[f]	0.06	0.1	0.02	0.07	0.4
Potassium	mg/L	--[f]	16	12	16	17	26
Radium	pCi/L[a]	5	705	114	136	304	65
Ore Zone Radium[f]	pCi/L	5	1,277	136	434	939	333
Silica	mg/L	--[f]	17	17	13	34	21
Sodium	mg/L	--[f]	116	114	194	31	40
Sulfate	mg/L	3,000	236	219	451	298	1,102
Uranium	mg/L	--[g]	0.01	0.05	0.04	0.01	0.09
Ore Zone Uranium[f]	mg/L	--[g]	0.02	0.06	0.11	0.01	0.01
Zinc	mg/L	25	0.01	0.01	0.01	0.01	0.02
pH	s.u.[e]	6.5-8.5	8.1	8.1	8.4	7.9	7.7
TDS	mg/L	5,000	623	573	863	660	1,887

[a] *Included as a comparison for assessing potential impacts.*

[b] *Groundwater meets Wyoming Class III standards. Applicable values are milligrams per liter.*

[c] *Micro-ohms per centimeter.*

[d] *Picocuries per liter.*

[e] *Standard units.*

[f] *No standard.*

[g] *The standard is in pCi/L; no direct comparison to mg/L.*

Source: Table D6-33 in PRI 2009; WDEQ-LQD 2005a (Standards, Guideline 8).

On a regional basis, groundwater in the GHPA and vicinity is dominated by sulfate due to the presence of gypsum and other secondary sulfate minerals in the sand units. In the eastern part of the GHPA, groundwater is usually dominated by calcium sulfate due to the presence of historic workings and their influence on groundwater quality (PRI 2009). In the western part of the GHPA, with fewer historic mine workings, the groundwater tends to be sodium bicarbonate-sulfate water. In areas where water infiltrating through overlying geologic units has affected groundwater quality in the Wind River Formation, the water tends to be dominated by bicarbonate. WCC, for example, has calcium bicarbonate water and Cameron Spring has water dominated by sodium bicarbonate that is derived from the Wagon Bed Formation (PRI 2009). Groundwater in the GHPA and vicinity is generally within the Wyoming Class III water standards, except for radionuclides. Historic mine workings that affect groundwater quality are summarized in **Table 3.15-5**.

Within the GHPA, the Muskrat Deposit and Bountiful Deposit are the least affected by historic mine workings and show groundwater dominated by bicarbonate with elevated sulfate that is approximately equal to bicarbonate. Sodium concentrations are greater than calcium, making the groundwater sodium bicarbonate – sulfate water. Background groundwater quality ranges for TDS, uranium, and radium are provided below:

- The TDS is in the range of 500 to 700 mg/L;
- Background uranium ranges from 0.01 to 0.05 mg/L; and
- Background radium ranges from 114 to 705 pCi/L.

The Peach Deposit has sulfate greater than bicarbonate and sodium greater than calcium, making the groundwater sodium sulfate water. TDS has an average value of 863 mg/L, reflecting the increase in sulfate. The Buss Deposit and the Pix Deposit have calcium sulfate water. Background groundwater quality ranges for TDS, pH, and uranium are provided below:

- The TDS values range from 660 mg/L and 1,887 mg/L, respectively;
- The pH values in ***mine units*** 4 and 5 is below 8.0 s.u., while the pH in ***mine units*** 1, 2, and 3 is above 8.0 s.u.; and
- Background uranium in the Pix Deposit is 0.09 mg/L, which is higher by a factor of 2 compared to other deposits.

In general, radium concentrations in groundwater are higher in the southwestern part of the GHPA and uranium concentrations in groundwater are higher in the northeastern part of the GHPA. TDS and calcium decrease from west to east across the GHPA, while sodium and bicarbonate increase from west to east (PRI 2009).

Mine Unit 5 shows the effect of reclaimed historic pits that are currently acting as flow-through pits and altering the chemistry of the groundwater. This has been demonstrated by monitoring well GW-11. Sampling of this well in 1981 and 1982 showed a calcium sulfate water with TDS ranging from 508 to 532 mg/L and sulfate in the range of 276 to 308 mg/L. Sampling of this well in 1996 and 1997 by Cameco showed TDS values ranging from 1,350 to 1,450 mg/L and sulfate in the range of 650 to 741 mg/L, suggesting contamination of groundwater in the Wind River Aquifer by historic workings in the vicinity of Mine Unit 5 (PRI 2009).

Mine Unit 4 may have evidence of mixing of surface ***water*** and groundwater, or mixing of deep and shallow groundwater. Characterizations of the sands in the vicinity of the ***mine unit*** suggests a mixing of deep sulfate waters from geologic units such as the East Canyon Conglomerate, or the 40, 50, 60, and

Table 3.15-5 Historic Workings Table

Name	Location	Name of Disturbance	Status of Disturbance
UPZ Shaft	Mine Unit 2	Underground Mine Shaft	Reclaimed 1991, TVA Permit #438
Pathfinder Lucky Mc Area 4 Pit and Spoils	North of Mine Unit 3	Pit Open to Water Table, and Associated Spoils	Reclaimed as Groundwater-Fed Impoundment by Pathfinder, Permit 356C
Atlas Mine Workings	Mine Unit 3	Underground Mine Workings Approximate Bottom Elevation 6,400 feet	Surface Reclamation, 1989, AML Project 16C
Buss Pit and Spoils	Northeast of Mine Unit 4	Buss I, II, III, and Cap Pits and Associated Spoils	Reclaimed as Groundwater-Fed Impoundment, 1995 by PRI, Permit 438
Bengal Pit and Spoils	Northeast of ***Mine Unit*** 4	Open Pit and Associated Spoils	Reclaimed as Backfill, 1988-1991 by TVA, Permit 438
Two States Pit and Spoils	North of Mine Unit 4	Open Pit and Underground Workings, Bottom Elevation 6,670 to 6,700 feet Above Water Table	Future AML Project 161
Veca Pit and Spoils	South and West of ***Mine Unit*** 5	Open Pit and Associated Spoils	Reclaimed as Surface Water Impoundment, 1989, AML Project 16D
Tee Pit	East of Mine Unit 5	Open Pit and Spoils	Backfilled, Reclaimed 1989, AML Project 16E
A-8	Northeast of Mine Unit 5	Open Pit and Spoils, Underground Workings	Backfilled, Reclaimed 1989, AML Project 16E
C-13	Northeast of Mine Unit 5	Open Pit and Spoils	Backfilled, Reclaimed Pre 1988 by Umetco, Permit 349C
C-18	North of Mine Unit 5	Open Pit and Associated Spoils	Future AML Project
Rox Shaft	West of Mine Unit 5	Underground Mine Workings, Ion-Exchange Facility	Surface Reclamation, 1989, AML Project 16C
Thunderbird Shaft	West of Mine Unit 5	Underground Mine Workings	Surface Reclamation, 1989, AML Project 16C
PC Pit	West of Mine Unit 5	Open Pit and Spoils	Reclaimed Groundwater-Fed Impoundment, 1991, AML Project 16F

Locations of Disturbances Shown on Plates D6-1 and D6-3 of the WDEQ application (PRI 2009).

70 Sands, with bicarbonate dominated surface water or water from shallow parts of the Wind River Aquifer. This intercommunication between aquifer units or groundwater and surface water may be due to movement of water along the Buss Fault or hydraulic intercommunication between sand units (PRI 2009).

Sampling of historic pits by Cameco has shown that water in the Veca Pit has elevated uranium and radium (PRI 2009). The water is dominated by calcium sulfate. The PC Pit has elevated uranium and radium. The water is calcium-magnesium–sodium sulfate water. The water in Buss 1 Pit Lake is calcium sulfate dominated. Additional water quality sampling data for the pits and monitoring wells near the Veca Pit are provided in **Table 3.15-6**.

Table 3.15-6 Water Quality Within Historic Pits

Monitoring Location	Low Range	High Range
Veca Pit		
TDS	614 mg/L	1,190 mg/L
Sulfate	344 mg/L	808 mg/L
Bicarbonate	<100 mg/L	---
pH	7.6	7.9
Monitoring Wells near Veca Pit		
TDS	2,660 mg/L	2,710 mg/L
Sulfate	1,410 mg/L	1,641 mg/L
Calcium	505 mg/L	580 mg/L
Selenium	0.08 mg/L	0.097 mg/L
Uranium	0.05 mg/L	0.09 mg/L
Radium	---	22.2 pCi/L
PC Pit		
TDS	1,280 mg/L	2,940 mg/L
Sulfate	1,750 mg/L	1,980 mg/L
pH	7.6	7.9
Buss Pit		
TDS	2,540 mg/L	3,080 mg/L
Sulfate	1,678 mg/L	2,100 mg/L
Selenium		0.01 mg/L
Uranium	---	0.11 mg/L
Radium	1.8 pCi/L	3.7 pCi/L

Source: PRI 2009.

In addition to groundwater quality impacts from historic mining activities, groundwater quality in the GHPA has been impacted by past milling activities to the north of Mine Unit 5. As discussed in Section 2.1.2.1, Historic Mining, an area with historic uranium mill tailings has been reclaimed and capped (Gas Hills East). Seepage from these tailings continues to impact groundwater (DOE 2010) including a plume of elevated metals and radionuclides that extends about 1,000 feet southwest of the cap (**Figure 3.15-4)**. Mine Unit 5 currently lies on the leading edge of this contaminant plume which is moving at an average rate of 36 feet per year (maximum flow rate of 102 feet per year; DOE 2010). The distance across Mine Unit 5 along the flow path of the southwest flow system is about 1,000 feet, suggesting that over the next 27 years, the plume may be located within Mine Unit 5.

In summary, groundwater quality ***of the mine units*** in portions of the GHPA is affected by the presence of historic workings and the effects of past mining and milling activities on groundwater. Reclaimed ***mine*** pits ***that act*** as flow-through pits ***for groundwater can alter*** groundwater quality ***due*** to reaction with mine spoils ***in the*** pit backfill. Faults ***and historic mine workings may*** allow communication of groundwater between sand units in the Wind River Aquifer ***and with surface water.*** Overlying geologic units may contribute infiltrating water to the sand units and increase the bicarbonate content ***of the groundwater.*** Each mine unit in the GHPA has a distinctive signature to groundwater quality that reflects the mineralogy of the sand units, geologic structures, ***influence from past mining activities,*** and hydraulic communication between sand aquifers.

3.15.2.5 Hydrogeology Below the Mine Units

Deeper potential bedrock aquifers in the GHPA and vicinity are shown in Table 3.15-7 and include the Frontier, Muddy, Cloverly, Morrison, Nugget, Phosphoria, Tensleep, Amsden, Madison, and Flathead aquifers (Taucher et al. 2012). Aquifers are considered major, minor, or marginal aquifers based on the amount of water they can produce. Some of the aquifers listed are considered major aquifers because, they have the potential to provide large amounts of good quality water and commonly flow in the aquifers is enhanced by natural fractures and the quality of water decreases with depth, but there are exceptions. Taucher et al. (2012) did not define what constitutes relative good or poor quality, but water can be used for agricultural purposes until the salinity reaches about 2,000 mg/L. Major aquifers in the GHPA are the Nugget, Tensleep, Madison, and Flathead aquifers. With a few exceptions, minor aquifers have yields less than 50 gpm and water quality ranges from good to poor. Minor aquifers in the GHPA consist of the following hydrogeologic units: Frontier, Cloverly, Morrison, Sundance, and Phosphoria. Confining units hold water within the aquifer, and generally are composed of rocks that have very low permeability and transmit water at low rates. These kinds of rocks are referred to as aquitards and it is commonly assumed that aquitards do not transmit large volumes of fluids. If the flow trhough aquitards is high enough, these aquitards are referred to "leaky confining units" (Taucher et al. 2012). Occasional porous and permeable sandstone or limestone layers are present in the confining units and constitute some of the marginal aquifers. Marginal aquifers have very low flow rates of about 1 to 5 gallons per minute, but water quality can be sufficient for domestic and agricultural uses. Marginal aquifers associated with a confining unit in the GHPA are the Crow Mountain and Red Peak members of the Chugwater aquifer. Another marginal aquifer is the Amsden aquifer. It is considered a marginal aquifer because it is not a common a source of water and little is known about it compared to the prolific Madison aquifer (Taucher et al. 2012).

Generally, groundwater flow in these bedrock aquifers is from the recharge areas that surround the Wind River Basin to the center of the basin (Taucher et al. 2012). Commonly, the quality of the groundwater is better at shallower depths near the recharge areas with generally decreasing quality in deeper areas. However, good water quality can occur in deep wells far from the outcrop recharge areas if there is sufficient permeability to allow strong flow to occur as in case of natural fracture systems or karst development.

Table 3.15-7 Bedrock Lithostratigraphic Units and Hydrogeologic Units, Wind River Basin

Era	System	Series	Lithostratigraphic Unit	Hydrogeologic Unit	Description
Mesozoic	Cretaceous	Upper	Frontier Formation	Frontier aquifer	Minor aquifer
			Mowry Shale	Mowry confining unit	Major aquitard
		Lower	Muddy Sandstone	Muddy Sandstone unit	Not defined.
			Thermoplis Shale	Thermopolis confining unit	Major aquitard
			Cloverly Formation	Cloverly aquifer	Minor aquifer
	Jurassic	Upper	Morrison Formation	Morrison confining unit	Minor aquifer
	Jurassic	Upper-Middle	Sundance Formation	Sundance aquifer	Minor aquifer
	Jurassic-Triassic		Nugget Sandstone	Nugget aquifer	Major aquifer
	Triassic	Upper-Lower	Chugwater Group	Popo Agie confining unit	Marginal aquifer
				Crow Mountain aquifer	
				Alcova confining unit	
				Red Peak Aquifer	
	Triassic	Lower	Dinwoody Formation	Dinwoody confining unit	Marginal aquifer
Paleozoic	Permian		Phosphoria Formation	Phosphoria aquifer and confining unit	Minor aquifer
	Pennsylvanian	Middle	Tensleep Sandstone	Tensleep aquifer	Major aquifer
		Lower	Amsden Formation	Amsden aquifer	Marginal aquifer
	Mississippian	Lower	Madison Limestone	Madison aquifer	Major aquifer
	Cambrian	Upper	Gallatin Limestone	Gallatin confining unit	Minor aquifer
		Middle	Gros Ventre Formation	Gros Ventre confining unit	Minor aquifer
			Flathead Sandstone	Flathead aquifer	Major aquifer
Precambrian			Precambrian rocks	Precambrian basal confining unit	Major aquitard

Source: Adapted from Taucher et al. 2012.

Aquifers that have potential as water supplies or as candidates for injection disposal in the GHPA are the Cloverly, Morrison, Nugget, Phosphoria, Tensleep, Madison, and Flathead aquifers. Table 3.15-8 lists these aquifers and TDS data provided by Taucher et al. (2012). The samples were collected as environmental samples or produced water samples from oil fields from wells throughout the Wind River Basin and do not necessarily represent the quality of water in these aquifers in the GHPA and vicinity. For comparison purposes, the analytical results from water samples from the proposed disposal wells drilled by Cameco also are displayed in the table. The analytical results show a broad range of TDS concentrations with the oil field samples showing the highest values and variability, although some of the oil field samples have relatively low values, indicating probable flushing of poorer quality water due to good porosity and permeability connections to recharge areas and indicating likely hydrodynamic flow conditions.

Table* 3.15-8 *Water Quality Based Potential Injection Disposal Candidate Aquifers in GHPA

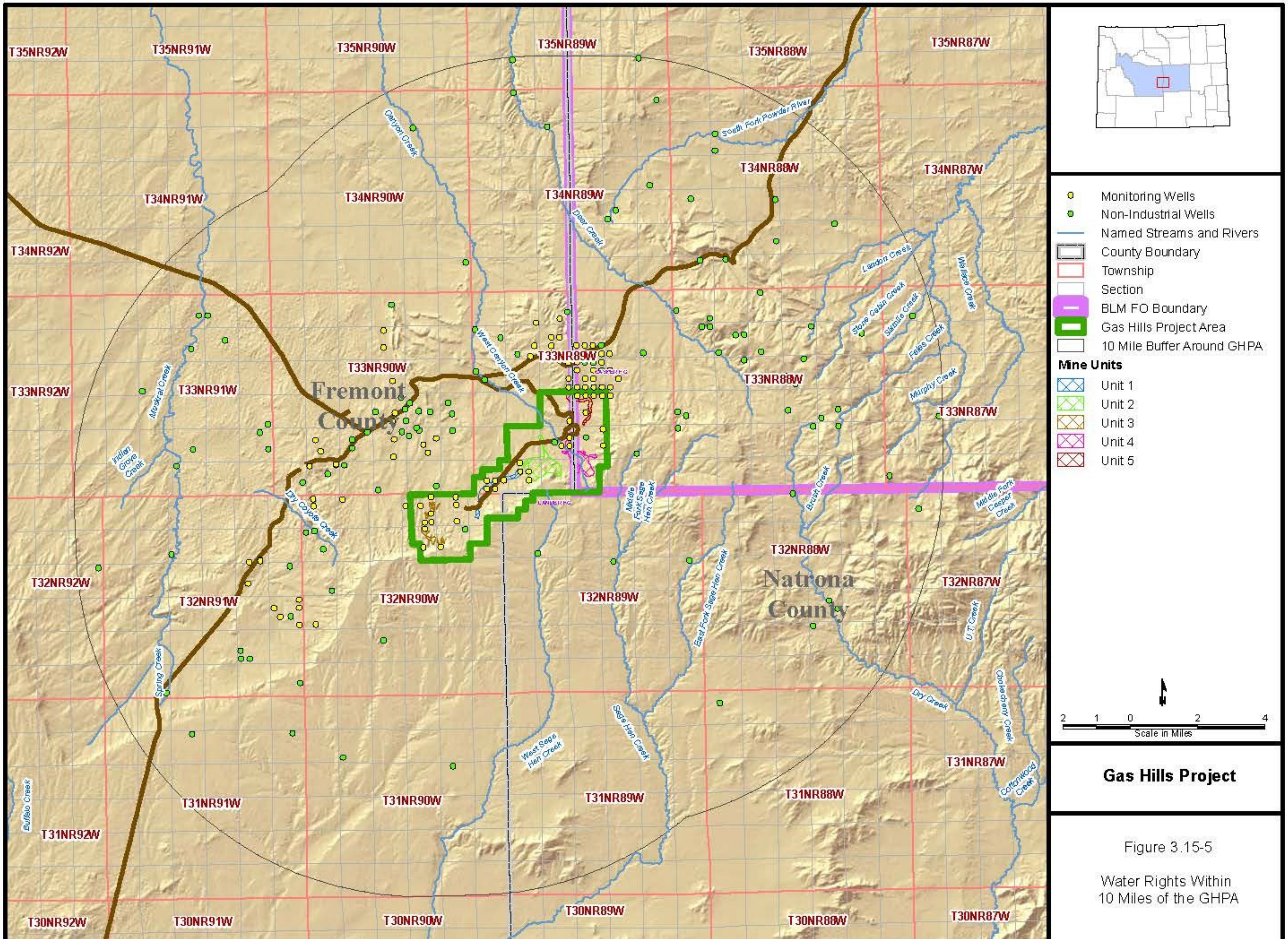
Aquifer	*TDS Non-oil field (mg/L)*	*TDS Produced Water (mg/L)*	*Gas Hills #1 and #2 (mg/L)*
Cloverly	*214 to 1,500*	*1,110 to 30,000*	*--*
Morrison	*867 and 1,740*	*1,090 to 12,000*	*--*
Nugget	*272 and 1,470*	*1,200 to 217,000*	*--*
Phosphoria	*215 to 4,030*	*372 to 155,000*	*--*
Tensleep	*146 to 1,060*	*167 to 25,600*	*--*
Madison	*181 to 920*	*291 to 30,600*	*--*
Flathead	*37 and 228*	*2,590*[a]	*3,080 and 3,220*

[a] *One sample.*

Source: Subsurface Technology 2012; Taucher et al.. 2012.

3.15.3 Water Use

Water use is administered by the Wyoming State Engineer's Office (WSEO). **Table *3.15-9*** tabulates the water rights (for both surface water and groundwater) within 10 miles of the GHPA. Locations of these ***water rights*** are shown in **Figure 3.15-5**. Water rights with a Certificate Record book/page number below the permit number are an adjudicated, or finalized, water right. No public water supply wells or intakes are within the GHPA. Currently permitted water use in the GHPA is limited to livestock and wildlife watering, and miscellaneous uses which are related to the mining activity in the area, including ***the industrial*** water supply at the Carol Shop facility. The majority of the water right permits within the GHPA are held by PRI, with several by BLM, and 1 each by Umetco Minerals Corporation and Matador Cattle Company. The water permits identified as reservoirs are located in depressions left by previous mine operations that have filled with water.



Gas Hills Project

Figure 3.15-5

Water Rights Within 10 Miles of the GHPA

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P181094.0W	Carlson Grant	Meeks Ridge L2B4	205	DOM_GW	T13N	R117W	S25	SE¼SW¼
P11378.0W	USDOI - BLM	Barlow Well #4103	100	STK	T31N	R88W	S6	SE¼NW¼
P63385.0W	USDOI - BLM	West Diamond Project #4548	290	STK	T31N	R90W	S8	SW¼SW¼
P63386.0W	USDOI - BLM	Agate Butte Project #4550	235	STK	T31N	R90W	S14	NW¼NW¼
P77596.0W	Baker, DVM James D./ USDOI - BLM	West Diamond Well #2	340	STK	T31N	R91W	S12	NW¼NE¼
P64313.0W	USDOI - BLM	Beaver Rim #5093	280	STK	T31N	R91W	S9	NW¼NE¼
P179702.0W	Lola James R. and Angela M.	Wet 2	176	DOM_GW	T32N	R72W	S24	NW¼NW¼
P107493.0W	Street Jerry & Judy	Street Spring #2	1	STK	T32N	R87W	S06	NE¼SW¼
P62782.0W	France Joe	F 2	435	STK	T32N	R88W	S04	NW¼NE¼
P62783.0W	France Joe	F 33	278	STK	T32N	R88W	S22	SW¼NE¼
P62824.0W	USDOI - BLM/France Joe	33-6	271	STK	T32N	R88W	S27	NW¼NW¼
P3021.0W	France Eva l.	Circle Bar #1	120	DOM_GW	T32N	R88W	S22	NE¼SE¼
P46376.0W	Matador Cattle Co.	Sage Hen #4	5	STK	T32N	R89W	S13	NW¼NE¼
P46377.0W	Matador Cattle Co.	Sage Hen #3	2	STK	T32N	R89W	S15	NE¼NW¼
P49333.0W	Matador Cattle Co.	Barrel Springs #1	4	STK	T32N	R89W	S08	SW¼SW¼
P34024.0W	Pathfinder Mines Corp.	GR-1	193	MIS	T32N	R90W	S07	NW¼NW¼
P44457.0W[a]	Matador Cattle Co.	Cameron Springs #1	4	STK	T32N	R90W	S11	NE¼NE¼
P45504.0W	USDOI - BLM	West Diamond #2	0	STK	T32N	R90W	S28	SE¼NW¼
P46382.0W	Matador Cattle Co.	Wild Horse #1	4	STK	T32N	R90W	S18	SE¼SE¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P47062.0W	Pathfinder Mines Corp	West Gas Hill Mine Sump	350	IND_GW; MIS	T32N	R90W	S07	NE¼NW¼
P49123.0W	Matador Cattle Co.	Wild Horse #2	85	STK	T32N	R90W	S18	SE¼SE¼
P93946.0W	USDOI - BLM	PWR #107 Spring(178)	-1	STK	T32N	R90W	S07	NW¼SE¼
P38624.0W	American Nuclear Corp.	Peach #6	460	MIS	T32N	R90W	S03	SE¼SE¼
P102706.0W	Mcintosh Jennifer Ann/ Joe E.	32-32-91	120	STK	T32N	R91W	S32	SE¼SE¼
P105282.0W	USDOI - BLM	Day Loma Pit Well #1	225	MIS	T32N	R91W	S24	NW¼SE¼
P46383.0W	Matador Cattle Co.	Mud Springs #1	4	STK	T32N	R91W	S26	NW¼SW¼
P49124.0W	Matador Cattle Co.	Coyote Springs #2	190	STK	T32N	R91W	S13	NW¼NE¼
P50224.0W	The Matador Cattle Company/Wyoming State Office of Lands & Investments	Adams #1	400	STK	T32N	R91W	S36	NE¼SE¼
P93756.0W	USDOI - BLM	Mud Spring	-1	STK	T32N	R91W	S26	SE¼SW¼
P93895.0W	USDOI - BLM	No Name Spring #17	-1	STK	T32N	R91W	S26	SE¼SW¼
P176489.0W	Hancock William and Ada	Sherlock #1	60	STK	T32N	R91W	S09	SW¼SW¼
P169222.0W	USDOI - BLM/Clark Mike	S Muskrat Well Section 13	0	STK	T32N	R92W	S13	NE¼NE¼
P129109.0W	Backus Jay	Six Mile #1	60	DOM_GW; STK	T33N	R87W	S06	SE¼SE¼
P171548.0W	Garnier III Ira J.	Garnier #5	2	DOM_GW; STK	T33N	R87W	S31	NW¼SW¼
P22948.0P	USDOI - BLM	Murphy Creek Well #1	1,130	STK	T33N	R87W	S20	SW¼SE¼
P71756.0W	Clear Creek Cattle Co.	Lesmeister Spring	5	STK	T33N	R88W	S23	SW¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P71757.0W	Clear Creek Cattle Co.	Little Cross L #1 Spring	4	STK	T33N	R88W	S06	NW¼SW¼
P71759.0W	Clear Creek Cattle Co.	French Rocks #1 West	5	STK	T33N	R88W	S09	SE¼SW¼
P71761.0W	Clear Creek Cattle Co.	East Slope #1	5	STK	T33N	R88W	S04	NE¼NW¼
P71763.0W	Stroecker Anna	Stroecker Spring	5	STK	T33N	R88W	S15	SE¼SW¼
P71764.0W	USDOI - BLM/Clear Creek Cattle Co.	Government #1 West (Rattlesnake)	5	STK	T33N	R88W	S06	SE¼ SE¼
P71765.0W	USDOI - BLM/Clear Creek Cattle Co.	Government #2 East (Rattlesnake)	4	STK	T33N	R88W	S15	NW¼ NE¼
P37858.0W	Allison Velda	Allison #4	20	DOM_GW	T33N	R88W	S22	NW¼SW¼
P44796.0W	Matador Cattle Co.	Rattlesnake #1	2	STK	T33N	R88W	S07	NE¼NE¼
P44797.0W	Matador Cattle Co.	Rattlesnake #2	4	STK	T33N	R88W	S08	SE¼ NE¼
P44799.0W	Matador Cattle Co.	Rattlesnake #4	5	STK	T33N	R88W	S08	SW¼SW¼
P44801.0W	Matador Cattle Co.	Rattlesnake #6	4	STK	T33N	R88W	S23	NW¼ SE¼
P44802.0W	Matador Cattle Co.	Rattlesnake #7	-4	STK	T33N	R88W	S27	NE¼ NE¼
P46384.0W	Matador Cattle Co.	Holiday #1	5	STK	T33N	R88W	S19	SW¼SW¼
P46387.0W	Matador Cattle Co.	Little X-L #1	2	STK	T33N	R88W	S06	NW¼SW¼
P94133.0W	USDOI - BLM	Upper Mac Spring	-1	STK	T33N	R88W	S30	NW¼NW¼
P94134.0W	USDOI - BLM	Spring #7	-1	STK	T33N	R88W	S19	NW¼SW¼
P22949.0P	USDOI - BLM	Six Mile Well #1	708	STK	T33N	R88W	S12	SE¼NW¼
P196585.0W	Backus Jay	Backus #10	0	DOM_GW; STK	T33N	R88W	S10	NE¼NE¼
P94135.0W	USDOI - BLM	Spring #8	-1	STK	T33N	R88W	S19	SW¼SW¼
P71760.0W	Clear Creek Cattle Co.	French Rocks #2 East	4	STK	T33N	R88W	S15	NW¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P44800.0W	Matador Cattle Co.	Rattlesnake #5	3	STK	T33N	R88W	S17	NE¼NE¼
P71758.0W	Clear Creek Cattle Co.	Mckenzie Spring	5	STK	T33N	R88W	S19	SW¼SW¼
P44795.0W	Matador Cattle Co.	Mckenzie Bogs #1	4	STK	T33N	R88W	S26	NW¼NE¼
P71768.0W	Clear Creek Cattle Co.	Lybyer #1	3	STK	T33N	R88W	S15	NW¼SW¼
P71755.0W	Clear Creek Cattle Co.	Cross L #2 Spring	3	DOM_GW; STK	T33N	R88W	S07	NW¼NE¼
P44798.0W	Matador Cattle Co.	Rattlesnake #3	5	STK	T33N	R88W	S08	SW¼NE¼
P102340.0W	USDOI - BLM/Union Carbide Corp.	Guard Well 3b	0	IND_GW; MIS	T33N	R89W	S04	NE¼SE¼
P67075.0W	USDOI - BLM/Clear Creek Cattle Co.	Beaver Rim #2	159	STK	T33N	R89W	S15	SE¼SW¼
P71766.0W	Umetco Minerals Corp.	MWC-34	10	MIS	T33N	R89W	S27	NE¼NE¼
P82563.0W	Umetco Minerals Corp.	MWC-35	200	MIS	T33N	R89W	S15	NE¼NW¼
P82564.0W	Umetco Minerals Corp.	MWC-36	190	MIS	T33N	R89W	S10	SE¼SW¼
P82565.0W	Umetco Minerals Corp.	MWC-42	200	MIS	T33N	R89W	S10	SE¼SW¼
P83269.0W	Umetco Minerals Corp.	MWC-45	240	MIS	T33N	R89W	S10	SE¼SW¼
P84751.0W	Umetco Minerals Corp.	MWC-47	240	MIS	T33N	R89W	S15	NW¼NE¼
P84753.0W	Umetco Minerals Corp	MWC-48	255	MIS	T33N	R89W	S15	NW¼NE¼
P84754.0W	Umetco Minerals Corp	ENL MWC-42	245	MIS	T33N	R89W	S15	NW¼NE¼
P85776.0W	Matador Cattle Co.	COLE #80	240	STK	T33N	R89W	S10	NE¼SW¼
P46385.0W	Matador Cattle Co.	Medicine Springs #1	2	STK	T33N	R89W	S18	SW¼NE¼
P46388.0W	Matador Cattle Co.	Iron Spring #1	6	STK	T33N	R89W	S07	NW¼NW¼
P46389.0W	Matador Cattle Co.	Lincoln Springs #1	3	STK	T33N	R89W	S08	SE¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P49121.0W	Umetco Minerals Corp.	MWC 55	5	MIS	T33N	R89W	S07	SE¼NE¼
P91277.0W	Umetco Minerals Corp.	MWC 57	171.78	MIS	T33N	R89W	S10	NE¼SE¼
P91279.0W	Umetco Minerals Corp.	MWC 59	252	MIS	T33N	R89W	S15	NE¼NW¼
P91281.0W	Umetco Minerals Corp.	MWC 60	250	MIS	T33N	R89W	S10	SE¼SW¼
P91282.0W	Umetco Minerals Corp.	MWC 62	160	MIS	T33N	R89W	S15	SE¼SW¼
P91284.0W	USDOI - BLM	PWR #107 Spring (77)	165	STK	T33N	R89W	S15	SE¼SW¼
P93801.0W	USDOI - BLM/Power Resources, Inc	Gas Hills Water Well-1	-1	MIS	T33N	R89W	S18	NE¼SW¼
P9573R CR15/76 [a]	BLM	Veca Pond Reservoir	N/A	Stock Water; Wildlife	T33N	R89W	S22	NW¼SW¼
P10039R CR 15/77 [a]	PRI	Buss I Reservoir	N/A	Stock Water	T33N	R89W	S27	SW¼NW¼
P10040R CR15/78 [a]	PRI	Buss III Reservoir	N/A	Stock Water	T33N	R89W	S27	NE¼SW¼
P10041R CR15/79 [a]	PRI	Cap Pit Reservoir	N/A	Stock Water	T33N	R89W	S27	NW¼NE¼
P95290W CR10/404 [a]	PRI	Buss I Reservoir Well	171	Misc. (Reservoir Supply)	T33N	R89W	S27	SE¼NW¼
P71766W [a]	BLM	Beaver Rim #2 Well	-4	Stock Water	T33N	R89W	S27	NE¼NE¼
P44612W [a]	PRI	Carol Well #1	200	Misc. (Drinking Water, Sanitary Purposes, General Clean-up)	T33N	R89W	S28	NE¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P184398W [a]	PRI	Carol Well #1	N/A	Misc. (Oil & Gas Well Drilling, Potable & Sanitary Supply)	T33N	R89W	S28	NE¼SW¼
P104718W [a]	Umetco Minerals Corp.	C-18 Pit Well	80	Misc. (Pit Dewatering)	T33N	R89W	S22	NE¼NW¼
P179593W [a]	PRI	Gas Hills Water Well-1	N/A	Misc.	T33N	R89W	S32	SE¼NW¼
P179593.0W	Umetco Minerals Corp.	Process Water Well #6	0	IND_GW; MIS	T33N	R89W	S32	SE¼NW¼
P162305.0W	USDOI - BLM/Highland Uranium Project Power Resources Inc.	Buss I Reservoir	1,685	MIS	T33N	R89W	S18	NE¼SW¼
P95290.0W	Umetco Minerals Corp.	MWC 56	210	MIS	T33N	R89W	S27	SE¼NW¼
P91278.0W	Umetco Minerals Corp.	MWC-49	261	MIS	T33N	R89W	S15	NE¼NW¼
P84755.0W	USDOI - BLM/Clear Creek Cattle Co.	Cross Meadows 12-1	240	STK	T33N	R89W	S15	NW¼NE¼
P182674.0W	Umetco Minerals Corp. NW	MWC-33	0	MIS	T33N	R89W	S12	SW¼SW¼
P82562.0W	USDOI - LM/Union Carbide Corp.	Guard Well 3c	210	IND_GW; MIS	T33N	R89W	S15	NE¼NW¼
P67076.0W	Matador Cattle Company	Sage Hen #1	159	STK	T33N	R89W	S15	SE¼SW¼
P46378.0W	Umetco Minerals Corp	MWC 61	5	MIS	T33N	R89W	S26	SE¼SE¼
P91283.0W	Umetco Minerals Corp	MWC 58	150	MIS	T33N	R89W	S15	SE¼SW¼
P91280.0W	BLM/Power Resources	Carol Well # 1	250	MIS; MIS	T33N	R89W	S10	SE¼SW¼
P184398.0W	USDOI-BLM/Umetco Minerals Corp.	Aljob #2	400	MIS	T33N	R89W	S28	NE¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P104730.0W	USDOI - BLM/Union Carbide Corp.	Guard Well 3B	537	IND_GW; MIS	T33N	R89W	S15	SE¼NE¼
P27451.0W	USDOI - BLM /Umetco Minerals Corp	Dick #1	355	MIS	T33N	R90W	S31	NE¼SE¼
P682.0G	Pathfinder Mines Corp.	Lucky Mc #5	995	DOM_GW; IND_GW	T33N	R90W	S23	NE¼SW¼
P710.0G	Federal Uranium Corp	SAGEBRUSH #1 ON CLAIM SAGEBRUSH #4	180	DOM_GW	T33N	R90W	S32	NE¼NE¼
P782.0G	Federal American Partners	Federal Water #1	371	MIS	T33N	R90W	S33	NW¼NW¼
P438.0G	Pathfinder Mines Corp.	Lucky Mc 1	90	DOM_GW	T33N	R90W	S23	NW¼SE¼
P46386.0W	Matador Cattle Co.	Clay Ruins #1	3	STK	T33N	R90W	S28	NE¼NE¼
P46768.0W	Federal American Partners	George 1	140	MIS	T33N	R90W	S27	NE¼NE¼
P47061.0W	Pathfinder Mines Corp	ENL Lucky Mc #11	2,140	IND_GW; MIS	T33N	R90W	S22	NW¼SW¼
P87214.0W	Pathfinder Mines Corp	Area 4 Reclamation Reservoir	460	MIS	T33N	R90W	S35	SE¼SE¼
P87215.0W	Pathfinder Mines Corp	Area 5 Reclamation Reservoir	250	MIS	T33N	R90W	S26	SE¼NW¼
P501.0G	Pathfinder Mines Corp.	Lucky Mc #3	218	DOM_GW; IND_GW	T33N	R90W	S26	SW¼NW¼
P502.0G	Pathfinder Mines Corp.	Lucky Mc #4	112	DOM_GW; IND_GW	T33N	R90W	S22	SE¼SE¼
P89649.0W	USDOI - BLM	Willow Springs Well	190	STK	T33N	R90W	S34	SW¼SW¼
P557.0W	Ormsbee Development Co.	MIMAR #1	110	MUN_GW	T33N	R90W	S28	NE¼SW¼
P558.0W	Ormsbee Development Co.	MIMAR #2	110	MUN_GW	T33N	R90W	S28	SE¼NW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P559.0W	Ormsbee Development Co.	MIMAR #3	110	MUN_GW	T33N	R90W	S28	SE¼NW¼
P148078.0W	Dick Dean D./Teresa A.	Dick #1	60	DOM_GW	T33N	R90W	S03	SW¼NE¼
P149399.0W	USDOI – BLM	Sagebrush/ Tablestakes Pit	28	MIS	T33N	R90W	S32	SW¼NE¼
P175221.0W	BRS INC.	Gunnel #1	1,495	MIS	T33N	R90W	S25	NE¼NW¼
P183419.0W	Wyoming State Board of Land Commissioners/ USDOI - BLM/Barnhart Drilling Co., Inc.	Lucky Mc #12	1,451	MIS	T33N	R90W	S24	SE¼NW¼
P182956.0W	USDOI - BLM/Wyoming State Board Of Land Commissioners/ Barnhart Drilling Co., Inc.	Lucky Mc14	1,505	MIS	T33N	R90W	S24	NE¼SW¼
P439.0G	Pathfinder Mines Corp.	Lucky Mc 2	110	DOM_GW	T33N	R90W	S26	NE¼NW¼
P47060.0W	Pathfinder Mines Corp.	ENL Lucky Mc #8	1,500	IND_GW; MIS	T33N	R90W	S22	NE¼SE¼
P716.0G	Pathfinder Mines Corp.	Lucky Mc #6	1,340	DOM_GW; IND_GW	T33N	R90W	S23	SW¼NW¼
P717.0G	Pathfinder Mines Corp.	Lucky Mc #7	1,720	DOM_GW; IND_GW	T33N	R90W	S22	NE¼NE¼
P100564.0W	Hancock Bill/Ada	Musk Rat #1	100	DOM_GW; STK	T33N	R91W	S02	NW ¼SW¼
P24156.0P	Matador Cattle Co.	Puddle Springs #17-1	150	STK	T33N	R91W	S25	NE¼SE¼
P24179.0P	Matador Cattle Co.	Puddle Springs #17-3	175	DOM_GW; STK	T33N	R91W	S24	SE¼SE¼
P119032.0W	Wyoming State Board of Land Commissioners/ Hancock William/Ada	Ohio #1	115	STK	T33N	R91W	S16	SW¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P127731.0W	Hancock William/Ada	Hancock #1	60	STK	T33N	R91W	S34	NW¼NW¼
P130612.0W	Hancock William/Ada	Hancock No. 2	140	STK	T33N	R91W	S27	NW¼SE¼
P130613.0W	Hancock William/Ada	Hancock No. 3	60	STK	T33N	R91W	S10	NW¼SE¼
P89712.0W	USDOI - BLM	Pipeline Well	43	STK	T33N	R91W	S11	SW¼NE¼
P5286.0P	Grieve Land & Cattle Co.	Muskrat #1	50	DOM_GW; STK	T33N	R91W	S03	NE¼SE¼
P44529.0W	Matador Cattle Co.	Puddle Springs 1	6	STK	T33N	R91W	S25	NW¼NE¼
P146970.0W	Herbst Lois G.	#1	170	MIS	T34N	R88W	S08	SW¼SW¼
P24150.0P	Matador Cattle Co.	Ervay Basin #12-4	150	STK	T34N	R88W	S08	SW¼NW¼
P24155.0P	Matador Cattle Co.	Ervay Basin #12-2	450	STK	T34N	R88W	S28	NE¼SE¼
P24173.0P	Matador Cattle Co.	Mcrae Gap #13-1	50	STK	T34N	R88W	S26	NW¼NE¼
P71762.0W	Clear Creek Cattle Co.	Roberts Spring	5	STK	T34N	R88W	S31	NW¼NE¼
P71821.0W	Clear Creek Cattle Co.	Waterworks Well	160	MIS	T34N	R88W	S26	NW¼NE¼
P191436.0W	Herbst Lazy Ty Ranch, LLP	Ervay Basin No. 3	450	STK	T34N	R88W	S19	NE¼NW¼
P85633.0W	Clear Creek Cattle Co.	ENL Waterworks Well	160	MIS	T34N	R88W	S26	NW¼NE¼
P24154.0P	Matador Cattle Co.	Ervay Basin #12-1	145	STK	T34N	R88W	S21	SE¼NE¼
P24172.0P	Matador Cattle Co.	JE Ranch #12-5	175	DOM_GW; STK	T34N	R88W	S32	NE¼NW¼
P2662.0W	Miles Nellie K./ Miles James N.	miles #6	92	STK	T34N	R89W	S05	NE¼NW¼
P79467.0W	M 3 Industries	M3 #1	140	MIS; STK	T34N	R89W	S01	SW¼NE¼
P96884.0W	Herbst Lazy Ty Land Co.	Herbst Ervay Basin #1	75	STK	T34N	R89W	S23	SW¼SW¼
P98996.0W	Herbst Lazy Ty Land Co.	Herbst Ervay Basin #2	3,378	STK	T34N	R89W	S23	NE¼SW¼

Table 3.15-9 Water Rights Within 10 Miles of the GHPA

Water Right	Applicant	Facility Name	Well Depth (feet bgs)	Uses	Location Legal No. Description			
P18297.0P	Miles James N./ Miles Nellie K.	Miles #7	132	STK	T34N	R89W	S09	NE¼NW¼
P24149.0P	Matador Cattle Co.	Ervay Basin #12-3	160	STK	T34N	R89W	S13	SE¼SW¼
P174546.0W	Burgett Glenn	Burgett #1	55	STK	T34N	R89W	S31	NW¼NE¼
P6774.0P	Thompson J. L.	South #4	160	STK	T34N	R90W	S11	NE¼NW¼
P169586.0W	Burgett Glenn H.	Liam	0	STK	T34N	R90W	S36	NE¼NE¼
P13585.0P	Wyoming State Board of Land Commissioners/ Diamond Ring Ranch	Delfelder #3	200	STK	T35N	R89W	S36	NW¼NW¼
P18295.0W	Miles Nellie K./ Miles James N.	Miles #4	328	DOM_GW; STK	T35N	R89W	S32	NE¼NW¼
P18296.0P	Miles Nellie K./ Miles James N.	Miles #5	368	STK	T35N	R89W	S32	NE¼NW¼
P179706.0W	Hansen William	Bill Hansen #1	40	STK	T40N	R116W	S18	NE¼SW¼
P181273.0W	Anobile John R. and Melissa A.	Anobile #1	320	DOM_GW	T50N	R82W	S06	NE¼NW¼
P180954.0W	J.M. Huber, Corp.	Maniqault Fed 9LW-28 57-75	612	CBM; STK	T57N	R75W	S28	NE¼SE¼

[a] Wells located within the GPHA.

Source: WSEO 2011.

3.16 Wild Horses

Management of wild horses on BLM-administrated lands is regulated under the Wild Free-Roaming Horses and Burros Act of 1971, the multiple use objectives of the FLPMA, and the Wyoming Standards of Healthy Rangelands. Within the state of Wyoming there are currently 16 Herd Management Areas (HMAs) with a target wild horse population of 3,725 (BLM 2009b). Appropriate management levels were established in 1993 and 1994 and acknowledged throughout the state for each HMA through a 2003 Consent Decree between the State of Wyoming and the BLM. The appropriate managed level establishes a herd population range for the HMAs that ensures a healthy balance between all grazing activity (wild horses, livestock, and wildlife) and the vegetation, water, and soil resources that supports them. Vegetative community health within the HMAs is assessed using the Wyoming Standards for Healthy Rangelands. Drought conditions reduce available forage for wild horses, which may increase grazing competition between horses and livestock. Dietary overlap occurs between wild horses and cattle, although there are some differences. Horses tend to be less selective and will graze vegetation closer to the ground, sometimes creating adverse effects (BLM 2007d).

Due to a lack of natural predators, wild horse reproduction and recruitment rates exceed mortality rates. Therefore, herd populations are controlled artificially to maintain the health of horses and rangelands. Population size, drought conditions, and vegetation monitoring typically dictate the timing and frequency of the gathers. Herd populations increase at approximately 15 to 20 percent annually (BLM 20***13***, Lander ***Proposed*** RMP and ***Final*** EIS). Generally, gathers are conducted every 3 to 5 years, at which time the overall health of the population is assessed. To maintain the appropriate management levels, some horses are removed and an anti-fertility vaccine (Porcine Zona Pellocida) is administered to mares.

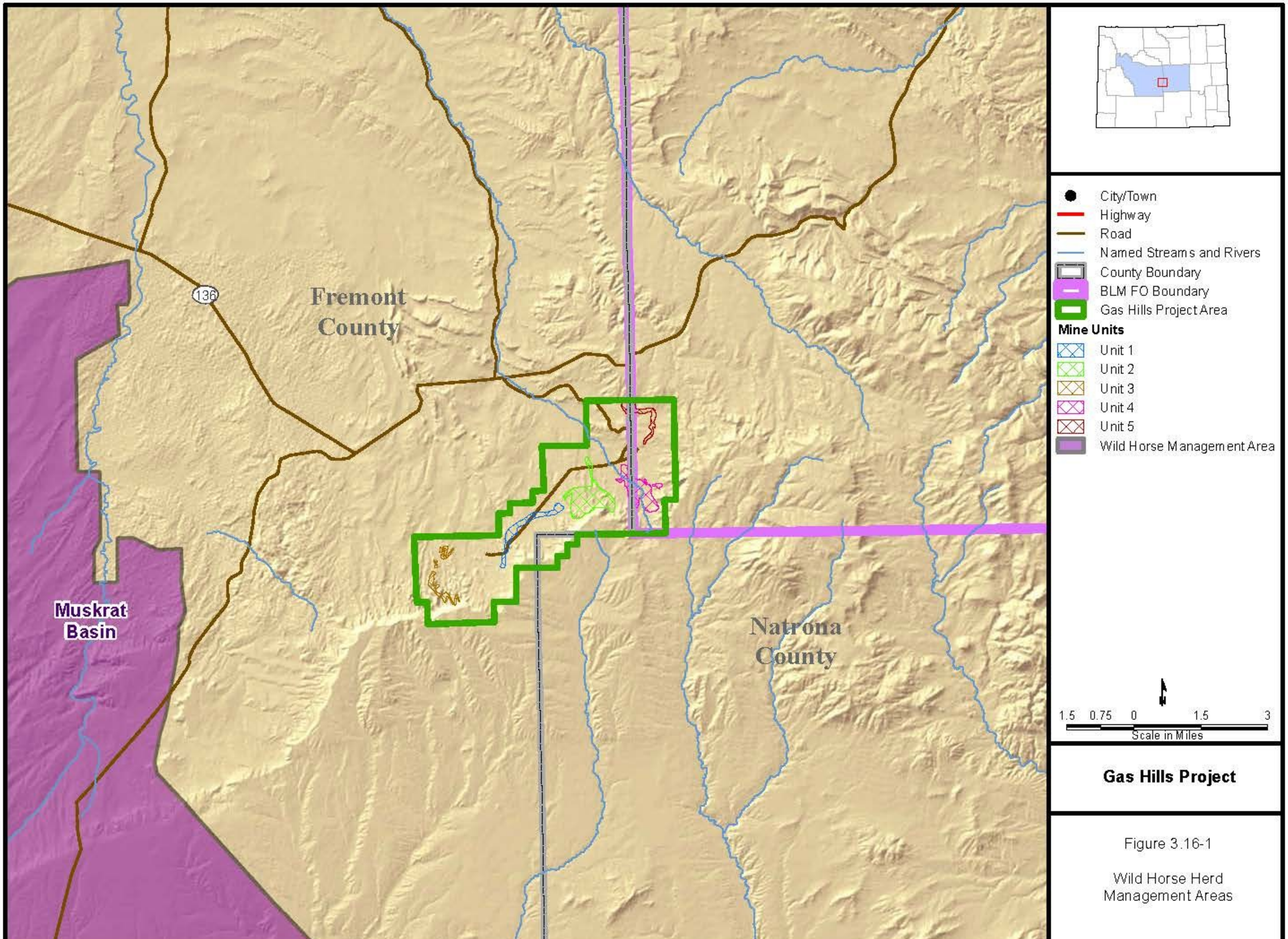
3.16.1 Muskrat Basin, Conant Creek, Rock Creek, and Dishpan Butte HMAs

Although no wild horse HMAs overlap the GHPA, the Muskrat Basin HMA lies 5 miles to the southwest (**Figure 3.16-1**). This HMA is adjacent to 3 other HMAs; Conant Creek, Rock Creek, and Dishpan Butte. Although these horse herds are managed as individual populations there is no geographical separation between them and gates remain open for most of the year. Due to connectivity these HMAs are frequently referred to as the North Lander Complex of HMAs. The free-roaming nature of wild horses and the openness of these HMAs benefit the genetic viability of the wild horse populations. This North Lander Complex of HMAs consists of approximately 375,300 acres and is located in central Fremont County. The total appropriate management level ranges from 320 to 536 horses with no wild burro populations (see **Table 3.16-1** for individual HMA statistics). Over the last 10 years, 667 horses have been removed from the complex during gathers.

Table 3.16-1 Herd Management Areas and Appropriate Management Levels

HMA	BLM Acres	Other Acres	Appropriate Management Level (number of horses)	Number Removed from 2004 Gather
Conant Creek	49,528	8,190	60-100	95
Dishpan Butte	92,275	7,466	50-100	123
Muskrat Basin	176,340	16,922	160-250	127
Rock Creek	19,100	5,483	50-86	0

Source: Tabular data was obtained from BLM (2009a).



Gas Hills Project

Figure 3.16-1

Wild Horse Herd Management Areas

3.17 Wildlife and Fisheries

The study area for wildlife and fisheries resources is defined as the area encompassed by the GHPA. The study area is characterized by flat to low rolling terrain with intermittent terraces, steep slopes, and rocky ridges. As discussed in Section 3.13, Vegetation, 7 vegetation cover types, and 1 land use cover type is located within the study area. Vegetation cover types include bottomland sagebrush, mixed sagebrush grassland, rough breaks, upland grass, reclaimed areas, reservoirs, and wetlands. The land use cover type is disturbed land. Mixed sagebrush grassland is the most common vegetation community within the study area. A variety of wildlife species are associated with upland communities found within the study area, with greater species diversity occurring in areas exhibiting greater vegetation structure and soil moisture, such as wetlands. Due to a lack of perennial water sources that provide suitable aquatic habitat, no fisheries are known to occur within the study area and therefore not discussed further in this section.

Information regarding wildlife and fisheries resources and their habitat within the study area and CISAs was obtained from a review of existing published sources, BLM, WGFD, and USFWS file information, WYNDD database information, and site-specific surveys conducted by HWA (2010, 2009).

3.17.1 Terrestrial Wildlife

Wildlife species that may occur within the study area are typical of the grassland and sagebrush shrub communities of central Wyoming. Baseline descriptions of both resident and migratory wildlife include species that have either been documented within the study area or those that may occur within the study area based on habitat associations. Species that inhabit wetland/waterbody habitat are limited to the intermittent drainages, ponds, and wetlands that occur within the study area or occur in the immediate vicinity.

Available water for wildlife consumption is limited within the study area. Clean water sources, particularly those that maintain open water and a multi-story canopy, support a greater diversity and population density of wildlife species than any other habitat types occurring in the region.

3.17.1.1 Big Game Species

Big game habitat information (e.g., crucial winter habitat, parturition habitat, migration corridors, etc.) and GIS shapefiles were obtained from the WGFD and reviewed for this Project. This information is updated regularly and presents the most accurate data for the study area. Big game species that may occur within the study area include pronghorn, mule deer, and elk (BLM 2007a; WGFD 2004). The study area does not contain any big game crucial winter habitat or parturition habitat identified by the WGFD. Recent surveys in 2010 and 2011 have documented pronghorn, mule deer, and elk within the study area (HWA 2011a,b).

Pronghorn are most prominent in portions of the study area with adequate forage and surface water (BLM 2007a; WGFD 2004). Pronghorn inhabit grasslands and sagebrush shrublands in flat to rolling topography and browse on shrubby plants, especially sagebrush, throughout the year. During the winter, pronghorn generally utilize areas of relatively high sagebrush densities and overall low snow accumulations, on south- and east-facing slopes. The WGFD has classified the study area into 2 categories for pronghorn: spring/summer/fall and yearlong range. The study area is located within WGFD's Pronghorn Herd Unit 632 (Beaver Rim). In 2009, WGFD trend data indicated a total of 24,938 animals in this herd unit (WGFD 2009a). This is an overall increase in the number of animals in the herd unit since 2000 (average of 23,654 animals from 2000 to 2009). Over the past 5 years, annual harvest estimates indicate 1,253 animals per year have been harvested in Pronghorn Herd Unit 632. Overall, populations of pronghorn within the Project region have increased since the early 2000s.

Mule deer may occur throughout the study area. Mule deer feed on a wide variety of plants including forbs, grasses, sedges, shrubs, and trees. Like pronghorn, winter habitat for mule deer occurs in areas of relatively high sagebrush densities and overall low snow accumulation, on south- and east-facing slopes. The WGFD has classified the study area into 2 categories for mule deer; yearlong and winter/yearlong range. The study area is located within WGFD's Mule Deer Herd Units 646 (Sweetwater) and 648 (Beaver Rim). In 2009, the WGFD estimated a total population of approximately 6,198 animals in Mule Deer Herd Unit 646 and 1,266 animals in Mule Deer Herd Unit 648 (WGFD 2009a). This is an overall increase in the number of animals since 2000 (average of 4,933 animals in Mule Deer Herd Unit 646 and 949 animals in Mule Deer Herd Unit 648 from 2000 to 2009). Over the past 10 years, annual harvest estimates indicate approximately 51 and 427 animals per year harvested in Mule Deer Herd Units 646 and 648, respectively (WGFD 2009b). Similar to pronghorn populations, mule deer populations within the Project region have increased since the early 2000s. However, despite the higher availability of pronghorn antelope in the GHPA, mule deer are hunted at a higher rate.

Elk also occur infrequently within the study area, particularly in the fall and winter months. In the open sagebrush shrublands of Wyoming, elk typically roam over vast expanses away from human development. The WGFD has classified the majority of the study area as not containing elk habitat; however, a small portion in the southeastern corner of the study area is classified as yearlong range. The study area is located within WGFD's Elk Herd Unit 638 (Green Mountain). In 2009, the population of elk in Herd Unit 638 was unknown, although the herd is managed with a population goal of 500 animals. Over the past 5 years, annual harvest estimates indicate approximately 258 animals per year have been harvested in Elk Herd Unit 638 (WGFD 2009b). Similar to pronghorn and mule deer, populations of elk within the Project region have increased since the early 2000s.

Black bears and mountain lions also are classified as big game species in Wyoming (WGFD 2009a). Both species are fairly common in Wyoming, especially in high elevation forests and riparian areas. Both species occur at very low densities in habitats found within the study area (e.g., mixed sagebrush grassland, rough breaks, etc.); therefore, their potential for occurrence is extremely low.

3.17.1.2 Small Game Species

Small game species that occur within the study area include upland game birds, small mammals, furbearers, and waterfowl. Upland game birds that occur within the study area include greater sage-grouse and mourning dove. The greater sage-grouse is a federal ESA candidate, BLM-sensitive species and is discussed further in Section 3.17.2, Special Status Wildlife Species. Mourning dove occur in habitats ranging from deciduous forests to shrubland and grassland communities, often nesting in trees or shrubs near riparian areas or water sources. Small game mammals likely to occur within the study area include desert cottontail and red fox. Furbearers likely to occur within the study area include badgers and bobcats (BLM 2007a; WGFD 2004). These species have a wide distribution in Wyoming and are found within a variety of habitat types including bottomland sagebrush, mixed sagebrush grassland, rough breaks, upland grass, reclaimed areas, and wetlands.

The study area is located within the Central Flyway, which is 1 of the 4 USFWS designated migratory bird flyways in North America. Common waterfowl species that may occur within the study area year-round depending on the availability of open water include Canada goose, mallard, green winged teal, northern pintail, gadwall, and American widgeon. Other common summer residents include blue-winged teal, cinnamon teal, northern shoveler, redhead, and ring-necked duck (BLM 2007a; HWA 2011a; Stokes and Stokes 1996; WGFD 2004). These species distributions are limited to the ponds and wetland/riparian habitats found within the study area.

3.17.1.3 Nongame Species

A diversity of nongame species (e.g., small mammals, raptors, passerines, amphibians, and reptiles) occupies a variety of trophic levels and habitat types within the study area. Common nongame wildlife species include small mammals such as bats, voles, squirrels, gophers, prairie dogs, woodrats, and mice. These small mammals provide a substantial prey base for predators in the Project region including larger mammals (long-tailed weasel, short-tailed weasel, raptors (eagles, buteos, accipiters, owls), and reptiles (snakes). The white-tailed prairie dog is a BLM sensitive species and is discussed further in Section 3.17.2, Special Status Wildlife Species. A number of bat species also occur within the study area, including little brown myotis, big brown bat, and western small footed myotis (WGFD 2010a, 2004). BLM sensitive bat species are discussed further in Section 3.17.2, Special Status Wildlife Species.

Raptors and Other Migratory Birds

Nongame birds encompass a variety of passerine and raptor species including migratory bird species that are protected under the MBTA (16 USC 703-711) and EO 13186 (66 *Federal Register* 3853). Pursuant to EO 13186, a MOU between the BLM and USFWS outlines a collaborative approach to promote the conservation of migratory bird populations. The purpose of the MOU is to strengthen migratory bird conservation by identifying and implementing strategies that promote conservation and avoid or minimize adverse impacts on migratory birds in coordination with state, tribal, and local governments. This MOU identifies specific activities where cooperation between the BLM and USFWS would contribute to the conservation of migratory birds and their habitat.

Raptor species that could potentially occur as residents or migrants within the study area include eagles (bald and golden eagles), buteos (e.g., red-tailed hawk, Swainson's hawk, ferruginous hawk), falcons (e.g., prairie falcon, American kestrel), accipiters (e.g., Cooper's hawk, sharp-shinned hawk), owls (e.g., great horned owl, burrowing owl, long-eared owl, short-eared owl), northern harrier, and turkey vulture (BLM 2007a; HWA 2011a,b; Stokes and Stokes 1996; WGFD 2004). Breeding raptor surveys were conducted within the study area in 2009, 2010, and 2011 using both aerial and ground inventory procedures (HWA 2011a,b). The raptor surveys were conducted during May, June, and July to identify occupied territories or active nest sites located within 1 mile from the outside edge of the study area. Aerial surveys focused on cliff nesters (e.g., golden eagle, prairie falcon) and species that commonly build nests in deciduous trees or on promontory points (e.g., red-tailed hawk, Swainson's hawk, ferruginous hawk, great-horned owl). The aerial surveys did not concentrate on cavity nesters (e.g., American kestrel), ground nesters (e.g., northern harrier), subterranean nesters (e.g., burrowing owl), or most conifer nesters (e.g., accipiters), based on visibility limitations from the airplane. These species were surveyed for with subsequent ground surveys conducted in June and July within 1 mile of the study area.

Based on the results of the ***2012*** ground raptor nest surveys, ***45*** nest sites ***(1*** new and ***44*** historic) were identified within 1 mile of the study area. Of these ***45*** nest sites, ***7*** were ***active;*** 1 ferruginous hawk ***nest, 1 prairie falcon nest, 2 great horned owl nests, 1 Swainson's hawk nest, 1 golden eagle nest, and 1 merlin nest (Cameco 2012).***

A variety of passerines occur within the study area throughout the year; however, they are most abundant during the spring/fall migration as well as during the breeding season (May 15 to June 30 [Nicholoff 2003]). Representative bird species that occur in the study area include Say's phoebe, horned lark, barn swallow, black-billed magpie, American raven, western meadowlark, green-tailed towhee, lark bunting, and lark sparrow (BLM 2007a; Stokes and Stokes 1996; WGFD 2004). BLM sensitive migratory bird species are discussed further in Section 3.17.2, Special Status Wildlife Species.

Birds of Conservation Concern and Wyoming Partners in Flight Priority Bird Species

A list of Birds of Conservation Concern was developed as a result of a 1988 amendment to the Fish and Wildlife Conservation Act. This Act mandated that the USFWS "identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the ESA of 1973." The goal of the Birds of Conservation Concern list is to prevent or remove the need for additional ESA bird listings by implementing proactive management and conservation actions, and that these species would be consulted on in accordance with EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (USFWS 2008). Important bird species that potentially could occur within the study area and their associated habitat types are presented in **Appendix *I***. The study area is located within Bird Conservation Region ***(BCR)*** 10, Northern Rockies.

This BCR contains large tracts of high elevation forests and sagebrush shrublands in Montana, Idaho, and Wyoming and is a major migration corridor for bird species migrating to and from western Canada through the U.S.

Partners in Flight (PIF) is a multi-faceted organization with the goal of documenting and reversing population declines of neotropical migratory birds and their habitats (Nicholoff 2003). PIF Priority Bird Species that potentially could occur within the study area and their associated habitat types are presented in **Appendix *I***.

Reptiles and Amphibians

Reptiles and amphibians occupying the study area are typically limited by their specific habitat requirements. Potential habitat for amphibians within the study area includes intermittent stream reaches, wetlands, springs, reservoirs, and ephemeral ponds. Species that could potentially occur within the study area include the eastern short-horned lizard, northern sagebrush lizard, prairie rattlesnake, northern leopard frog, chorus frog, and Great Basin spadefoot toad (Baxter and Stone 1980; BLM 2007a; WGFD 2010a, 2004). Surveys conducted in 2010 and 2011 documented boreal chorus frogs and tiger salamanders within the study area (HWA 2011b). BLM sensitive reptile and amphibian species are discussed further in Section 3.17.2, Special Status Wildlife Species.

3.17.2 Special Status Wildlife Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Twenty-seven special status wildlife species including federally listed, federally proposed, federal candidate, and BLM sensitive species were identified as potentially occurring within the study area (BLM 2010b, 2007a; USFWS 2010a,b; WGFD 2010a,b) (**Appendix *H***). The potential occurrence of special status species within the study area was based on range, known distribution, and the presence of potentially suitable habitat within the study area. A total of 13 wildlife species were eliminated from detailed analysis (black-footed ferret, swift fox, long-eared myotis, bald eagle, northern goshawk, peregrine falcon, long-billed curlew, white-faced ibis, yellow-billed cuckoo, trumpeter swan, boreal toad, Columbia spotted frog, and Yellowstone cutthroat trout) based on rationale presented in **Appendix *H***. The remaining 14 wildlife species that have the potential to occur within the study area are discussed below.

3.17.2.1 Mammals

White-tailed Prairie Dog

The white-tailed prairie dog (*Cynomys leucurus*) is classified as a BLM sensitive species. White-tailed prairie dogs inhabit xeric sites with mixed shrubs and grasses. This species is often associated with sagebrush and saltbrush and tends to occupy higher elevations (greater than 5,500 feet amsl) than the black-tailed prairie dog (WGFD 2010a). In Wyoming, the white-tailed prairie dog is found in the western 2/3 of the state, excluding the areas near Yellowstone and Grand Teton National parks (WGFD 2010a).

White-tailed prairie dog surveys were conducted during the summer months in 2009, 2010, and 2011 to determine location, size, and density of active colonies. Nine white-tailed prairie dog colonies (4 active and 5 inactive), encompassing 18.7 acres, were located within the study area (**Figure 3.17-1**) (HWA 2011a,b). Based on the results of these surveys, the potential for this species to occur within the study area is considered high.

Pygmy Rabbit

The pygmy rabbit (*Brachylagus idahoensis*) is classified as a BLM sensitive species. Pygmy rabbits inhabit sagebrush shrublands and require dense sagebrush canopies with deep soils with high clay content for burrowing. This species is often found in drainages with tall sagebrush present (BLM 2004; WGFD 2010a). Surveys in 2009 documented marginal habitat within the GHPA (HWA 2009). Pygmy

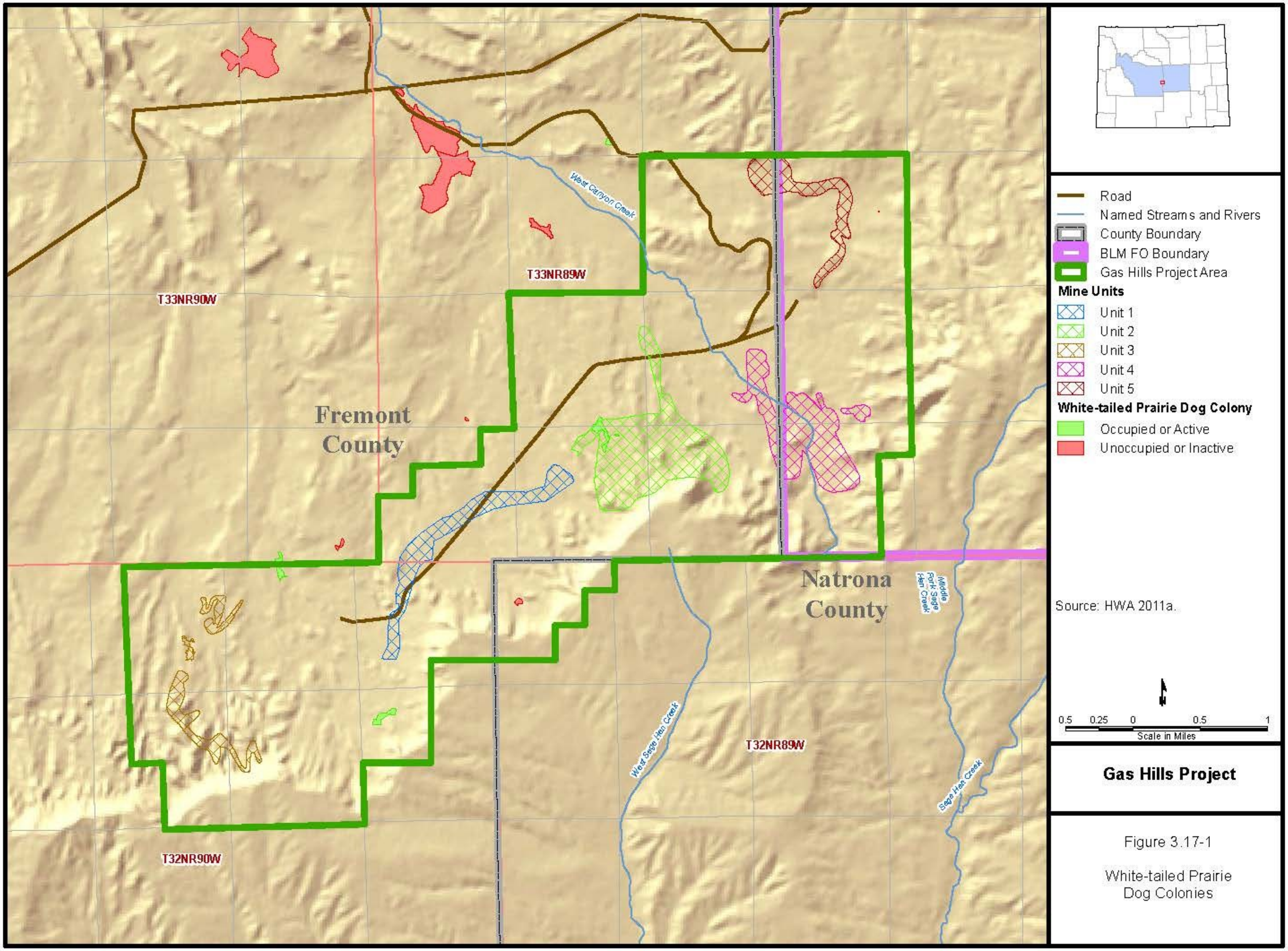


Figure 3.17-1

White-tailed Prairie Dog Colonies

rabbit occurrence surveys were conducted in June 2009 and December 2009 in order to search for pygmy rabbit sign (e.g., tracks, droppings). These 2 survey efforts found no sign of pygmy rabbits (HWA 2011a) and at this time it is assumed that pygmy rabbits do not occupy the GHPA. Based on marginal habitat and no known occurrence of this species within the GHPA, the potential for this species to occur within the GHPA is low.

Sensitive Bat Species

The Townsend's big-eared bat (*Corynorhinus townsendii*) and spotted bat (*Euderma maculatum*) are classified as BLM sensitive species. These species occur in a wide variety of habitats including semi-desert scrub, sagebrush shrubland, grassland, coniferous forest, and riparian areas. Roost sites consist of buildings, caves, mines, rock crevices, trees, and cliffs (Fitzgerald et al. 1994; WGFD 2010a). Based on the presence of suitable foraging habitats (and roosting habitat for the Townsend's big-eared bat), the potential for these species to occur within the study area is considered high.

3.17.2.2 Birds

Ferruginous Hawk

The ferruginous hawk (*Buteo regalis*) is classified as a BLM sensitive species. The ferruginous hawk breeds from the Canadian Prairie Provinces south to Oregon, Nevada, Arizona, and Oklahoma. It winters from the central and southern portions of its breeding range south into Baja, California and central Mexico. This species inhabits semiarid open country, primarily grasslands, basin-prairie shrublands, and badlands. It requires large tracts of relatively undisturbed rangeland and nests on rock outcrops, the ground, knolls, cliff ledges, or trees (Johnsgard 1990; WGFD 2010a). This species is found throughout Wyoming, although it is most common in the south-central portion of the state (WGFD 2010a). One active ferruginous hawk nest was found during the 2010 raptor nest surveys. However, this nest is greater than 1 mile northwest of the study area (HWA 2011a,b). Based on the results of the raptor nest survey and suitable nesting and foraging habitat, the potential for this species to occur within the study area is considered high.

Burrowing Owl

The burrowing owl (*Athene cunicularia*) is classified as a BLM sensitive species. This species breeds from south-central British Columbia, south through most of the western U.S., and Mexico (WGFD 2010a). This species typically inhabits level, open areas in heavily grazed or low-stature desert vegetation, with available burrows for nesting and cover (Johnsgard 1988; WGFD 2010a). Nesting habitat consists of abandoned mammal burrows on flat, dry, and relatively open terrain (Johnsgard 1988). While suitable habitat (e.g., white-tailed prairie dog colonies) occurs within the study area, no burrowing owls have been observed in recent years within the study area (HWA ***2011a,b; Cameco 2012).*** Due to the presence of active white-tailed prairie dog colonies and mixed sagebrush grassland habitat, the potential for this species to occur within the study area is considered high.

Greater Sage-grouse

The greater sage-grouse (*Centrocercus urophasianus*) is classified as a federal candidate species as well as a BLM sensitive species. On March 5, 2010, the USFWS determined that the greater sage-grouse warrants protection under the ESA; however, the USFWS concluded that proposing the species for protection is precluded by the need to take action on other species facing more immediate and severe extinction threats. Therefore, greater sage-grouse in Wyoming continue to be managed by the WGFD. Conservation efforts for this species in Wyoming currently ***are*** coordinated by the WGFD in cooperation with the USFWS, BLM, and regional greater sage-grouse working groups in an attempt to increase population levels and avoid federal listing under the ESA.

Core Population Areas

Greater sage-grouse require somewhat different seasonal habitats distributed over large areas to complete their life cycle. In an effort to prevent federal listing of greater sage-grouse, the Wyoming Greater Sage-grouse Implementation Team and local greater ***sage-grouse*** working groups have recently completed a revised map (version 3) of greater sage-grouse core population areas in Wyoming. Greater sage-grouse core population areas include areas with the highest densities of breeding greater sage-grouse in the state, as well as areas important for connectivity between populations. The core population areas include roughly 25 percent of the state but contain 83.1 percent of the greater sage-grouse population in the state. The GHPA contains 12 acres of core population area (Greater South Pass) (**Figure 3.17-2**). ***In addition, the Wyoming BLM and the state of Wyoming have issued regulations regarding management of the greater sage-grouse in Wyoming. BLM IM 2010-012, 2012-043, 2012-044, 2012-019, and State of Wyoming EO 2011-5 include specific protection measures regulating development in greater sage-grouse core population areas in Wyoming.***

Lekking/Nesting Habitat

The center of breeding activity for greater sage-grouse is referred to as ***a*** strutting ground or a lek. Leks typically are characterized as flat, sparsely vegetated areas within large tracts of sagebrush (Connelly et al. 2004). Males begin to appear on leks in March, with peak attendance of Wyoming leks occurring in April (WGFD 2010b). Greater sage-grouse nesting habitat typically is centered on active leks and consists of medium to tall sagebrush with a perennial grass understory (Connelly et al. 2000). Studies have shown that taller sagebrush with larger canopies and more residual understory cover usually lead to higher nesting success (Connelly et al. 2004, 2000). A total of ***22*** lek sites have been identified within 11 miles of the study area and ***4*** leks have been identified within 4 miles of the study area. All of these leks are classified as “occupied” by the WGFD. ***Four*** leks ***exist within 2 miles of the study area; these*** are ***the*** West Canyon Creek***, Black Mountain,*** Puddle Springs***, and Leighi Point leks. These*** leks were determined to be active in ***2011*** and ***2012*** as males were observed on the leks during the breeding season (**Table 3.17-1**).

The Black Mountain lek is located near the core area boundary (0.12 mile). The Governor’s Sage-grouse Implementation team has determined that protections implemented under EO 2011-5 for leks in core area are limited to the defined core area boundary. Therefore core area protections are not applicable to the GHPA (WGFD 2013).

Brooding Habitat

During the late spring and summer, hens and broods ***are*** typically found in habitats consisting of a high diversity of grasses and forbs that attract insects while providing cover from predators. These habitats include wet meadows, riparian areas, and irrigated farmland within or near sagebrush. Hens with broods utilize these habitats until forbs desiccate and insect abundance decreases. Unsuccessful hens and cocks also utilize these same habitats; however, due to their nutritional flexibility, they are able to occupy a wider variety of habitats during the spring and summer months (Connelly et al. 2004). In many greater sage-grouse populations, high quality brooding habitat is often the limiting factor due to drought, invasive weeds, and overgrazing associated with improper range management. The GHPA contains suitable brooding habitat and surveys in 2010 documented several hens with broods in sagebrush habitat near a reservoir in the western portion of the study area (HWA 2011a).

Wintering Habitat

Depending on the severity of the winter, greater sage-grouse move to south- and east-facing slopes that maintain exposed sagebrush. Studies have shown that south-facing slopes with sagebrush at least 10 to 12 inches above the snow level are required for both food and cover. Windswept ridges, draws, and

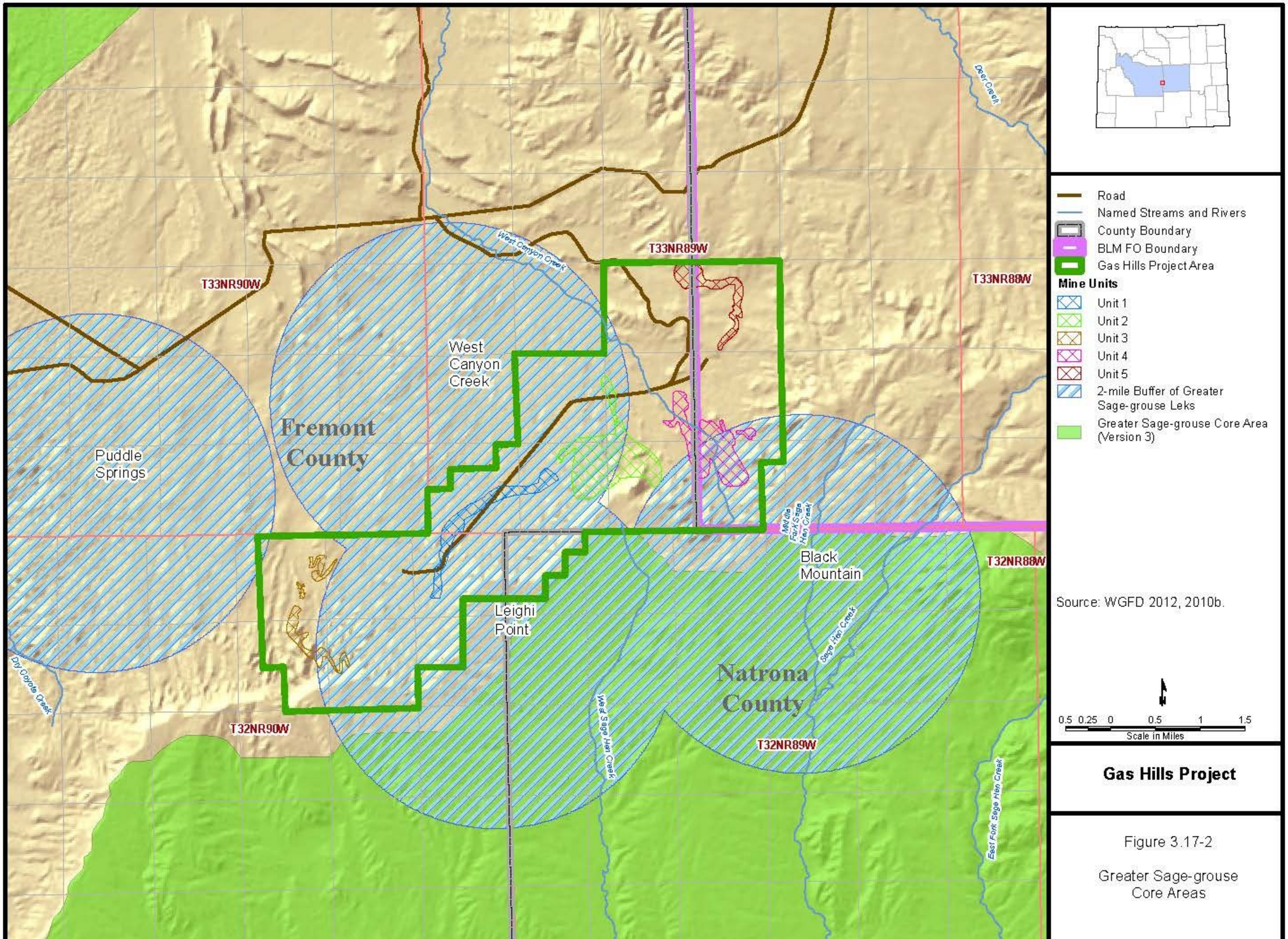


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Figure 3.17-2

Greater Sage-grouse Core Areas

Table 3.17-1 Activity Status of Greater Sage-grouse Leks Located within 2 Miles of the GHPA[a]

Name of Lek	Year	Active (Yes/No/Unknown)	Maximum Number of Males Observed	Date of Maximum Count
Puddle Springs	2008	Yes (1st year discovered)	10	April 17
	2009	Yes	1	May 12
	2010	Yes	12	April 26
	2011	Yes	9	April 5
	2012	Yes	12	April 11[a] April 25[b]
West Canyon Creek	2001	Unknown	-	Not checked.
	2002	Unknown	-	Not checked.
	2003	Yes	2	April 3
	2004	Unknown	0	April 3
	2005	Unknown	-	Not checked.
	2006	Unknown	0	April 13
	2007	Unknown	-	Not checked.
	2008	Yes	40	April 14
	2009	Yes	30	May 12
	2010	Yes	17	April 17[c] April 26[c]
	2011	Yes	9	April 5
	2012	Yes	13	April 18
Leighi Point	2012	Yes	18	May 4
Black Mountain	2012	Yes	18	May 4

[a] *Wyoming EO 2011-5 states that a 2-mile buffer of occupied leks is required for leks outside core areas.*

[b] *A maximum of 12 males were counted during both the April 11 and April 25 survey.*

[c] *A maximum of 17 males were counted during both the April 17th and the April 26th survey.*

Source: HWA 2011a,b, 2010; WGFD 2012.

swales also may be used, especially if these areas are in close proximity to exposed sagebrush (Connelly et al. 2004). In years with severe winter conditions (i.e., deep snow), greater sage-grouse often gather in large flocks in areas with the highest quality winter habitat. It is suggested that high quality winter habitat is limited in portions of the greater sage-grouse's range (Connelly et al. 2000). While no winter concentration areas have been mapped within the GHPA, suitable sagebrush habitat is present within the GHPA that may provide habitat for winter greater sage-grouse. ***Based on the presence of active leks near the study area and suitable nesting, brooding, and wintering habitat, the potential for this species to occur within the study area is considered high.***

Brewer's Sparrow, Loggerhead Shrike, Sage Sparrow, Sage Thrasher

The Brewer's sparrow (*Spizella breweri*), loggerhead shrike (*Lanius ludovicianus*), sage sparrow (*Amphispiza belli*), and sage thrasher (*Oreoscoptes montanus*) are classified as BLM sensitive species. These species typically are found in open habitats, including grassland, sagebrush shrubland, semi-desert scrub, and agricultural areas (BLM 2007a; WGFD 2010a). Surveys in 2010 documented Brewer's sparrows and loggerhead shrikes in suitable habitats but sage sparrows and sage thrashers were not documented within the study area (WGFD 2010a; HWA 2011a). However, based on the presence of suitable habitat, the potential for these species to occur within the study area is considered high.

Mountain Plover

The mountain plover (*Charadrius montanus*) is classified as a BLM sensitive species. The historic breeding range of the mountain plover included short-grass prairies from extreme southern Canada, south through the Great Plains of the U.S. (WGFD 2010a). Currently, mountain plovers only nest in isolated areas throughout their range. In Wyoming, the breeding range of this species is widespread and relatively common in favored habitat; however, population levels and trends are not known (WGFD 2010a). Breeding habitat for this species appears to vary geographically. However, throughout its range, suitable breeding habitat is characterized primarily by shortgrass prairie grassland where grazing is intensive, or in areas of fallow fields or active prairie dog towns (WGFD 2010a). Ground surveys were conducted in 2009, 2010, 2011, ***and 2012*** to determine location, size, and species composition of suitable habitat. A total of 141 acres of potentially suitable habitat was mapped within 0.25 mile of the study area (**Figure 3.17-3**) (HWA 2011a,b). Based on the known distribution of the mountain plover in Wyoming, and documented observations within the study area in 2009***,*** 2010***, and 2012*** (***Cameco 2012*****;** HWA ***2011a,b),*** the potential for this species to occur within the study area is considered high.

3.17.2.3 Reptiles and Amphibians

Northern Leopard Frog

The northern leopard frog (*Rana pipiens*) is classified as a BLM sensitive species. It is one of the most common and widespread amphibians in the U.S.; however, populations are known to be declining throughout its range. This species is found in or near permanent water in the plains, foothills, and montane zones. Northern leopard frogs have been documented up to 11,000 feet amsl in mountainous portions of their range. Preferred habitats are swampy cattail marshes on the plains and beaver ponds in the foothills and montane zones. This species is common throughout Wyoming except in Teton County, Park County, and Yellowstone National Park (WGFD 2010a). While surveys in 2010 did not document northern leopard frogs within the study area (HWA 2011a), the potential for this species to occur within the study area is considered high due to the presence of suitable habitat.

Great Basin Spadefoot

The great basin spadefoot (*Spea intermontana*) is classified as a BLM sensitive species. This species ranges from southern British Columbia south through the Great Basin to northern Arizona and New Mexico. The Great Basin spadefoot prefers sagebrush communities below 6,000 feet amsl, although they have been found at elevations of 9,200 feet amsl. This species requires loose soil for burrowing. In Wyoming, this species is most abundant west of the Continental Divide in the Wyoming Basin and the Green River Valley, but in the center of the state, it crosses the Divide into Fremont and Natrona counties (WGFD 2010a). While surveys in 2010 did not document Great Basin spadefoots within the study area (HWA 2011a), the potential for this species to occur within the study area is considered high due to the presence of suitable habitat.

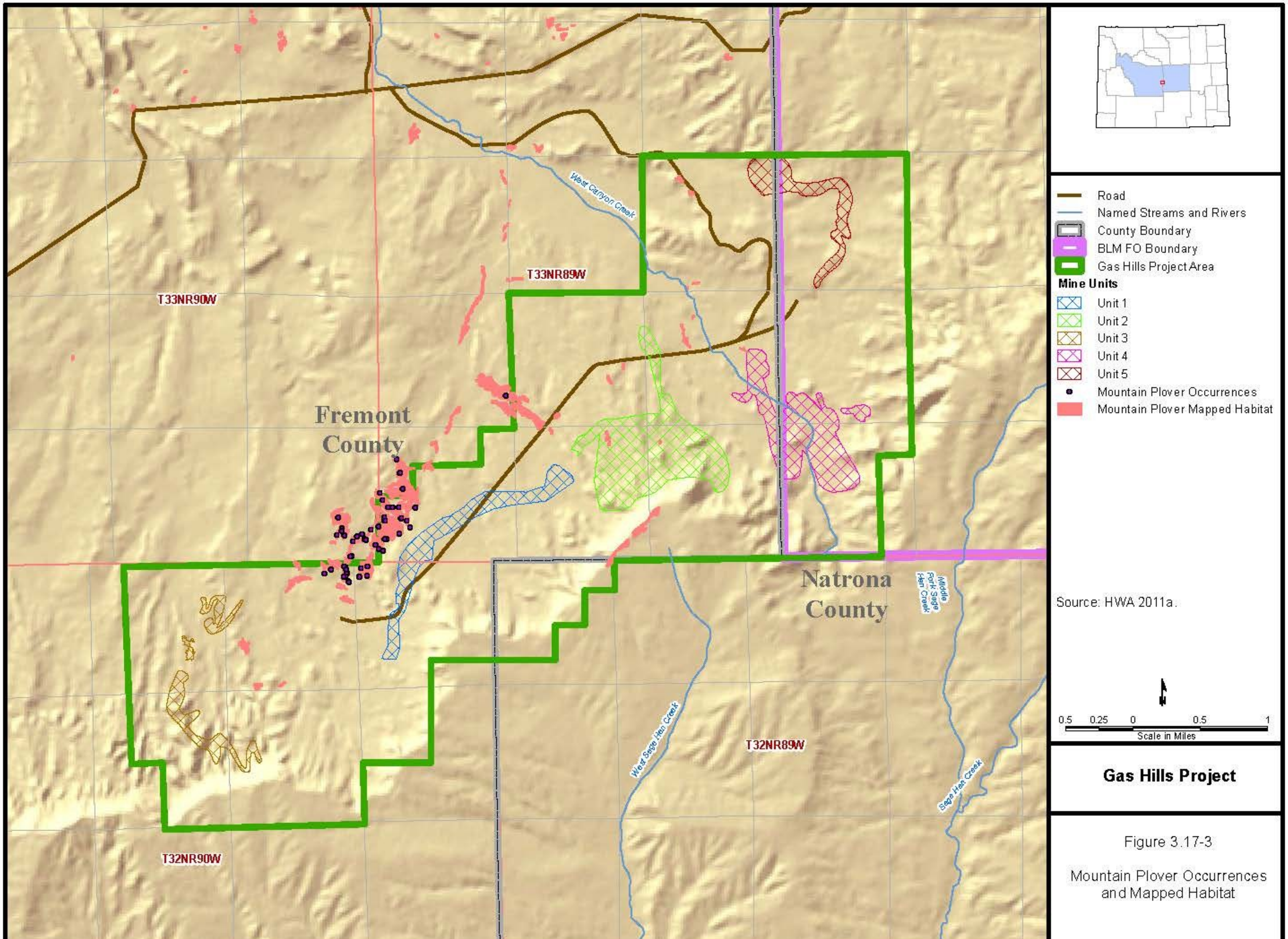

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Figure 3.17-3

Mountain Plover Occurrences and Mapped Habitat