ENVIRONMENTAL ASSESSMENT FOR THE OPERATION OF THE GAS HILLS PROJECT SATELLITE *IN SITU* LEACH URANIUM RECOVERY FACILITY

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1.0 INTRODUCTION

1.1 Background

In a letter to the U.S. Nuclear Regulatory Commission (NRC) dated June 24, 1998, Power Resources, Inc. (PRI) submitted an application requesting an amendment to Source Material License SUA-1511 for the Highland Uranium Project to allow the operation of a satellite *in situ* leach (ISL) uranium recovery facility at the Gas Hills Project site (PRI 1998). This application was supplemented and revised by PRI in letters dated September 24 (PRI 1999a) and November 11, 1999 (PRI 1999b), in response to NRC requests for additional information dated May 21 (NRC 1999a) and July 15, 1999 (NRC 1999b). Subsequent revisions to the application were provided by PRI in letters dated May 3, 2002 (PRI 2002a) and October 10, 2003 (PRI 2003a).

As noted in the June 24, 1998 application, PRI proposed to operate the Gas Hills Project as a satellite facility to the existing licensed ISL uranium recovery facility at the Highland Uranium Project site. However, in July 2002, PRI acquired the existing licensed Smith Ranch Project ISL uranium recovery facility from the Rio Algom Mining Corporation. Following the acquisition, PRI combined and consolidated the facilities and work forces of both the Highland and Smith Ranch facilities which are located adjacent to each other. Subsequently, in a letter dated March 12, 2003 (PRI 2003b), PRI submitted an application requesting an amendment to Smith Ranch Source Materials License SUA-1548 to combine the licenses of the Highland and Smith Ranch facilities to facilitate operational activities and procedures at the newly combined sites. The staff approved the integration of the Highland license into the Smith Ranch license (SUA-1548) in a letter dated August 18, 2003 (NRC 2003a). As such, PRI's request to amend the Highland license for the Gas Hills Project became a request to amend the newly combined Smith Ranch-Highland license (SUA-1548) upon the integration of the two licenses for these contiguous facilities. The Gas Hills Project will be operated as a satellite facility to the combined Highland-Smith Ranch facilities. Environmental impacts associated with operations at the Gas Hills Project as a satellite to the combined Highland-Smith Ranch facilities, including transportation impacts, are not altered by the integration of the Highland and Smith Ranch licenses as the facilities are adjacent to each other.

The proposed Gas Hills Project is located in Fremont and Natrona Counties, Wyoming, approximately 65 miles due west of Casper. Figure A-1 (Appendix A, Figures) shows the general location of the Gas Hills Project. The satellite Gas Hills Project location is approximately 140 miles (via existing highways and access roads) from the Highland Uranium and Smith Ranch Projects which are located in central Converse County, Wyoming, approximately 24 miles northeast of Glenrock. Source Material License SUA-1511 for the commercial operation of the Highland Uranium Project was issued on July 1, 1987. Source Material License SUA-1548 for the commercial operation of the Smith Ranch Project was issued on March 1, 1992.

The planned Gas Hills Project covers approximately 8500 acres in an area of Wyoming (the Gas Hills Uranium District) where extensive conventional uranium mining and milling activities were previously conducted. PRI has mapped out five distinct areas (mine units) within the Gas Hills Project for well-field development and uranium recovery. As a satellite facility, only well-field, ion exchange, and water treatment facilities will be constructed and operated at the Gas

Hills Project. In this regard, the disturbed area of the project is expected to be limited to 1275 acres of the total project area (8500 acres). During process operations, uranium will be leached from identified subsurface ore bodies at Gas Hills by circulating local groundwater fortified with chemicals (a solution known as "lixiviant") through the mineralized zones. The dissolved uranium will be extracted from the uranium-bearing solution ("pregnant" lixiviant) at a surface ion exchange facility at Gas Hills. Then, the uranium-laden ion exchange resin will be transported by truck from the Gas Hills Project to the Highland Uranium or Smith Ranch Project (approximately 140 miles) for final processing into "yellowcake" (U_3O_8). Water treatment facilities, including evaporation ponds, will be provided at Gas Hills for treatment and storage of wastes from process operations and subsequent well-field groundwater restoration activities.

PRI's goal is to extract sufficient uranium from the Gas Hills mine units to yield as much as 2.5 million pounds of yellowcake per year over a production period of twenty years or longer. When the recovery of uranium from a mine unit reaches its economic limit, ISL operations will cease and groundwater restoration will begin. When the groundwater is returned to baseline (pre-mining) conditions or acceptable water quality based on class of use, the mine unit will be decommissioned and reclaimed. Following the decommissioning and reclamation of all mine units, the surface buildings and structures will be decommissioned and all disturbed areas will be reclaimed. PRI's goal in this process will be to return the disturbed areas of the Gas Hills Project to their original or baseline conditions to the extent practical. Radioactive solid wastes and contaminated materials generated during process operations and resulting from decommissioning activities will be disposed of at an NRC licensed disposal facility.

1.2 Purpose and Need for the Proposed Action

The purpose of PRI's request is to seek NRC approval to conduct ISL uranium recovery activities at the Gas Hills Project. In this regard, ISL uranium recovery is regulated by the NRC pursuant to the requirements of Part 40 of Title 10 of the Code of Federal Regulations (10 CFR Part 40), "Domestic Licensing of Source Material", and PRI must obtain approval from NRC to conduct uranium recovery activities at Gas Hills. Additionally, consistent with Bureau of Land Management (BLM) requirements in 43 CFR Subpart 3809, "Surface Management," PRI must obtain approval from BLM of a Plan of Operations relating to PRI's conduct of ISL mining of uranium on public lands managed by BLM. The required Plan of Operations must include a description of the proposed ISL uranium recovery operations, a reclamation plan, and a monitoring plan to generally demonstrate that the proposed activities will not result in unnecessary or undue degradation of public lands. Lastly, PRI must obtain the necessary approvals and permits from the State of Wyoming for the construction of well-field and water treatment facilities and the conduct of ISL uranium recovery activities. In this regard, PRI previously submitted a seven volume mine permit application to the Wyoming Department of Environmental Quality (WDEQ), Land Quality Division (LQD), which has jurisdiction over all mining operations on all lands at the Gas Hills Project. The mine permit application includes an extensive description of the proposed ISL mining operations as well as commitments by PRI to reclaim disturbed lands concurrently with ongoing mining operations and at the cessation of operations. The WDEQ LQD has approved PRI's application to conduct ISL mining operations at Gas Hills, conditional on PRI's acquiring the necessary approvals from NRC and BLM, as described above. Source material recovered at Gas Hills and other uranium recovery facilities serves as a needed source for fuel in domestic nuclear power facilities.

1.3 Proposed Action

PRI proposes to operate an ISL uranium recovery facility at the Gas Hills Project as a Satellite to the existing licensed Highland Uranium or Smith Ranch Project. Accordingly, PRI has requested that Source Material License SUA-1511 for the Highland Uranium Project (or Source Materials License SUA-1548 for the Smith Ranch Project when the licenses are combined) be amended to permit the ISL uranium recovery activities at Gas Hills. The environmental assessment (EA) provided herein assesses the likely impacts to the environment from PRI's proposal to operate an ISL uranium recovery facility at Gas Hills. In developing this EA, the BLM was a cooperating agency and contributed to the preparation of the EA. As such, this document serves to satisfy the requirements under the National Environmental Policy Act of 1969 (NEPA) for both the NRC and BLM to consider the environmental impacts of proposed actions under their jurisdiction.

1.4 Alternatives to the Proposed Action

1.4.1 Alternatives Available to PRI

There are essentially two alternatives available to PRI for the extraction and processing of uranium from underground ore bodies with the ultimate goal of producing "yellowcake" as the desired end product. The first alternative would involve the extraction and processing of uranium in a conventional mining and milling facility which would include the extraction of ore by open pit or underground mining, the processing of the ore in a large mill, and the disposition of the mill tailings waste in an expansive impoundment. The second alternative would involve extraction and processing of uranium in an ISL uranium recovery facility. The PRI proposed action is a limited ISL uranium recovery facility as the final processing of the recovered uranium into "yellowcake" would be performed in an existing offsite facility.

The economic costs and environmental impacts associated with conventional mining and milling are greater than the corresponding costs and impacts of an ISL uranium recovery facility, especially given the lower grade and moderate depth of the ore at Gas Hills, the labor intensive requirements of mining ore, the capital investment required for a conventional mining and milling facility, and the unavoidable surface and subsurface impacts and requirements related to mining and tailings disposal. For these considerations, conventional mining and milling is the less preferred alternative for the Gas Hills site. As the owner and operator of two existing ISL uranium recovery facilities (Highland and Smith Ranch) with full processing capability, PRI's proposal to develop and operate the Gas Hills Project as a satellite uranium recovery facility makes economic sense with favorable environmental implications.

1.4.2 Alternatives Available to NRC and BLM

The action that the NRC and BLM are considering is the PRI request to amend Source Material License SUA-1511 for the Highland Uranium Project (or Source Materials License SUA-1548 for the Smith Ranch Project) to permit the operation of the Gas Hills Project as a satellite uranium recovery facility. In this regard, the alternatives available to the BLM are:

- Approve PRI's Plan of Operations for the conduct of ISL mining on the public lands managed by BLM at Gas Hills.

- Disapprove PRI's Plan of Operations for the conduct of ISL mining on the public lands managed by BLM at Gas Hills (essentially the No Action alternative).

The selection of either alternative is based on PRI's compliance with the standards and procedures specified in 43 CFR Subpart 3809 to prevent unnecessary or undue degradation from mining of mineral resources on the public lands managed by the BLM. If BLM's review results in the disapproval of PRI's Plan of Operations for the Gas Hills Project (essentially the No Action alternative), then, there would be no impacts from the proposed project.

The alternatives available to the NRC are:

- Approve the license amendment request with any license conditions that are considered necessary to protect public health and safety and the environment.

- Deny the license amendment request (essentially the No Action alternative).

The selection of either alternative is based on a consideration of a number of factors related to protection of public health and safety and the environment. Consistent with the requirements of 10 CFR Parts 40.32 and 40.45, the PRI license amendment request will be approved if, among other things:

- The application is for a purpose authorized by the Atomic Energy Act; and

- The applicant is qualified by reason of training and experience to use the source material for the purpose requested in such manner as to protect health and minimize danger to life or property; and

- The applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property; and

- The issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

If the staff's review results in the denial of the license amendment request (the No Action Alternative), then, obviously, there would be no environmental impacts from the proposed Gas Hills Project.

1.5 Review Scope

To determine whether the stipulations above will be met as conditions for approval of the proposed action, the NRC has performed an evaluation of the safety and environmental aspects of the proposed action. Specifically, the NRC has prepared an EA pursuant to the requirements of 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." 10 CFR Part 51 implements NRC's environmental protection program under NEPA. In accordance with 10 CFR Part 51, this EA serves to (1) present information and analysis for determining whether to issue a Finding of No Significant Impact (FONSI) regarding the proposed action or to prepare an Environmental Impact Statement (EIS), (2) fulfill the NRC's compliance with NEPA when no EIS is necessary, and

(3) facilitate preparation of an EIS when one is necessary. A Safety Evaluation Report (SER) has been developed along with this EA to assess the safety aspects of the proposed Gas Hills Project. Based on the findings in the SER and this EA, the staff determines the acceptability of PRI's request to amend Source Material License SUA-1511 for the Highland Uranium Project (or Source Materials License SUA-1548 for the Smith Ranch Project) to allow the operation of an ISL uranium recovery facility at the Gas Hills Project site.

2.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 Site Location and Layout

As shown on Figure A-1, the proposed Gas Hills Project site is located in Fremont and Natrona Counties, Wyoming, approximately 65 miles due west of Casper. The general layout of the proposed 8500 acre project site, including the 5 mine units and the surface facilities, is shown on Figure A-2.

2.2 Land Use of Proposed Site and Surrounding Area

The BLM administers public land on which the majority of the proposed facility would be located, and public land in the immediate vicinity of the site. The BLM currently authorizes grazing on the public land it administers to a single company for sheep and cattle. Other small parcels of privately and state-owned land are also located within the area to be used for the proposed facility.

In addition to agriculture, the area surrounding the proposed site has been used for a number of purposes. The Gas Hills Uranium District has been exploited for its uranium reserves by a number of companies, and has produced more than 50,000 tons of ore over the last forty years. Most of the mines and processing facilities involved in these activities have been, or are being, decommissioned and reclaimed. It is estimated that more than 20 per cent of the land that would be used by the proposed facility has been disturbed by previous uranium mining activities. The area has also seen production of oil and gas, although there is currently no production of oil and gas within two miles of the proposed facility boundary.

The area is also used for recreational activities, including hunting, and is an important wildlife habitat for mule deer and pronghorn antelope.

Access roads to the surrounding area from the proposed site consist of a graded road to paved State Highway 136 to Riverton in the west, a graded road to US 20/26 to Waltman in the northeast, and a mine haul road to Jeffrey City in the southwest.

There are six non-operating uranium mining/mill sites within fifty miles of the proposed facility. Three of these are located within the Gas Hills Uranium District and are currently being decommissioned, one near Jeffrey City (also being decommissioned), another near Rawlins (not currently operating) and another near Riverton (site reclaimed).

2.3 Socioeconomics

2.3.1 Population Distribution

The proposed facility is located in a remote rural area on the boundary between Fremont and Natrona Counties in central Wyoming, roughly 45 miles east of Riverton and approximately 65 miles west of Casper. The majority of the population in the area resides on widely scattered ranch property. Both counties have experienced fluctuating populations since the 1970s with changes in the fortunes of oil, gas and uranium extraction industries in the region, and both counties suffered declining populations during the 1980s.

In contrast, during the 1990s, both counties experienced small increases in population. In Fremont County, the population increased by 7.1 per cent to 36,044 between 1990 and 1998 and in Natrona County, the population increased by 3.5 per cent to 63,341 over the same period (U.S. Bureau of the Census, 1999a). In Fremont County, Riverton saw its population grow by 9.2 per cent to 10,050 over the period 1990 to 1996 and Lander grew by 5.0 per cent to 7,370 (U.S. Bureau of the Census, 1997). In Natrona County, Casper experienced a 4.4 per cent growth rate in the early 1990s, producing a 1996 population of 48,800. Baroil, 35 miles south of the proposed site, had a population of 230 throughout the early 1990s. Jeffrey City, located 25 miles to the south of the proposed site, is the nearest population center and has an estimated stable population of less than 100.

Over the period 1998 to 2008, population in the area surrounding the proposed facility is expected to continue to increase. Annual increases of 0.5 per cent are expected in Fremont County, with similar rates projected for Riverton and Lander. Slightly smaller annual population growth rates of 0.3 per cent are projected for both Natrona County and Casper over this period.

Figure A-3 shows centers of population within 50 miles (80 kilometers) of the proposed site, with each segment representing the 16 major compass points. Table 2.3-1 shows how population is distributed within each compass direction, at specific distance intervals.

2.3.2 Community and Economic Activity

Community Activity. There are no schools, hospitals, sports facilities, residential areas or parks within 2 miles of the boundary of the proposed facility. The nearest residential area is a single residence located approximately 11 miles northeast of the site.

Agricultural activity on or within two miles of the proposed site is limited to livestock grazing with very little precipitation and no irrigated water available. There are no farm crops, vegetable gardens, or milk producers within two miles of the proposed facility. No changes in the pattern or level of use of agricultural lands are expected over the life of the project.

Table 2.3-1 Population Distribution in the Gas Hills Region

Distance	N*	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
0-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-20	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
20-30	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
30-40	4	4	4	0	0	0	0	0	0	0	0	0	0	0	4	4	20
40-50	8	29	10	0	0	0	0	10	0	100	4	0	4	4	4	5	178
50-60	8	12	70	0	0	0	0	0	0	0	20	5	0	0	4	10	129
60-70	8	12	9	0	0	0	0	50	230	0	12	12	4	0	685	8	1,030
70-80	4	0	8	5	80	0	10	0	0	0	8	8	9,000	200	16	16	9,355
Total	36	61	101	5	80	0	10	60	230	100	44	25	9,008	204	713	43	10,720

Source: PRI, 1998

*denotes compass direction from the Gas Hills Project site;

Distances are in kilometers from the center of the proposed site.

Employment. Although employment levels within four miles of the proposed site are negligible, should construction and operation of the proposed facility occur, there would be impacts on the economy of Fremont and Natrona Counties. Tables 2.3-2 and 2.3- 3 provide information on current levels of employment in the two counties. The economies of both counties are dominated by trade and service industries, with 68 per cent of total employment in Natrona County and 62 per cent in Fremont County (County Business Patterns, 1998; U. S. Bureau of Census, 1999). Agriculture is the third most important industry in Fremont County with 11 per cent of county employment. Employment growth in Fremont County in the 1990s has been positive in all the major sectors of the economy, and fairly evenly spread, with relatively large growth rates in mining and finance, insurance and real estate. In Natrona County, a number of sectors, in particular mining, manufacturing and finance, insurance and real estate have seen their workforce decline, while employment in the service sector has grown significantly.

Table 2.3-2 Fremont County Employment by Industry, 1990 and 1996 (1997)*

Sector	1990		1996		Annual Employment Growth Rate 1990-1996
	Employment	per cent of County Total	Employment	per cent of County Total	
Agriculture*	840	9.8	1,170**	10.9	5.7
Mining	222	2.6	390	3.6	9.8
Construction	573	6.7	740	6.9	4.3
Manufacturing	595	7.0	750	7.0	4.0
Transportation and Public Utilities	527	6.2	550	5.1	0.7
Trade	2,399	28.1	3060	28.5	4.2
Finance, Insurance and Real Estate	310	3.6	440	4.1	6.2
Services	2,789	32.7	3570	33.2	4.2
TOTAL	8,540		10,730		3.9

Source: U. S. Bureau of Census, 1999b; *U. S. Department of Agriculture, 1999; ** hired farm workers

Table 2.3-3 Natrona County Employment by Industry, 1990 and 1996 (1997)*

Sector	1990		1996		Annual Employment Growth Rate 1990-1996
	Employment	per cent of County Total	Employment	per cent of County Total	
Agriculture*	385	1.9	450**	1.9	2.6
Mining	1,520	7.4	1,190	5.1	-4.0
Construction	1,610	7.9	1,710	7.3	1.0
Manufacturing	1,720	8.4	1,600	6.8	-1.2
Transportation and Public Utilities	1,230	6.0	1,290	5.5	0.7
Trade	7,630	37.2	8,380	35.6	1.6
Finance, Insurance and Real Estate	1,330	6.5	1,160	4.9	-2.2
Services	4,490	21.9	7,540	32.1	9.0
TOTAL	20,500		23,510		2.3

Source: U. S. Bureau of Census, 1999b; *U. S. Department of Agriculture, 1999; **hired farm workers

Income. Total personal income and per capita income for Natrona and Fremont County are shown in Tables 2.3-4 and 2.3-5. Incomes in both counties have fallen slightly during the 1990s despite annual employment growth in much of the economy.

Table 2.3-4 Fremont County Personal Income

	1990	1996*	2000**	Annual Income Growth Rates
Total Personal Income ($ millions)	430	430	430	-0.03
Personal Income Per Capita	12,690	11,910	11,800	-1.05

Source: U. S. Bureau of Census, 1999b; *IMPLAN, 1999; **Argonne National Laboratory (ANL) Projections.

Table 2.3-5 Natrona County Personal Income

	1990	1996*	2000**	Annual Income Growth Rates
Total Personal Income ($ millions)	1,090	1,040	1,000	-0.09
Personal Income Per Capita	17,840	16,200	15,690	-1.59

Source: U. S. Bureau of Census, 1999b; *IMPLAN, 1999; **ANL Projections.

Housing. There is no housing in the immediate vicinity of the proposed facility. It is expected that the majority of the construction and operations workforce will live in Riverton and commute to the site. In addition, workers at the facility may also use housing in surrounding Fremont and in Natrona County. Table 2.3-6 provides information on housing trends in the three areas. Riverton, after experiencing small annual population growth rates in the 1980s of roughly 0.1 per cent, has seen its population grow by 1.0 per cent per annum throughout the 1990s (U.S. Bureau of the Census, 1999). These trends are reflected in the Riverton housing market, which grew by roughly 300 units between 1990 and 1996. Based on annual population growth rates, there are expected to be more than 100 vacant rental units available to construction workers in Riverton in the year 2000.

Population in the two counties declined in the 1980s by a little over 1.0 per cent annually, and this was reflected in the housing market, producing annual declines of between 0.1 per cent and 0.2 per cent in total housing stock. Increasing population during the 1990s (0.8 per cent annually in Fremont County and 0.4 per cent annually in Natrona County), however, has produced a moderately expanded housing market, with approximately 1,000 new units added in each county during the period. Vacancy rates have outstripped growth in the housing stock, however, increasing 5.2 percentage points over the period 1980-1998 in Fremont County, and by 8.7 percentage points in Natrona County over the same period. Based on annual population growth rates, there are expected to be more than 670 vacant rental units available to construction workers in the year 2000 in Fremont County, and 1,390 in Natrona County.

Table 2.3-6 City and County Occupied Housing Characteristics

	1980	1990	1998 (projected)	2000 (projected)
Riverton, Fremont County				
Owner Occupied	2,433	2,448	2,742*	2,812
Rental	914	920	1,030*	1,057
Vacancy Rate 9.6per cent (1996)				
TOTAL UNITS	3,701	3,725	4,172*	4,278
Fremont County				
Owner Occupied	9,137	8,356	8,947	9,084
Rental	3,732	3,646	3,904	3,964
Vacancy Rate 16.9per cent (1998)				
TOTAL UNITS	14,570	14,437	15,459	15,695
Natrona County				
Owner Occupied	18,812	16,416	16,983	17,112
Rental	7,029	7,421	7,677	7,736
Vacancy Rate 18.0per cent (1998)				
TOTAL UNITS	28,493	29,082	30,087	30,315

Source: U. S. Bureau of Census, 1994; ANL projections.
* 1996 data.

2.4 Cultural Resources

2.4.1 Known Archaeological and Architectural Resources

Cultural resource surveys were conducted for the project area by Pronghorn Archaeological Services in 1992 and 1997. In 1992, approximately 1,600 acres of the amendment area were inventoried for archaeological sites (Phillips 1993a). The 1992 Class III inventory resulted in the recordation of 13 sites and 4 isolated artifacts. One previously recorded site was also relocated. One prehistoric camp (Site 48FR3232) that contains several stone circles and related cairns was recommended as eligible for listing on the *National Register of Historic Places* (National Register). However, four sites (48FR144, 48FR3235/48NA2151, 48FR3236, and 48FR3239) are considered to be of unknown status until further information is made available through subsurface testing (Kelly 1993). These four sites (three prehistoric camps and one lithic scatter) must therefore be treated as if they are eligible for purposes of identifying project impacts until the testing can be completed.

Also in 1992, Pronghorn Archaeological Services reexamined 19 sites previously recorded by the Office of the Wyoming State Archaeologist in 1980 (Phillips 1993b). All but three of the reexamined sites were recommended as not eligible for listing on the National Register; Sites 48NA419-21 have the potential for containing buried prehistoric deposits and are considered to be of unknown status until further subsurface testing can be completed. These three sites must also be treated as if they were eligible for the purposes of identifying project impacts. In 1997, 2,840 additional acres were inventoried (Hatcher 1997). The 1997 Class III inventory resulted in the recordation of 20 prehistoric sites and 14 isolated artifacts. Three previously recorded sites were also relocated. Only one of those sites (Site 48FR3874) was recommended eligible for listing on the National Register.

The proposed location of Mine Unit V does not appear to have been surveyed for cultural resources. However, a large percentage of this area has been severely disturbed by previous mining activities. One abandoned mining structure is located outside of the mine unit boundary (Box Mine). There are remnants of the Thunderbird Mine nearby as well (a concrete pad is present), but they are also outside of the mine unit boundary. Pending information from the Wyoming State Historic Preservation Officer (WY SHPO), if any undisturbed areas exist within Mine Unit V they may have to be surveyed.

In summary, 4,440 acres of the project area (total area 8,500 acres) were surveyed for archaeological sites. Additional portions of the project area had been surveyed in 1980 and only reexamination of the previously recorded sites was necessary. Two sites are considered eligible for listing on the National Register, and seven sites have not yet been tested sufficiently to determine their eligibility status and must therefore be treated as if they were eligible. A portion of Mine Unit V may require a Class III inventory prior to any proposed activities there.

2.4.2 Native American Sites

Native American Elders from the Eastern Shoshone and Arapaho Tribal Councils were consulted regarding the proposed project. In February 1998, Eastern Shoshone Elders visited the project area. The Native American Elders expressed concern for the protection of Site 48FR3232 that contained stone circle features and related cairns (Kelly 1998). No additional project areas were identified as containing sacred sites, traditional cultural properties, or resource (e.g., plant) collecting localities.

2.4.3 National Historic Landmarks, National and State Register Properties

The closest site listed on the National Register is the Castle Gardens Petroglyph Site, located approximately 14 miles northwest of the project area. The nearest State Landmark is Hell's Half-Acre, located approximately 27 miles northeast of the project area.

2.5 Climate and Meteorology, Air Quality and Noise

2.5.1 Climate and Meteorology

The climate of the area surrounding the Gas Hills site is semiarid and cool. Wyoming is in the latitudes of prevailing westerly winds. Air movement in this direction is most pronounced during the winter, while in the spring and summer, circulation patterns bring moist air and precipitation from the Gulf of Mexico. 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 are experienced 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 following climatic and meteorological information for the Gas Hills site is based on the data collected at the Gas Hills 4E National Weather Service Station (NWS), located at the Gas Hills site, and the Casper NWS station located at the Natrona County International Airport (NCIA) near Casper, WY. The Gas Hills NWS station records temperature and precipitation data only. Wind conditions at the Gas Hills site are represented by the data collected at the NWS station at Casper, WY, which is located about 56 miles east of the Gas Hills site. Although there is another first-class NWS station in Lander about 55 miles west of the Gas Hills site, the data at this station are not considered representative of the Gas Hills site because of its proximity to the Wind River Mountains. 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 Gas Hills site. The Lucky Mc Mine, located adjacent to the western part of the Gas Hills site, recorded wind data intermittently from September 1978 through January 1983.

At the Gas Hills 4E weather station, July is the warmest month and January the coldest. Based on 34 years of record (September 1962 - July 1996), the mean maximum and minimum temperatures are 82.8°F and 53.7°F respectively in July and 29.1°F and 10.9°F respectively in January. The highest and lowest temperatures recorded during this period are 96°F and -34°F.

The mean annual precipitation at the Gas Hills 4E station is approximately 8.9 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 1964 to 1994, annual snowfall at the NWS station in Casper, WY averaged 78.8 inches and no measurable amount of snowfall was observed in July and August. Monthly snowfall amounts are unusually uniform from November through February, but increase slightly during March and April.

Annual-average relative humidity in the area ranges from 64 to 71 per cent for the nighttime hours and from 43 to 46 per cent for daytime hours. The NWS station recording evaporation data nearest to the Gas Hills site is located at the Pathfinder Reservoir about 60 miles southeast of the site. Annual mean lake evaporation is estimated at approximately 42 inches. The U.S. Weather Bureau estimates the mean annual potential evapotranspiration rate for the site to be about 22 inches.

Based on the wind data collected by the U.S. Environmental Protection Agency (EPA) in Casper, WY for the period of 1984-1992, average wind speed is about 12.9 mph (EPA 1998). The dominant wind direction is from the southwest at an average wind speed of about 17.5 mph.

Predominance of wind from the southwest at the Casper station is due primarily to nearby topographic features.

Extreme weather events are rare in the State of Wyoming. Hailstorms are the most destructive type of local storm in the State, and crop and property damage from hail is significant (Ruffner 1985). Based on forty years of data collected at the Casper station, the fastest observed 1-minute wind was 81 mph in January with the second fastest wind of 63 mph in December. The highest peak gust wind speed at the Casper station for a recent ten-year period was 67 mph in January and a peak gust wind greater than 60 mph was observed every month of the year (Wood 1996).

Tornadoes also occur in the State but are less frequent and destructive in the region than in the Midwest. For a 47-year period (1950-1996), 449 tornadoes were reported with a tornado event frequency of 9.8×10^{-5}/yr/mi^2, an average of 10 tornadoes per year in Wyoming (Storm Prediction Center 1999). For the period 1954-1983, only 3 tornadoes and an average area per event of 0.018 mi^2 with a tornado event frequency of 1.8×10^{-5}/yr/mi^2 were reported for the 1° by 1° box (~5,600 mi^2), which includes the Gas Hills site (Ramsdell and Andrews 1986). The mountain ranges surrounding the Gas Hills site provide a barrier to much of the westward flow of moist air that produces thunderstorms which often lead to tornadoes.

2.5.2 Air Quality

The Gas Hills site is located in the Casper Intrastate Air Quality Control Region (AQCR), which covers the central part of the State of Wyoming. The State of Wyoming Ambient Air Quality Standards (SAAQS) for six 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 identical to the National Ambient Air Quality Standards (NAAQS) with a few exceptions (Wyoming Rules and Regulations of Department of Environmental Quality, Chapter I). One exception is that the SAAQS for SO_2 are more stringent than the NAAQS. Other exceptions are that the $PM_{2.5}$ NAAQS is not adopted yet, but the standard for total suspended particulates (TSP) is still in effect in the State of Wyoming. The NAAQS, Wyoming's SAAQS, and the highest ambient concentrations measured at the monitoring station nearest to the Gas Hills site are listed in Table 2.5-1. 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} (PM with an aerodynamic diameter $\leq 10\ \mu m$) for the city of Sheridan (40 CFR 81.321). Air monitoring for SO_2, NO_2, O_3, CO, and Pb was discontinued in the 1970s and 1980s because monitoring data gathered were close to background levels or low with respect to applicable ambient standards (Schick 1998).

Prevention of significant deterioration (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 major modifications to existing sources. The State of Wyoming is in a Class II PSD area and contains seven Class I PSD areas consisting of national parks and national wilderness areas. PSD Class I areas nearest to the Gas Hills site include Wind Cave National Park in South Dakota approximately 220 miles to the east-northeast and Bridger National Wilderness Area about 80 miles to the west of the Gas Hills site.

2.5.3 Noise

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, Title 42, United States Code, Parts 4901-4918), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statues and regulations. Currently, no quantitative noise-limit regulations exist in the State of Wyoming.

The EPA guideline recommends an L_{dn}[1] of 55 dBA[2] which is sufficient to protect the public from the effect of broad-band environmental noise in typically quiet outdoor and residential areas (EPA 1974). For protection against hearing loss in the general population from non-impulsive noise, the EPA guideline recommends an Leq[3] of 70 dBA or less over a 40-year period.

Currently, no noise monitoring data are available around the Gas Hills site, and no schools, hospitals, sports facilities, residential areas or parks are located within 2 miles of the Gas Hills site boundary. The nearest residence is located approximately 11 miles north-northeast of the site, and the closest population center, Jeffrey City, WY, is located about 25 miles south of the site with a 1990 population of less than 100 (PRI 1998). The acoustic environment around the Gas Hills site can be considered that of a remote rural-to-wilderness location with typical residual sound levels of approximately 20 to 25 dBA (Liebich and Cristoforo 1988). However, ambient noise levels at residences would be substantially increased at times when traffic is passing on nearby roadways.

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[1] L_{dn} is the day-night weighted equivalent sound level.

[2] dBa is a unit of weighted sound-pressure level, measured by the use of the metering characteristics and the "A" weighting specified in the *American National Standard Specification of Sound Level Meters ANSI S1.4-1983 and Amendment S1.4A-1985* (Acoustical Society of America 1983, 1985).

[3] L_{eq} is the equivalent steady sound level that, if continuous during a specific time period, would contain the same total energy as the actual time-varying sound. For example, L_{eq}(1-h) is the 1-hour equivalent sound level.

TABLE 2.5-1 National Ambient Air Quality Standards (NAAQS), Wyoming's State Ambient Air Quality Standards (SAAQS), and Highest Concentrations Measured at the Monitoring Station nearest to the Gas Hills Project Site.

Pollutant[a]	Averaging Time	NAAQS[b] (μg/m³) Primary	NAAQS[b] (μg/m³) Secondary	SAAQS[c] (μg/m³)	Highest Measured levels Conc.(μg/m³)	Highest Measured levels Location (Year)
SO_2	Annual	80	-[d]	60	6	Casper (1982)
	24 hours	365	-	260	-	-
	3 hours	-	1,300	1,300	-	-
NO_2	Annual	100	100	100	39	Casper (1984)
CO	8 hours	10,000	-	10,000	-	-
	1 hour	40,000	-	40,000	-	-
O_3	8 hours	157	157	157	-	-
	1 hour	235	235	-	-	-
TSP	24 hours	-	-	150	95[e]	Casper (1998)
PM_{10}	Annual	50	50	50	16	Casper (1998)
	24 hours	150	150	150	48[f]	Casper (1998)
$PM_{2.5}$	Annual	15	15	-	-	-
	24 hours	65	65	-	-	-
Pb	Calendar quarter	1.5	1.5	1.5	0.01	Casper (1989)

[a] Notation: CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb =lead; $PM_{2.5}$ = particulate matter ≤ 2.5 μm; PM_{10} = particulate matter ≤ 10 μm; SO_2 = sulfur dioxide; and TSP = total suspended particulates.

[b] National Ambient Air Quality Standards (NAAQS), other than those for O_3 and PM_{10} and those based on annual averages, are not to be exceeded more than once per year. The O_3 1-hour standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to one. The O_3 1-hour standard applies only to areas that were designated nonattainment when the O_3 8-hour standard was adopted in July 1997. The O_3 8-hour standard is attained when the average of the annual 4th-highest daily maximum 8-hour average concentration is less than or equal to the standards. The PM_{10} 24-hour standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The PM_{10} annual standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The $PM_{2.5}$ 24-hour standard is attained when the 98th percentile 24-hour concentration is less than or equal to the standard.

[c] The procedures for determining attainment of the state standards are the same as for the NAAQS.

[d] A hyphen indicates that no standards or monitoring data exist.

[e] The second highest concentration was 77 $\mu g/m^3$.

[f] The second highest concentration was 37 $\mu g/m^3$.

Sources: Code of Federal Regulations, Title 40, Part 50; Wyoming Rules and Regulations of Department of Environmental Quality, Chapter 1; Wyoming Department of Environmental Quality (1999)

2.6 Geology and Seismology

2.6.1 Regional and Local Geology

The Gas Hills project is located in the Gas Hills Uranium Mining District in central Wyoming. This district comprises approximately 40 square miles located in the south central portion of the Wind River Basin along a structural hinge line between the Wind River Basin and the Split Rock Syncline. The approximate location of this boundary is the Beaver Rim which is an east/west trending, north facing, 500 to 700 feet (ft) high escarpment formed by erosion.

The Wind River Basin covers approximately 8,000 square miles and has a trapezoidal shape. The basin is asymmetric with its synclinal axis located along its northern flank. It is bounded by the Casper Arch on the east, the Wind River Range on the west, the Owl Creek Mountains on the north, and the Granite Mountains on the south. Along its axis, the basin contains up to 30,000 ft of sediment. The Wind River Basin was formed during the Late Cretaceous and early Tertiary by a major tectonic event, commonly known as the Laramide Orogeny. The Laramide Orogeny within the Gas Hills District folded Pre-Tertiary sediments into a series of asymmetric anticlines and synclines which plunged northwest into the Wind River Basin. By the end of the Paleocene, these features had been highly incised and breached by erosion. South of the Gas Hills, Precambrian basement rocks were exposed in the Granite Mountains and to the north, a thick wedge of Paleocene sediments had been deposited along the axis of the Wind River Basin. During the Early Eocene, high energy streams emanating from the Granite Mountains deposited their sediment loads onto the erosional surface in the Gas Hills area creating a series of alluvial fans. This deposition produced an angular unconformity as the Early Eocene alluvial fans were placed in contact with moderately to steep dipping Lower Cretaceous to Pennsylvanian aged sediments. The alluvial fan sediments then coalesced to form the Wind River Formation, which contains the uranium in the Gas Hills area. As much as 1,000 ft of Wind River sediments may have been deposited in the area.

During the Late Eocene, fluvial and lacustrine sediments were deposited in the area forming the Wagon Bed Formation. Regional uplift occurred during the early Oligocene and the area was deeply eroded. This erosional surface was then in turn covered with a thick sequence of airborne tuffaceous siltstone forming the White River Formation.

During the Late Miocene to early Pliocene, a regional tectonic event occurred that produced a collapse of the Granite Mountains and formed the Split Rock Syncline. This 6,000 square mile syncline is bounded on the north and south by fault zones. Its axis runs along the crest of the partially buried granite Mountains. Within the Gas Hills Project site, along the north flank of the Split Rock Syncline, the Wind River and younger formations were tilted one to three degrees to the south and cut with several east-west trending normal faults. Deposition also continued during the Miocene as aeolian and fluvial sediments were deposited in the Split Rock Syncline forming the Split Rock Formation.

Regional uplift during the late Plicoene and early Pleistocene started the present cycle of erosion in the area. The existing drainage was formed which included the Sweetwater River which flows east along the axis of the Split Rock Syncline and the Wind River which flows north through the Wind River Basin. These rivers define the present day topography in the Gas Hills area. Drainage south of the Beaver Rim flows into the Sweetwater River. Headwater erosion by north flowing Wind River tributaries created the Beaver Rim escarpment.

The known economic deposits within the Gas Hills Project site occur in the Tertiary (Eocene) Wind River Formation. Although Pre-Tertiary structures (faulting and folding) controlled the deposition of the Wind River Formation, they do not offset the formation, and therefore do not influence mining development of the uranium deposits within the site.

Normal faulting which occurred during the late Miocene and early Pliocene may have local effects on mining. These faults can either be subsidiary (i.e., those that limited displacement and/or are laterally or vertically discontinuous, and would not offset sand units to the point that hydrologic continuity may be interrupted) or traceable. Traceable faults are continuous, mappable faults which have a significant enough displacement to offset sand units to the point that hydrological continuity may be interrupted.

The Gas Hills Project has been divided into five local mining areas: Mine Unit 1, Mine Unit 2, Mine Unit 3, Mine Unit 4, and Mine Unit 5. These units correspond to the following deposits: Muskrat Deposit, Bountiful Deposit, Peach Deposit, Buss Deposit, and the Pix Deposit, respectively. These areas are shown in Figure 1 and briefly discussed below.

Mine Unit 1

Mine Unit 1 is located in the west central portion of the Gas Hills Project site (Figure A-2). Uranium deposits within this mining unit are contained in the 70 Sand (the Wind River Formation is composed of a series of sand and shale units, the sand units are numbered by even increments of ten starting with the deepest sand unit designated as 10 Sand). The 70 Sand is part of the Coyote Creek Fan System. There is a single sand layer, no identified traceable faults, and typically several hundred feet of hydrostatic head (confined water pressure). Ore within this unit is high grade.

The 70 Sand consists of medium to very coarse grained arkosic sandstone. This sand ranges in thickness from 20 to 80 ft. The 70 Sand is generally underlain and overlain by continuous shale beds that act as confining layers for water within the unit.

The confining units consist of shales and siltstones. The upper unit is continuous throughout the region and ranges in thickness from 55 to 150 ft. It separates the 70 Sand from several thin layers of discontinuous sandstones. The lower confining unit ranges in thickness from 20 to 50 ft. and separates the 70 Sand from the 50 Sand (sand units are not necessarily continuous throughout an area - e.g., in this case, the 60 Sand is not encountered beneath the 70 Sand as anticipated).

The 70 Sand in Mining Unit 1 is separated from the underlying formations by as much as 200 ft. of Wind River Formation sediment. The underlying Pre-Tertiary units are Triassic in age. There are no known traceable faults within the proposed mining unit. The Jasper Fault and the HBow Fault lie to the south of the unit. There has been no previous mine development within the proposed pattern of development.

Mine Unit 2

Mine Unit 2 is located in the east central portion of the Gas Hills Project site (Figure A-2). Uranium deposits within this unit are roll fronts within multiple sands (40, 50, 60, 70, and 80 Sands) which in this area are part of the Canyon Creek Fan System. The unit contains two traceable faults. Considerable attention will be given to mapping, hydrological testing, and to pattern planning in the vicinity of these faults and where discrete sand units come together.

The Mine Unit 2 sands consist of medium to very coarse akosic sandstones with cobble and boulder conglomerate interbeds. The individual sandstones within this area range in thickness from a pinchout to 100 ft. The sands are typically separated vertically by confining units of shale that can be up to 20-ft thick. In the planned vicinity of ore development, the confining units tend to be continuous. East of the planned development area, the shale interbeds disappear.

The upper confining unit for the 70 Sand consists of siltstone and claystone. It is continuous throughout the east central portion of the site and has a thickness that ranges from 75 to 400 ft. The confining unit below the 40 Sand is the Triassic Chugwater Formation. This formation is predominantly composed of shale and siltstone, and is not considered to be an aquifer (i.e., it would not provide significant quantities of groundwater). The total thickness of the Chugwater Formation is about 1,000 ft. Between the sand layers at the Mining Unit, there are shale layers that range from 5 to 20 ft. thick.

The proposed area of pattern development would cross two traceable faults, the Bountiful and the Uranium Point Zone (UPZ) Fault. The Bountiful Fault has a displacement of 40 to 50 ft. The UPZ Fault has up to 50 ft of displacement. Prior to mine development in this area, the faults will be hydrologically tested to determine their potential impact on mining.

Previous mining has occurred in the vicinity of Mining Unit 2. The UPZ mine shaft is located on the southern edge of Mine Unit 2. Federal American Partners commenced construction of this shaft in 1979. Construction was halted in 1983, at which time, the TVA poured a concrete floor in the bottom of the shaft and allowed it to flood. At the end of construction, the shaft was 880-ft deep. Pump stations were installed at 250 and 495 ft and the shaft is concrete lined. The shaft was reclaimed in 1991 and filled with materials removed from the shaft during its construction, as well as broken concrete from the reclaimed surface facilities, and capped with concrete.

Mine Unit 3

Mine Unit 3 is located in the western portion of the Gas Hills Project site (Figure A-2). The uranium production zones in this unit are roll fronts within multiple sands (30, 40, and 50 Sand) that are part of the Coyote Creek Fan System. This ore body is a southern extension of the Lucky Mc open pit mine. Pit dewatering over the years has lowered the potentiometric surface within the northern portion of the Mine Unit 3 (i.e., water levels have been reduced because water has drained from the sand unit). Because of insufficient water pressure, the upper geologic section of this unit may be excluded from development. This mining unit has two traceable faults as well as the abandoned Atlas underground mine. In order to develop this mining unit, additional mapping and hydrological testing will be required for pattern design.

The 30, 40, and 50 Sands consist of medium to coarse grained arkosic sandstones. The individual sands range in thickness from a pinchout to 50 ft. Within the planned development area, the sands are generally separated by confining claystones and siltstones that can be up to 30-ft thick. The 30 through 70 Sands coalesce along the northwest side of Mine Unit 3 and form a single hydrostratigraphic unit.

The upper confining unit to the 70 Sand is a claystone that is continuous throughout the proposed development area. This claystone ranges from 5 to 40 ft in thickness. The confining unit immediately below the 30 Sand is composed of claystones and mudstones of the Wind River Formation or shales of the Pre-Tertiary Formations.

Mine Unit 3 is underlain by the Morrison, Cloverly, Thermopolis, Muddy, Mowry, and Frontier Formations. The Morrison,Thermopolis, and Mowry Formations are not considered to be aquifers. The Cloverly Formation, which is considered to be an aquifer, is separated from the proposed production sand by confining units within the Wind River Formation. There are no aquifers within the Muddy Formation, and there is very little aquifer potential within the Frontier Formation.

The proposed development area for Mining Unit 3 would intersect the traceable PCH Fault. Hydrological testing would be performed to determine its potential impact on the proposed mining. The Peach pump test performed in 1996 indicates a zone of higher transmissivity (a measure of the ease with which water moves through a porous medium) near the Jasper Fault. In addition, water level data collected from wells in the area indicate that the Lucky Mc Fault located north of the planned development, may represent a hydrological barrier.

The Atlas Underground Mine was developed in the area of Mining Unit 3 in the 1960s and reclaimed in the 1980s. It is located in the western portion of the site. This mine developed underground ore in the 30, 40, and 50 Sands.

Mine Unit 4

Mine Unit 4 is located in the eastern portion of the Gas Hills Project site (Figure A-2). The uranium production targets in this unit are roll fronts located in the 50 through 90 Sands. These sands are part of the Canyon Creek Fan System. The reclaimed Buss open-pit mine located to the northeast of the proposed mining unit has lowered the groundwater level surface within portions of this mining unit. Roll fronts in the higher part of the section near the open-pit mine may be excluded from development because of insufficient water pressure.

The sand units of Mining Unit 4 consist of medium to very coarse grained arkosic sandstones with cobble and boulder conglomerate interbeds. The individual sandstones within this area range in thickness from 30 to 100 ft. The sands can be separated vertically by mudstone or siltstone interbeds which can range from pinchouts to fifteen feet thick. These confining units are not always continuous and frequently disappear allowing the sand units to coalesce.

An upper confining unit overlies the uppermost uranium bearing sandstone (90 Sand) throughout the mine unit area south of the Buss Fault. It has a thickness that ranges from 10 to 100 ft. A thinner (10 to 40 ft), locally continuous confining bed overlies the 80 Sand south of the Buss Fault. The confining unit north of the Buss Fault is shale on top of the 60 Sand (the 70 and 80 Sands are generally unconfined - the top surface of the groundwater is at atmospheric pressure). The shale on top of the 60 Sand has a thickness that ranges from 10 to 20 ft. The confining unit below the 50 Sand ranges from 5 to 30 ft in thickness and is continuous throughout the mining unit. This confining unit separates the 50 Sand from the underlying East Canyon Conglomerate.

Mine Unit 4 is underlain locally by a lower confining unit and over 300 ft of East Canyon Creek Conglomerate which either rests on a Wind River Formation shale or unconformably overlies the Jurassic Sundance Formation.

The proposed mining unit would intersect at least one known traceable fault, the Buss Fault. This fault has a vertical displacement of about 50 ft. A hydrological testing program would be used to determine the potential impact of this fault on mine development.

The Buss open-pit mine is located in the northeastern portion of the planned development area. It was reclaimed in 1995. The mine extracted ore from the 60, 70, 80, and 90 Sands. Reclamation of this mine has affected the overall water quality in the vicinity of Mining Unit 4. In addition, upper ore zones (80 and 90 Sands) were mined in the Two States and Blackstone Pits. An underground drift was developed south of the Two States Pit. Other open-pit mines in the area include the Cap, Bengal, and Mars Pits, which have been backfilled above the water table.

Mine Unit 5

Mine Unit 5 is located in the northeastern portion of the Gas Hills Project site (Figure A-2). The uranium production areas in this unit are roll fronts within the 50 Sand which in this area is part of the Canyon Creek Fan System. The reclaimed Veca Open Pit Mine, located west of the unit, has been backfilled above the water table. Historic mining in this open-pit mine has affected water quality in the vicinity of Mining Unit 5. The Thunderbird/Rox Mine is located within the northern portion of Mining Unit 5 and is likely to affect operations in the area. Additional mapping and hydrological testing will be required for pattern development.

The 50 Sand in the vicinity of Mining Unit 5 consists of medium to very coarse grained arkosic sandstones with interbeds of cobble and boulder conglomerate. The thickness of the 50 Sands in this area ranges from 50 to 70 ft. Because of the complexity of the sand layers in the vicinity of Mine Unit 5, no isopach map was prepared for the 50 Sand.

An upper confining unit overlies the 50 Sand throughout the mine unit area and ranges from 15 to 40-ft thick. The confining unit below the 50 Sand ranges in thickness from 20 to 40 ft. This confining unit separates the 50 Sand from the underlying East Canyon Conglomerate.

Mine Unit 5 is underlain by a lower confining unit and 250 ft of East Canyon Conglomerate which unconformably overlies the Jurassic Sundance Formation.

The proposed mining unit would intersect one traceable fault, marking the southern side of the Thunderbird Graben which is characterized by two parallel striking faults. The stratigraphic section between these two faults is downthrown by about 150 ft.

Mine Unit 5 is near several open-pit mines and several hundred acres of Abandoned Mine Land Program (AML), Umetco, and TVA reclamation. In addition, the Rox and Thunderbird underground mines, which are located within the Thunderbird Graben, were abandoned in the 1960s and reclaimed in the 1980s. A hydrological testing program will address the potential impacts of previous mine development, including the downgradient movement of high total dissolved solid (TDS) water from the abandoned mine reclamations.

Ore Deposit Geology

The uranium ore deposits are found within the Puddle Springs Arkose Member of the Eocene Wind River Formation. Alluvial fans were formed when high energy bedload streams with headwaters in the Granite Mountains deposited sedimentary loads on an incised erosional surface. After deposition and burial, uranium-bearing, oxidized groundwater solutions migrated down the permeable fluvial axes of the fans. Lobes of alteration spread parallel to the axes, and uranium was deposited at an oxidation-reduction interface (roll front) in a tongue-like geometry. Faulting and folding of the surface then complicated the geological picture.

The Gas Hills area is comprised of four distinct Eocene Wind River Formation alluvial fans and roll front systems. These are (from east to west): Deer Creek, Canyon Creek, Coyote Creek, and Muskrat Creek. The proposed Gas Hills Project contains a large segment of the Canyon Creek system and the eastern margin of the Coyote Creek system.

The uranium ore bodies within the Site are contained within channel sandstones and conglomerates of the Wind River Formation. The ore bodies, which occur as roll fronts, are typically 156 ft thick and vary in width from a pinchout to 100 ft. The fronts are anisotropic with the bulk of the high grade ore being contained within a few feet of the oxidation/reduction contact and the balance of the ore grading out from the contact point.

Uranite and coffinite are the uranium ore minerals found at the oxidation-reduction contact. Other minerals concentrated in varying degrees within the roll front complex include selenium, vanadium, molybdenum, arsenic, and iron (pyrite).

Other Mineral Resources

The Gas Hills Mining district has produced more than 100 million pounds of uranium ore over the past forty years. Three uranium processing facilities are located within close proximity of the Gas Hills Project. These facilities include the UMETCO Minerals Corporation, the Pathfinder Mines Corporation, and the American Nuclear Corporation facility. These facilities and the conventional mines that delivered ore to them have been, or are, in the process of being decommissioned and reclaimed. In addition to private sector mine reclamation, the State of Wyoming Abandoned Mine Lands Program has completed several mine reclamation projects in the area and continues to complete such projects.

There is no current oil or gas production within the Gas Hills Project or within two miles of the proposed site boundary. In addition, there are no known saleable minerals within the proposed site boundary.

2.6.2 Seismicity

Historical Seismicity. The Gas Hills Mining district is located in the south central portion of the Wind River Basin. Historically, central Wyoming has had a moderate level of seismic activity compared to the rest of the State. A discussion on historical earthquakes in the surrounding area (Atlantic City Area, Lander Area, Sand Draw/Gas Hills Area, and the Casper Area) is given below.

Atlantic City Area

The Atlantic City Area is located about 62 miles southwest of the Gas Hills Project. One of the first recorded earthquakes in central Wyoming occurred on December 10, 1873, near Atlantic City in southern Fremont County. It was felt as an Intensity III event in nearby Camp Stambaugh (Case 1996a). An Intensity V earthquake was reported from Atlantic City on December 12, 1923; no significant damage was reported (Humphreys 1924). Non-damaging earthquakes were also reported in the area on October 30, 1925 (Intensity III) and on August 22, 1959 (Intensity IV). On February 23, 1963, a magnitude 4.3 (Modified Mercalli), Intensity V earthquake occurred about 30 miles west, northwest of Atlantic City. No damage was reported. On November 3, 1984, a magnitude 5.0, Intensity VI earthquake was recorded approximately 10 miles northwest of Atlantic City. This earthquake was one of the strongest recorded in the southwestern quarter of the State.

Lander Area

The Lander Area is approximately 62 miles west of the Gas Hills Project. A number of earthquakes have occurred in the Lander Area. The first reported earthquake occurred on January 22, 1889, and had an Intensity of III-IV (Case 1993). This event was followed by an Intensity IV earthquake on November 21, 1895, which resulted in houses being jarred and dishes being rattled. On November 23, 1934, an Intensity V earthquake was centered about 20 miles northwest of Lander. Cracks were found in buildings in two business blocks and the brick chimney of the Fremont County Courthouse was moved two inches away from the building.

There were a series of earthquakes in the Lander Area in the 1950s that produced little damage. On August 17, 1950, there was an Intensity IV earthquake that caused loose objects to rattle and buildings to creak. On January 12, 1954, there was an Intensity II event, and on December 13, 1955, there was an Intensity IV event near Lander (Murphy and Cloud 1957), with no report of damage.

On June 14, 1973, a small earthquake was reported about 8 miles east northeast of Lander. This event has since been interpreted as a probable explosion. On January 31, 1992, a non-damaging magnitude 2.8 earthquake occurred approximately 20 miles northwest of Lander (Case 1994). This event was followed by a magnitude 4.0, Intensity III earthquake on October 10, 1992. Its center was approximately 22 miles east of Lander (Case 1994).

Sand Draw/Gas Hills Area

The first earthquake reported in the Gas Hills Area occurred on August 11, 1916, about 6 miles south of Jeffrey City (Reagor et al. 1985). No damage was associated with this Intensity III event. On April 22, 1973, a magnitude 4.8, Intensity IV earthquake was recorded approximately 12 miles north of Jeffrey City. On March 25, 1975, there was a magnitude 4.8, Intensity III earthquake recorded about 18 miles northwest of Jeffrey City. A mobile home 35 miles southeast of Riverton was moved one inch off its foundation. On December 19, 1975, a non-damaging magnitude 3.5 earthquake was recorded approximately 25 miles northeast of Jeffrey City (Reagor et al. 1985). On August 16, 1985, a magnitude 4.3, Intensity IV event was recorded about 25 miles northwest of Jeffrey City; no damage was reported. On June 1, 1993, a non-damaging magnitude 3.8, Intensity III earthquake occurred near Baroil, about 20 miles southeast of Jeffrey City (Case 1994).

Casper Area

The Casper Area is about 62 miles southeast of the Gas Hills Project. Two of the earliest recorded earthquakes in Wyoming occurred near Casper. The first occurred on June 25, 1884. It had an estimated Intensity of V. In homes on Casper Mountain, dishes rattled to the floor, and people were thrown from their beds. On November 14, 1897, an even larger event occurred. An Intensity VI-VII earthquake, one of the largest ever recorded in central and eastern Wyoming, caused considerable damage to a few buildings.

On October 25, 1922, an Intensity IV earthquake was reported in the Casper Area. Dishes were rattled, and hanging pictures were tilted near Salt Creek. On December 11, 1942, an Intensity IV earthquake was recorded north of Casper. On August 27, 1948, another Intensity IV earthquake was reported in the area. No damage was, however, reported. In the 1950s, two earthquakes caused concern. On January 24, 1954, an Intensity IV earthquake near Alcova occurred but did not produce any reported damage. On August 19, 1959, an Intensity IV earthquake was felt in Casper. Most recently, on October 19, 1996, a magnitude 4.2 earthquake was recorded about 15 miles northeast of Casper. No damage was reported.

Earthquake Design Considerations.

The Uniform Building Code (UBC) is a document that was prepared by the International Conference of Building Officials. Its stated objective is to provide minimum standards to safeguard life or limb, health, property, and the public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures within its jurisdiction. The Gas Hills Area is in Seismic Zone 1 of the UBC. Because effective peak accelerations (90 per cent chance of non-exceedance in 50 years) ranges from 5 to 10 per cent in Zone 1, an average peak acceleration of 7.5 per cent the acceleration of gravity (g) can be applied in designing a non-critical facility near the center of the zone (Case 1996b).

There are three exposed active faults in the vicinity of the Wind River Basin and the Gas Hills Project. Of these faults, the Green Mountain segment of the South Granite Mountain Fault System was analyzed deterministically to estimate the ground motion at the Gas Hills site. This fault was the only one analyzed because it is closer to the site than the other faults, its recurrence interval is shorter, and it can produce a maximum credible earthquake for the area. For the site, which is located about 28 miles from the nearest segment of the Green Mountain Fault, the expected horizontal ground acceleration at the site would be about 6%g for a magnitude 6.75 earthquake (Campbell 1987).

Within a tectonic province, earthquakes associated with buried faults are assumed to occur randomly. These earthquakes are designated as “floating earthquakes.” In a report by Algermissen et al. (1982), the Wind River Basin was assigned a floating earthquake with a magnitude of 6.1. This value was updated to 6.25 by Bernreuter et al. (1994).

In addition, Federal or State regulations usually specify if a floating earthquake analysis is required for a facility. For uranium mill tailing sites, the NRC requires analyzing the impacts of a floating earthquake with an epicenter 9 miles from the site. A magnitude 6.25 earthquake placed 9 miles from the Gas Hills Project site would generate horizontal accelerations of about 15%g (Case 1996b).

For short-term probabilistic seismic hazard analyses, USGS acceleration maps are frequently used. These maps are for return periods of 500, 1,000, and 2,500 years. Although the draft maps are subject to change, the 500-year map provides accelerations that are comparable to those derived from the UBC and from the deterministic analysis for the Green Mountain Segment of the South Granite Mountain Fault System. The acceleration in central Wyoming is 7%g for the 500-year map, and 20%g on the 2,500-year map.

For structure design within the Gas Hills Project, an acceleration of 7.5%g would be adequate (Case 1996b).

2.6.3 Soils

The soils that occur within the Gas Hills Project site are typical of the semiarid areas of the western United States. The greatest proportion of the upland soils are residual (developed in place) and are formed from weathered sedimentary bedrock. These soils reflect the character of the bedrock. The areas of sandy and medium-textured friable soils are underlain by sandstone and loamstone, while the heavy clay soils in the area are underlain by shale. The soils vary widely in both depth and suitability of the material for topsoil. The soils are, in general, shallow near the Beaver Rim and deep within the wide valleys that are characteristic of the site.

The ephemeral stream channels of the site are characterized by alluvial soils. These soils were developed from a variety of material washed from the uplands and redeposited along the stream channel. The characteristics of these soils are derived from their parent material.

Table 2.6-1 lists the soils found within the site and their estimated areas. A taxonomic classification of the soils is given in Table 2.6-2; properties are listed in Table 2.6-3. Soils maps are provided in Appendix D7 of the PRI license application (PRI 1998). As indicated in the above tables, the most prevalent soil type within the site is the Blackhall-Rock Outcrop Complex (Soil mapping unit 116). It covers almost 30 per cent of the total land area. The next most abundant soil types are Coalmont-Milren-Cragosen Complex, Rolling (Soil mapping unit 131) with about 20 per cent of the total land area, and Havre-Forelle-Glendive Complex (Soil mapping unit 158) with about 15 per cent of the total land area. About 10 per cent of the total land area is occupied by reclaimed areas (Soil mapping unit 229).

A number of the soils present within the site have limiting factors that limit their utility as a topsoil as a plant growth medium. For example, the Blackhall-Rock Outcrop Complex and the Havre-Forelle-Glendive Complex have a high alkalinity and a high pH, and the Coalmont-Milren-Cragosen Complex has cobbles/gravel near the surface (Table 2.6-3).

Table 2.6-1. Acres of Soil Mapping Units within the Gas Hills Project Site.

Soil mapping unit	Name	Acres present
116	Blackhall-Rock Outcrop Complex, Steep	2,427
131	Coalmont-Milren-Cragosen Complex, Rolling	1,605
136	Cragosen-Carmody-Blazon Complex, Hilly	245
137	Brownsto-Lupinto Complex	492
142	Diamondville-Forelle Association, Rolling	266
148	Forelle-Poposhia Association	73
158	Havre-Forelle-Glendive Complex	1,168
174	Milren-Bosler-Rock River Sandy Loams	808
186	Poposhia-Blazon-Carmody Complex, Hilly	216
229 (D)	Disturbed	318
229 (R)	Reclaimed	837
M	Unnamed Torrifluvent	28
R	Water surface (Reservoir)	17
Total		8,500

Table 2.6-2. Taxonomic Classification of the Predominant Soil Series within the Gas Hills Project Site.

Series name	Map unit	Taxonomic classificiation
Blackhall	116	Loamy, mixed (calcareous), frigid, shallow Ustic Torriorthent
Blazon	116	Loamy, mixed (calcareous), frigid, shallow Ustic Tottiorthent
Carmody	136	Coarse-loamy, mixed (calcareous), frigid, Ustic Torriorthent
Coalmont	137	Fine, montmorillonitic Borollic Paleargid
Cragosen	131	Loamy-skeletal, mixed (calcareous), frigid, shallow Ustic Torriorthent
Diamondville	142	Fine-loamy, mixed Borollic Haplargid
Forelle	158	Fine-loamy, mixed Borollic Haplargid
Glendive	158	Coarse-loamy, mixed (calcareous), fridig Ustic Torrifluvent
Havre	158	Fine-loamy, mixed (calcareous), frigid Ustic Torrifluvent
Milren	174	Fine, montmorillonitic Borollic Paleargid
Poposhia	186	Fine-loamy, mixed (calcareous), frigid Ustic Torriorthent
Rock River	174	Fine-loamy, mixed Borollic Haplargid

Table 2.6- 3. Estimated Suitability Ranges for the Dominant Soil Series within the Gas Hills Project Site.

Series name	Depth of suitable material for plant growth (in)	Limiting factors
Blackhall	0-6	alkalinity, high pH
Blazon	6-12	strong alkalinity, high pH
Carmody	18-24	strong alkalinity, high pH
Coalmont	12-18	alkalinity, high pH
Cragosen	0-6	cobbles/gravel near the surface
Diamondville	12-18	alkalinity, high pH
Forelle	36-48	alkalinity, high pH
Glendive	24-30	alluviated material
Havre	24-36	alkalinity, high pH
Milren	24-36	alkalinity, high pH
Poposhia	18-24	sodium hazard
Rock River	42-60	alkalinity, high pH

2.7 Hydrology

2.7.1 Surface Water

The Gas Hills Project lies primarily within the Wind River drainage basin. Only a small portion of the project lies within the Sweetwater River drainage basin. Surface drainage within the project is primarily to West Canyon Creek which flows to Canyon Creek. Canyon Creek flows to Deer Creek which is a tributary to Poison Creek. The southwest portion of the project drains to Fraser Draw which is a tributary to Muskrat Creek. Both Muskrat Creek and Poison Creek are tributaries to the Wind River.

Surface water exists in various forms within the project site. These include a number of springs, West Canyon Creek (spring-fed), reservoirs and ponds that are remnant of previous mining activity at the site. Surface flows are ephemeral in nature and drainage areas are usually dry. Stream beds and ponds may develop from intense thunderstorms or melting snow, however, these waters dissipate through percolation, runoff, and evaporation. The quality of the surface waters can vary significantly in terms of their chemical, physical, and radionuclide characteristics. However, in general, the surface waters on the project site are suitable for wildlife and livestock consumption.

2.7.2 Ground Water

2.7.2.1 Regional Aquifers and Aquitards

The Wind River Formation contains the aquifers of primary importance within the project area. It consists of alternating layers of sandstone, siltstone, claystone, and conglomerate. The water bearing sands and conglomerate units are collectively referred to as the Wind River Aquifer.

The Wind River Aquifer is underlain by a thick sequence of aquifers and aquitards. The primary aquifers in this sequence are the Cloverly Formation, the Nugget Formation, and the Pennsylvanian Tensleep Formation. Aquitards which underlie the Wind River Aquifer are the Frontier, Mowry, Thermopololis, Morrison, Sundance, Chugwater, Dinwoody, and the Amsden Formations. The Chugwater and Sundance Formations comprise the primary aquitards underlying the Wind River Formation beneath approximately 90 per cent of the project area.

The Wind River Aquifer is overlain by the Wagon Bed, White River, and Split Rock Formations. Of these formations, the primary aquifer is the Split Rock Formation. The Split Rock Formation consists of sandstones and conglomerates and is a significant ground-water resource south of the project area.

The regional water quality of the eastern and central portions of the Gas Hills Uranium Mining District transitions from a calcium-sulfate to a calcium-sodium bicarbonate-sulfate water in an upgradient to downgradient direction. In general the regional water quality ranges in pH from 6.5 to 8.4 and total dissolved solids from 264 to 1100 mg/L. The water from the Wind River Aquifer in the Gas Hills is Class III, suitable for livestock use in accordance with Wyoming Department of Environmental Quality/Water Quality Division Chapter VIII regulations. In the vicinity of uranium ore zones and roll front deposits elevated concentrations of radionuclides may occur rendering the water quality unsuitable for livestock use.

2.7.2.2 Site Aquifers and Aquitards

Uranium extraction will take place within 6 different sands of the Wind River aquifer. These are the 30, 40, 50, 60, 70 and 80 Sands. In some areas of the site these sands are hydraulically seperated by siltstone, clay, and shale beds, while in other areas of the site some of individual sand layers are hydraulically and stratigraphically interconnected.

Within the site boundary, uranium extraction will take place within 5 different mine units. From the southwest corner to the northeast corners these are Mine Units 3, 1, 2, 4, and 5. Within Mine Unit 3 uranium extraction will take place within the 30, 40, and 50 Sands. In Mine Unit 1, uranium extraction will take place in the 70 Sand. In Mine Unit 2 uranium extraction will take place within the 40, 50, 60, 70, and 80 Sands. In Mine Unit 4 uranium extraction will take place within the 50, 60, 70, and 80 Sands. In Mine Unit 5 uranium extraction will take place within the 50 Sand.

Wind River Aquifer ground-water flow directions within the site are generally toward the southwest with some local exceptions within the site boundary where the aquifer has been penetrated by open pit and underground mining operations. Localized faulting combined with discontinuous low permeability shale horizons have resulted in the perching of some saturated sand horizons above the main saturated sand aquifers of the Wind River Aquifer.

The ground-water gradient varies across the site. The gradient ranges from 0.045 ft/ft to 0.0017 ft/ft. The ground-water gradient in some areas of the site has been influenced by prior mining activities. Dewatering of open pits and underground mines in the East Gas Hills has resulted in stagnation of ground-water flow in some areas of the site. Water levels are expected to recover between 5 and 30 ft in this area due to the cessation of mining in the East Gas Hills. The gradient in areas near the dewatering effects of the Pathfinder C-4 Pit is approximately 0.0017 feet toward the north.

Transmissivity and horizontal hydraulic conductivity values for the Wind River Aquifer were determined from aquifer tests conducted on several wells in and near the site. Transmissivity values varied from 4.88 $x10^{-4}$ ft^2/min to 6.7 x 10^{-1} ft^2/min and horizontal hydraulic conductivity values ranged from 2.43 x 10^{-5} ft/min to 6.7 10^{-3} ft/min. Across the site hydraulic conductivities generally increase from east to west. Table 2.7-1 contains calculated hydraulic conductivities for each mine unit.

Table 2.7-1 Horizontal Hydraulic Conductivities Derived From Aquifer Tests

Area	Average Hydraulic Conductivity (ft/min)	Minimum (ft/min)	Maximum (ft/min)
Mine Unit 1	1.62 x 10^{-3}	9.67 x 10^{-4}	2.83 x 10^{-3}
Mine Unit 2	1.33 x 10^{-3}	6.52 $x10^{-4}$	4.65 x 10^{-3}
Mine Unit 3	2.94 x 10^{-3}	5.35 x 10^{-5}	6.70 x 10^{-3}
Mine Unit 4	8.40 x 10^{-4}	2.43 x 10^{-5}	2.76 x 10^{-3}
Mine Unit 5	2.46 x 10^{-4}	2.87 x 10^{-6}	7.16 x 10^{-4}

Storage Coefficients derived from the aquifer tests range from 8.53 $x10^{-5}$ to 1.28 x 10^{-3} and demonstrate that the Wind River Aquifer is an artesian aquifer. The average storage coefficient for the Wind River Aquifer throughout the site is 3.10 $^{x\,10-4}$.

2.7.2.3 Mine Unit Hydraulic Descriptions

For Mine Unit 1, geologic cross sections indicate that the production zone, the 70 Sand, is confined above and below by relatively thick, continuous confining units of the Wind River. The gradient is relatively flat in a northeast to southwest trending regional flow direction. Aquifer testing performed to date in Mine Unit No.1 indicates that the hydraulic conductivity of the 70 Sand varies from 9.67 x 10^{-4} ft/min to 2.83 x 10^{-3} ft/min. Within the 70 Sand, hydraulic conductivities are higher towards the west.

Well-field development in Mine Unit No. 2 is proposed for roll front deposits within the 40, 50, 60, 70, and 80 Sands. The sands typically are separated vertically by confining units which can range up to 20 feet in thickness, although the individual sand units coalesce into one unit in the eastern portion of Mine Unit No.2. The hydraulic gradient across Mine Unit No. 2 is very flat in the direction of regional flow (northeast to southwest). Mine Unit No. 2 is located downgradient from the historic East Gas Hills disturbance area. The flat gradient results from dewatering associated with the Buss Pit and other open pits and underground mining disturbances in the East Gas Hills. Water levels are relatively stable in the area, but are expected to recover once the water level in the adjacent disturbed area recovers, and the regional hydraulic gradient is reestablished. Hydraulic conductivities calculated from aquifer tests in Mine Unit No. 2 are fairly consistent ranging from 6.52×10^{-4} ft/min to 4.65×10^{-3} ft/min.

Well-field development in Mine Unit No. 3 is proposed for roll front deposits within the 30, 40, and 50 Sands. Within the area of planned pattern development, the sands are generally separated by thin siltstone and claystone units, which may range from 5 to 30 ft. in thickness. Throughout portions of Mine Unit No. 3 the 30, 40, and 50 Sands coalesce to form a single hydrostratigraphic unit. The upper confining unit is a claystone which underlies the 70 Sand and ranges in thickness from5 to 40 ft. The confining units underlying the lowest production sand are claystones and mudstones of the Wind River Formation or shales of the Mesozoic Frontier, Mowry Thermopolis, Cloverly or Morrison Formations. Based on deep drilling data from drill hole PCHMP97-1, there is not an underlying aquifer within 100 feet of the ore zone aquifers. Three faults and the abandoned Atlas underground mine are located in the area of Mine Unit No. 3 and may impact ISL operations. Hydraulic conductivities are highly variable and range from 5.35×10^{-5} ft/min to 6.7×10^{-3} ft/min. Ground-water flow gradient and direction have been influenced by dewatering of the Pathfinder Lucky Mc Mine to the north.

Well-field development in Mine Unit No. 4 is proposed within the 50 through 80 Sands south of the Buss Fault. North of the Buss Fault, development is proposed for the 50 and 60 Sands and possibly, the 70 Sand. An upper confining unit overlies the 80 Sand, south of the Buss Fault and ranges in thickness from 10 to 40 ft. North of the Buss Fault, the confining unit is the shale on top of the 60 Sand which ranges in thickness from 10 to 20 ft. The 70 and 80 Sands are generally unconfined north of the fault. A confining unit below the 50 Sand ranging in thickness from 5 to 30 ft. underlies the entire Mine Unit No. 4 area. This confining unit separates the 50 Sand from the underlying East Canyon Conglomerate.

Mine Unit No. 4 is located downgradient from the historic East Gas Hills disturbance area. The flat gradient in the area results from dewatering associated with numerous open pits and underground workings north and east of the mine unit. Water levels are relatively stable, but are expected to completely recover once the water level in the adjacent disturbed area recovers, and the regional hydraulic gradient is reestablished. Hydraulic conductivities in Mine Unit No. 4 are quite variable, but generally lower than the more western mining units, ranging from 2.43×10^{-5} ft/min to 2.76×10^{-3} ft/min.

Well-field development for Mine Unit No. 5 is proposed within the 50 Sand which ranges in thickness from 50 to 70 ft. An upper confining unit overlies the 50 Sand and ranges in thickness from 15 to 40 ft. The confining unit below the 50 Sand ranges from 20 to 40 ft. in thickness. This unit separates the 50 Sand from the underlying East Canyon Conglomerate.

The hydraulic gradient in Mine Unit No. 5 is steeper than the rest of the Amendment Area and corresponds to the lower hydraulic conductivities calculated from the baseline aquifer testing (2.87×10^{-6} ft/min to 7.16×10^{-4} ft/min). Water levels and water quality in wells in the vicinity of the Veca Pit may indicate the affects of historic mining upgradient from Mine Unit No. 5.

2.7.2.4 Ground-Water Quality

PRI has collected and analyzed water quality samples from 47 wells within the site area (PRI 1998, Appendix D6). Within the site, average total dissolved solids concentrations in the Wind River Aquifer range from 623 mg/L to 1887 mg/L. In areas affected by past mining and reclamation activities and where ground water has flowed through spoils, or where concentration of salts through evaporation has occurred in open pits, total dissolved solids can range from 1,000 to 3,070 mg/L.

Uranium concentrations in the ground water are relatively low in uranium ore and non-ore zones. The maximum recorded uranium concentration is 0.320 mg/L and the average is 0.04 mg/L. Radium-226 concentrations are higher in uranium ore zones and near mined out ore zones than in non-ore zones. Radium values in non-ore zones are in the 5-50 picocuries per liter (pCi/L) range and in the ore zones can average from 65 to 705 pCi/L. To put the non-ore zone radium concentration values in perspective, the EPA drinking water standard for combined radium-226/228 is 5 pCi/L. Trace metal concentrations in ore and non-ore zones are typically low, with most constituents below their detection limits. However, in ground water affected by past mining activities, some trace metals including iron, manganese and arsenic are routinely elevated. Within the mine units, pH typically ranges from 6.3 to 9.7. In ground water affected by past mining, pH values are generally lower (more acidic), ranging from 6.3 to 7.9. Table 3.2 contains average concentrations for each mining unit of major water quality constituents and radionuclides of the Upper Wind River Aquifer.

2.7.2.5 Water Use

Water use in the vicinity of the Gas Hills Project area is limited to livestock, wildlife watering and some minor industrial use by the Pathfinder and Umetco mining operations. There is no current domestic or irrigation use of either surface or ground water in the vicinity of the project site. The majority of all ground-water rights located within one-half mile of the site boundary are for miscellaneous use as monitor wells and represent no consumptive use of ground water.

With the exception of some springs, ground water rights within a two mile radius of the project site that are permitted for consumptive use are associated with mining related activities.
Several ground-water rights associated with springs are held by the Matador Cattle Company. These springs discharge from the Wagon Bed Formation which is stratigraphically above the Wind River Formation and crops out within the project site. However, no ISL mining activities will occur in these areas or within the Wagon Bed Formation and, thus, the springs should not be impacted.

Several other springs permitted for stock usage discharge from the upper stratigraphic units of the Wind River Formation within and adjacent to the project site. The elevations of these springs are significantly higher than the Wind River Aquifer water level elevation in the project site. The springs discharge from perched ground-water zones within the Wind River Formation and are located a minimum of one-half mile from any proposed disturbances. Surface disturbance of the spring areas will not occur. Uranium extraction will take place in stratigraphically lower and hydrologically isolated units. Cameron Spring is located hydrologically and topographically upgradient from the proposed Mine Unit No. 1 and should not be affected by ISL activities.

Due to the remoteness of the location and the marginal quality of the water in the Wind River Aquifer, future domestic or irrigation use of the ground water in the vicinity of the project site is unlikely.

Table 2.7-2 Average Concentrations of Major Water Quality Constituents and Radionuclides For Upper Wind River Aquifer, by Mining Unit[1]

Constituent	Units	Mine Unit 1	Mine Unit 2	Mine Unit 3	Mine Unit 4	Mine Unit 5
Alkalinity	mg/L	231	245	172	184	187
Ammonium	mg/L	0.2	0.2	0.3	0.1	0.1
Bicarbonate	mg/L	282	293	197	225	228
Calcium	mg/L	69	69	64	129	408
Carbonate	mg/L	0.1	3.8	5.1	0.1	0.1
Conductivity	μmhos/cm	943	881	1278	879	2088
Chloride	mg/L	18	11	20	7	61
Fluoride	mg/L	1.0	1.1	0.8	1.0	1.0
Magnesium	mg/L	15	13	14	25	74
Manganese	mg/L	0.06	0.10	0.02	0.07	0.40
Silica	mg/L	17	17	13	34	21
Sodium	mg/L	116	114	194	31	40
Sulfate	mg/L	236	219	451	298	1102
pH	mg/L	8.1	8.1	8.4	7.9	7.7
Potassium	mg/L	16	12	16	17	26
Radium	pCi/L	705	114	136	304	65
T DS	mg/L	623	573	863	660	1887
Uranium	mg/L	0.01	0.05	0.04	0.01	0.09
Zinc	mg/L	0.01	0.01	0.01	0.01	0.02

1. From Table D6-3-3 titled “Average Concentrations in Background Ground Water by Mining Unit, Upper Wind River Aquifer, Fall 1996-Fall 1997" of Appendix D6 of Power Resources, Inc. Gas Hills Project, Amendment Application for US NRC Source Material License SUA-1511, June, 1998.

2.8 Ecology

2.8.1 Terrestrial Ecology

2.8.1.1 Flora

Five native vegetation types occur within the project area — mixed sagebrush grassland, rough breaks, bottomland sagebrush, upland grassland, and wetlands (Table 2.8-1). Rough breaks were divided into east and west categories due to distinct differences in characteristics. Combined, these vegetation communities occupy 86 per cent (7,320 acres) of the approximately 8,500 acres of the Gas Hills Project area. The remaining 14 per cent of the site is occupied by reclaimed land, disturbed land, and reservoirs. Each vegetation type and the remaining land cover types are described in the following paragraphs. Wetlands are described more fully in Section 2.8.3.

Native vegetation communities are distributed across the project area in relation to topographic position and soil conditions. Community types intergrade and clear boundaries between communities are usually not present. Mixed sagebrush grassland is the most prevalent vegetation type in the project area and occupies uplands with moderately deep to deep loamy soils and rocky soils. Dominant species in mixed sagebrush grassland include big sagebrush (*Artemesia tridentata*), thickspike wheatgrass (*Agropyron dasystachum*), and threadleaf sedge (*Carex filifolia*).

Rough breaks vegetation occurs on relatively steep slopes with shallow, rocky or gravelly soils; rocky outcrops and bare slopes are common within this vegetation type. Dominant species in rough breaks vegetation include big sagebrush, threadleaf sedge, thickspike wheatgrass, and bluebunch wheatgrass (*Agropyron spicatum*). Occasional junipers (*Juniperus* spp.) and limber pines (*Pinus flexilis*) are also found in this vegetation type.

Bottomland sagebrush occurs in drainages and upland areas where deeper, moister soils occur. Dominant plants species in bottomland sagebrush include big sagebrush, Cusick bluegrass (*Poa cusicki*), and thickspike wheatgrass. Along the upper portions of West Canyon Creek, bottomland sagebrush vegetation included some willows (*Salix* sp.) and Fremont cottonwood (*Populus fremontii*).

Upland grassland occurs in relatively flat upland areas with somewhat saline soil conditions within mixed sagebrush grassland. Dominant plant species in upland grassland include threadleaf sedge, birdfoot sagebrush (*Artemisia pedatifida*), and thickspike wheatgrass.

The remaining land cover types are distributed unevenly across the project area and are based on past and current human use of the site. Reclaimed areas are of various ages and are dominated by wheat grasses (*Agropyron* spp.) and Indian rice grass (*Oryzopsis hymenoides*). Few shrubs have become established in any of the reclaimed areas of the site. Disturbed lands consist of existing mine pits, topsoil stockpiles, spoils piles, roads, and buildings. Reservoirs on the project area include a stock pond in Section 32, Cameron Spring Reservoir, and several reclaimed mine pits (Buss, Veca, A-8, and PC pits).

Although not occurring in large number, several species of noxious weeds are present on the site. These include musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), hairy whitetop

(*Cardaria pubescens*), field bindweed (*Convolvulus arvensis*), tansymustard (*Descurainia pinnata)*, little blue mustard (*Chorispora tenella*), and American licorice (*Glycyrrhiza lepidota*). These weeds are most common along drainages, roads, and disturbed areas. Selenium indicator species also occur in certain areas of the site. Such species included two-grooved milkvetch (*Astragalus bisulcatus*), multistem goldenweed (*Haplopappus multicaulus*), and woody aster (*Xylorhiza glabriuscula*).

2.8.1.2 Fauna

Surveys of the project area were conducted for big game species, upland game birds, raptors, and migratory birds of high Federal interest.

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only big game species that occur in the project area. Pronghorn are common on the site (survey counts ranged from 54 to 142 animals) especially in habitats dominated by big sagebrush. Mule deer generally are less common (survey counts ranged from 4 to 140) and frequent rough breaks and sagebrush habitats. For pronghorn, most of the project area is classified as spring/summer/fall range and the remainder is year-long range. For mule deer, most of the project area is classified as year-long range, but portions are considered winter/year-long and spring/summer/fall range. Range designated as "crucial" for both species by the State of Wyoming occurs several miles to the north of the project area.

Sage grouse (*Centrocercus urophasianus*) and mourning doves (*Zenaida macroura*) are the only upland game birds known to occur on the project area. Mourning doves are common residents on the site from spring through fall. Sage grouse inhabit the area year-round, but do not appear to be abundant. A single sage grouse strutting ground, located within a half mile of the northern permit boundary, is the only known strutting ground within or adjacent to the project area. Since 1990, the number of male grouse observed on this strutting ground during annual surveys has ranged from 3 to 18. The Wyoming Game and Fish Department reported 15 strutting males were observed during April 1999 in the SE 1/4 of Section 19, Township 33 N, Range 89 W, immediately adjacent to the project boundary (Wichers 1999).

A number of species of raptors are known to nest within the project area and use a variety of nesting substrates including the ground, trees, rock outcrops, cliffs, highwalls, and a man-made nest structure. Species known to nest on the site include red-tailed hawk (*Buteo jamaicensis*; 8 nests), ferruginous hawk (*Buteo regalis*; 49 nests), golden eagle (*Aquila chrysaetos*; 3 nests), prairie falcon (*Falco mexicanus*; 3 nests), and great-horned owl (*Bubo virginianus*; 1 nest). Other species that occur on the site but have not been observed nesting include Swainson's hawk (*Buteo swainsoni*), rough-legged hawk (*Buteo lagopus*), bald eagle (*Haliaeetus leucocephalus*), turkey vulture (*Cathartes aura*), northern harrier (*Circus cyaneus*), and American kestrel (*Falco sparverius*). The open sagebrush and grassland habitats on the site provide suitable foraging habitat for these species.

Migratory birds of high Federal interest that are known to occur in the project area are the bald eagle, golden eagle, ferruginous hawk, prairie falcon, and loggerhead shrike (*Lanius ludovicianus*). As discussed previously, the golden eagle, ferruginous hawk, and prairie falcon nest on the site. Loggerhead shrikes probably also nest in the area, but nesting activity was not observed. Although not observed on the site, the burrowing owl (*Athene cunicularia*) and mountain plover (*Charadrius montanus*) have been seen in adjacent areas.

2.8.2 Aquatic Ecology

Limited aquatic habitat exists on the project area and the ecology of these habitats has not been examined. Fish are not known to exist in any of the aquatic habitats present on site. Aquatic habitats on the project area include West Canyon Creek, Cameron Spring Reservoir, a small stock pond (Section 32 Pond), and four reclaimed mine pits. West Canyon Creek, a small, low-gradient, soft-bottomed stream, is perennial for much of its length (about 2 miles) through the project area. Wetland vegetation grows in and along the perennial portions of the stream channel. Other streams in the project area flow intermittently, and only during spring run-off and following heavy rainfalls. Cameron Spring Reservoir is spring-fed and holds water year-round although water level varies based on changes in precipitation and evaporation rate. Most of the reservoir edge supports emergent wetland vegetation. Section 32 Pond is a small stock-watering pond that captures runoff of an ephemeral drainage and frequently dries up in the summer; little wetland vegetation grows along the shores of this pond. Reclaimed mine pits on the site vary in water source (groundwater vs. surface water) and depth, but none supports a significant amount of emergent vegetation.

2.8.3 Wetlands

A jurisdictional wetlands delineation for the project area has not been conducted. However, 28 acres of potential wetland were mapped based on the presence of wetland vegetation. Most of this wetland vegetation exists along and within the stream channel of West Canyon Creek, but wetland vegetation also occurs along the margins of Cameron Spring Reservoir and several small seeps which issue from the base of the Beaver Divide in the southern portion of the site. Wetland species on the site include creeping spikerush (*Eleocharis palustris*), bulrush (*Scirpus pungens*), sedges (*Carex* spp.), and rushes (*Juncus* spp.). A small stand of willows (*Salix* spp.) occurs in the upper portion of West Canyon Creek.

2.8.4 Threatened and Endangered Species

No Federally listed plant species were observed during surveys of the project area. Plant species of concern that, based on records of the Wyoming Natural Diversity Database, are known to occur in the region include Devil's Gate twinpod (*Physaria eburniflora*), Cedar Rim thistle (*Cirsium aridum*), and Nelson's milkvetch (*Astragalus nelsonianus*). These species are all considered rare in the state.

The U.S. Fish and Wildlife Service (USFWS) determined that three species listed as threatened or endangered could occur on the project area based on the species' range (Table 2.8-2). These include the black-footed ferret, bald eagle, and peregrine falcon (Long 1999). The mountain plover is proposed for listing as a threatened species and the swift fox is a candidate for listing. None of these species are known to occur on the project area. No roosting habitat is available in the area for the bald eagle, and no prairie dog colonies exist within a mile of the project area boundary, precluding occurrence of the black-footed ferret. A survey of 550 acres of white-tailed prairie dog towns located three to five miles N of the project area in 1994 showed no evidence of black-footed ferrets. Suitable habitat appears to exist on the site for the mountain plover as plovers may inhabit open grasslands and nest and raise young in sagebrush communities where the sagebrush is short in status and has low canopy cover. No mountain plovers were observed during surveys conducted of the project area in April and May 1997. Suitable habitat also appears to exist for the swift fox, however, no evidence of swift fox use of the project area was found based on 1993 surveys. Peregrine falcons could use the area for hunting during migration.

The State of Wyoming does not maintain a list of threatened or endangered plant or animal species, but has established a non-game bird and mammal plan that includes a list of species of special concern (Wyoming Game and Fish Department 1996). All of the Federally listed animal species are considered by the State as species of special concern. In addition, the ferruginous hawk and merlin, both known to occur on the site, are species of special concern. The ferruginous hawk nests and forages over the project area; the merlin has been observed once there during migration and could use the site for foraging.

Table 2.8-1 Area of Vegetation Map Units on the Gas Hills Project Site.

	Total Site Area		Disturbed	
Vegetation Map Unit	Area (acres)	per cent of Area	Area (acres)	per cent of Area
Mixed Sagebrush Grassland	4,089	47.2	552	51.0
Rough Breaks East	1,512	18.7	216	20.0
Bottomland Sagebrush	991	10.8	93	8.6
Reclaimed Areas	844	10.3	98	9.0
Rough Breaks West	569	7.0	29	2.7
Disturbed Land	319	3.9	41	3.8
Upland Grassland	131	1.5	42	3.9
Wetlands	28	0.4	11	1.0
Reservoirs	17	0.2	0	0.0
Total	8,500	100	1,082	100

Table 2.8-2 Federally Listed Threatened, Endangered, or Candidate Species and Wyoming Species of Special Concern That Could Occur on the Gas Hills Project Permit Area.

Species	Federal Listing Status	State Status	Habitat Use and Potential Occurrence
Ferruginous hawk (*Buteo regalis*)	NL	SSC3	Known to occur and nest throughout the site.
Bald eagle (*Haliaeetus leucocephalus*)	LT	SSC2	Potential winter resident. Winter roosts in timbered draws in the area. Migrant through area.
Merlin (*Falco columbarius*)	NL	SSC3	Known migrant in permit area. Lack of trees precludes nesting.
Peregrine falcon (*Falco peregrinus*)	LE	SSC3	Potential migrant through area.
Mountain plover (*Charadrius montanus*)	C	SSC4	Potential occurrence in short grass prairie and shrub-steppe; nests in areas with sparse vegetation.
Black-footed ferret (*Mustela nigripes*)	LE	SSC1	No ferrets observed on the permit area; Potential resident in prairie dog colonies; no prairie dogs observed on permit area and nearest population of white-tailed prairie dogs is>1m N of the permit boundary
Swift fox (*Vulpes velox*)	C	SSC3	Potential occurrence in grassland areas.

Source: Long 1999, Wyoming Game and Fish Department 1996.

[1] Federal listing codes: NL = not listed, LT = listed threatened, LE = listed endangered, C = candidate for listing

[2] Wyoming does not maintain a list of threatened or endangered plants or animals. Animal species of special concern are categorized according to population and habitat status and range from SSC1 (most vulnerable) to SSC4 (least vulnerable).

2.9 Transportation

Surface transportation routes from the Gas Hills site (Carol Shop) to nearby population centers and the Highland Uranium Project include the following roadways:

• To Jeffrey City	33 miles of graded road
• To Casper	3 miles of graded road to Fremont County line, 25 miles of graded County road to Waltman, and 49 miles of paved U.S. Highway 20/26
• To Riverton	7 miles of graded road and 44 miles of State Highway 136
• To Highland Uranium Project Site	7 miles of graded road, 44 miles of State Highway 136, 1 mile of State Highway 789, 22 miles of U.S. Highway 26, 100 miles of U.S. Highway 20/26, 21 miles of Interstate Highway 25, 19 miles of State Highway 95, 8 miles of State Highway 93, 2.5 miles of paved County Road 32 (Highland Loop Road), and 2.5 miles of paved private road controlled by PRI.

Table 2.9-1 lists the 1997 and 1998 average daily traffic (trucks and all vehicles) counts for the roadway segments listed above (Birge 1999). Table 2.9-2 provides the annual average traffic accident rate (trucks and all vehicles) for the period from 1983 to 1998 for the roadway segments listed above (Birge 1999, Stout 1999a, Stout 1999b). Truck traffic is heaviest on Interstate 25 between Casper (East Yellowstone Intersection) and its junction with State Highway 95 (Deer Creek Intersection), while overall traffic volume is highest on the segments of Wyoming 789, Interstate 25, and U.S. 26. State Highways 93 and 136 are lightly traveled. The percentages of truck traffic with respect to all vehicular traffic averaged over the road segments listed in Table 2.9-1 ranged from 7 per cent on Wyoming 789 to 33 per cent on Wyoming 93. As indicated in Table 2.9-1, traffic volumes on these roadways changed little from 1997 to 1998.

State Highway No. 136 is expected to be used for commuting by a large portion of the work force for the Gas Hills project. The roadways to the Highland Uranium Project site comprise the route to be used to transport the product from the Gas Hills Project, i.e., the uranium-loaded resin. In this regard, PRI estimates that, during the period of uranium recovery operations, one truckload of approximately 500 cubic feet of resin will be transported from the Gas Hills Project to the Highland Uranium Project once per day for processing into yellowcake. The interstate highway, U.S. highways, and state highways are maintained year round. Other roads may be closed during inclement weather.

The railroad line closest to the Gas Hills site (Burlington Northern and Santa Fe Rail Road) runs from south-southeast to west-northwest direction approximately 30 miles north of the site at its closest point (Briden, 1999). The airports with regular airline services that are closest to the Gas Hills site include Riverton Municipal Airport about 47 miles west-northwest of the site and Natrona County International Airport about 56 miles east of the site (Spaeth, 1999).

Table 2.9-1 Annual Average Daily Traffic Counts for the Roadways from the Gas Hills Project Site to Jeffrey City, Casper, Riverton, and the Highland Uranium Project Site (1997-1998) [a]

Roadway	Segment Description	Segment Length (mi)	Trucks 1997	Trucks 1998	All Vehicles 1997	All Vehicles 1998
Graded road	Gas Hills site [b] to Jeffrey City	33	- [c]	-	-	-
Graded road	Gas Hills site to Fremont County line	3	-	-	-	-
Graded road	Fremont County line to Waltman	25	-	-	-	-
U.S. 20/26	Waltman to Casper	49	380-830	380-830	2,050-13,100	2,150-13,300
Graded road	Gas Hills site to Wyoming 136	7	-	-		-
Wyoming 136	End of Wyoming 136 to Wyoming 789	44	20-160	20-160	130-1,100	130-1,120
Wyoming 789	Wyoming 136 to U.S. 26	1	580-630	580-630	8,600-12,800	8,750-13,000
U.S. 26	Riverton to Shoshoni	22	530-730	530-730	2,710-13,800	2,750-14,000
U.S. 20/26	Shoshoni to Waltman	51	270-380	270-380	1,810-3,100	1,860-3,200
Interstate 25	Casper to Wyoming 95	21	1,380-1,820	1,390-1,830	6,450-13,320	6,650-13,520
Wyoming 95	Interstate 25 to Wyoming 93	19	50-60	50-60	210-2,700	250-2,750
Wyoming 93	Wyoming 95 to the end of Wyom7ing 93	8	50	50	150	160
Graded road	End of Wyoming 93 to Highland Uranium Project	10	-	-	-	-

[a] Ranges of data over the road segment. Daily traffic data are for both directions over a 24-hour period.

[b] At the Carol Shop.

[c] No data available.

Source: Birge, 1999.

Table 2.9-2 Annual Average Traffic Accident Rates Available for the Roadways from the Gas Hills Site to Jeffrey City, Casper, Riverton, and the Highland Uranium Project Site for the 1983-1998 Period [a]

Roadway	Segment Description	Segment Length(mi)	Trucks			All Vehicles		
			Injury	Fatality	All	Injury	Fatality	All
Graded road	Gas Hills site[b] to Jeffrey City	33	-[c]	-	-	-	-	-
Graded road	Gas Hills site to Fremont County line	3	-	-	-	-	-	-
Graded road	Fremont County line to Waltman	25	-	-	-	-	-	-
Graded road	Gas Hills site to Wyoming 136	7	-	-	-	-	-	-
Wyoming 136	End of Wyoming 136 to Wyoming 789	44	0.4	0.2	0.0	2.6	1.0	0.0
Wyoming 789	Wyoming 136 to U.S. 26	1	1.6	0.5	0.1	16.4	5.1	0.2
U.S. 26	Riverton to Shoshoni	22	7.0	2.1	0.4	65.8	22.6	0.9
U.S. 20/26	Shoshoni to Waltman	49	12.9	3.3	0.6	140.0	34.0	1.2
U.S. 20/26	Waltman to Casper	51	3.2	0.6	0.3	25.1	6.9	0.9
Interstate 25	Casper to Wyoming 95	21	7.0	1.5	0.1	54.7	17.8	1.1
Wyoming 95	Interstate 25 to Wyoming 93	19	0.3	0.0	0.0	5.9	1.5	0.1
Wyoming 93	Wyoming 95 to the end of Wyoming 93	8	0.3	0.1	0.1	0.6	0.3	0.1
Paved road	End of Wyoming 93 to Highland Uranium Project	5	-	-	-	-	-	-

[a] Annual average frequencies of accidents resulting in injury and fatality and all accidents, involving trucks only and all vehicles over the entire road segment.
[b] At the Carol Shop. [c] No data available.
Source: Based on Birge, 1999 and Stout, 1999a,b.

2.10 Visual Resources

Description of the visual resources potentially affected by the proposed plant site involves an assessment of scenic quality in the area of the proposed facility, followed by the establishment of distance zones at discrete intervals from the proposed site. Potential sensitivity to changes in the visual environment at key viewing points is then established, together with the likely number of viewers at each of these points. Finally, four visual resource classes are established as the basis for managing areas with particular visual characteristics.

Scenic Quality. The scenic quality of the area in which the proposed facility would be located was rated according to the BLM Visual Resource Management (VRM) inventory guidelines (BLM, 1986a). These guidelines classify discrete areas as A (lands of outstanding or distinctive diversity or interest), B (lands of common or average diversity or interest), or C (lands of minimal diversity or interest) based on their landforms, vegetation, water, color, adjacent scenery, scarcity and cultural modifications.

Within 20 miles of the proposed facility, the majority of land, including the site itself, is designated as Class C by BLM (BLM 1986b). There are small pockets of Class B land to the northwest of the site in the Castle Gardens area, to the south along Beaver Divide, to the southeast in the Sage Hen Springs area, and to the east in the Rattlesnake Hills area. Class A land is limited to a small area around the center of the Castle Gardens area and in the center of the Rattlesnake Hills around Garfield Peak.

Distance Zones. Distance zone categories, as defined in the BLM visual resource management system, were used to classify the area surrounding the proposed site. The foreground-middleground zone is the area between the viewer and a distance of 3 to 5 miles, the background zone includes the area 3 to 5 miles from the viewer up to 15 miles, and the seldom seen zone is the area more than 15 miles beyond any given viewing point.

The majority of the land surrounding the site falls within the foreground-middleground zone associated with travel routes in the vicinity of the site. A smaller portion of the area is classified as background zone associated with the various hills and washes further from the site. Land in the seldom seen zone is found in the area of Garfield Peak in the Rattlesnake Hills and in the center of the Castle Gardens area.

Visual Sensitivity. Public concern for change in scenic quality around the proposed facility is measured in terms of high, medium or low sensitivity to changes in the landscape from key observation points (KOPs). KOPs for the proposed site were established using information collected from field surveys. KOPs include travel routes within the viewshed of the site. Sensitivity ratings for the proposed site take into account the type of user, the amount of use, the level of public interest and adjacent land uses, and viewer duration. Data are based primarily on information collected from local public officials at BLM. Table 2.10.1 shows use rates, in terms of annual average daily trips, together with sensitivity levels for each KOP.

Table 2.10.1 Use Rates for Travel Routes in 1998

Key Observation Point	Location	Use Rates*	Sensitivity
County Road 212/Gas Hills Road	Northwest of the Site, between Jeffrey City and Waltman	Less than 100	M
State Highway 136	Northwest of the Site to Riverton	130	M

Source: Wyoming Department of Transportation, 1999.
* measured in terms of average annual daily trips.

Visual Resource Management (VRM) Classes. There are four VRM classes used by BLM to manage visual resources (BLM 1986). Class 1 allows for ecological changes and only very limited management activity, with a view to preserving the existing landscape. The level of change must be very low and not attract attention. Class 2 aims to retain the existing landscape, with changes repeating the basic elements of form, color and texture found in the most important landscape features. Class 3 aims for partial retention of the existing landscape with only moderate changes allowed, and Class 4 includes activities that lead to significant modification of the existing landscape.

The majority of the area within a 15-mile radius surrounding the proposed facility, including the land on which the site is located, is managed by BLM as Class 4 land (BLM 1986b). Elsewhere in the area, Castle Gardens, Rattlesnake Hills and Beaver Divide are managed as Class 3 land, with Class 2 land in the center of the Castle Gardens area and around Garfield Peak.

2.11 Background Radiological and Nonradiological Characteristics

PRI established a pre-operational monitoring and sampling program at Gas Hills to determine the baseline radiological characteristics of the soil, surface water, groundwater, and air at the proposed project site. PRI also conducted pre-operational monitoring and sampling to determine the baseline nonradiological characteristics of the surface water and groundwater.

2.11.1 Soil Characteristics

A radiological survey and soil sampling program was performed to establish the background radiological environment over the proposed project site, including those areas anticipated to be disturbed by ISL operational activities and those areas previously disturbed by conventional uranium mining activities in the Gas Hills area. The proposed project site was divided into grids and gamma measurements were taken at approximately one meter above the surface for each grid square. In general, the gamma exposure rates in the undisturbed areas of the project site averaged approximately 20 microroentgen per hour (micro-R/hr). To put this background radiation level in perspective, exposure at 20 micro-R/hr would result in an annual dose of approximately 175 millirem and the average individual in the U.S. receives a dose of about 300 millirem from all sources of natural radiation, including contributions from radioactive material in soil. However, those areas disturbed by previous mining activities, including areas containing ore and waste stock piles, generally exhibited significantly higher levels of exposure with readings in a few isolated areas as high as 900 micro-R/hr.

As expected, the gamma measurements generally correlate with the radium-226 concentrations in the upper 15 cm of soil. Gamma levels of 20 micro-R/hr are reflective of radium-226 soil concentrations of about 2 pci/gm.

2.11.2 Surface Water Characteristics

As noted in Section 2.7.1, the chemical, physical, and radionuclide characteristics of the various surface waters can vary significantly. However, consumption of surface waters is limited to livestock and wildlife and the surface waters are generally suitable for that purpose.

2.11.3 Ground Water Characteristics

The baseline radiological and nonradiological characteristics of the uranium host and most important aquifer for the Gas Hills Project, the Wind River Aquifer, are discussed in Section 2.7.2.

2.11.4 Air Characteristics

PRI established a pre-operational air monitoring program at four locations across the Gas Hills Project site for ambient gamma exposure and radon concentrations. Gamma measurements resulted in average exposure rates of about 170 mR/yr and the average radon concentration was 1.6 pCi/l.

3.0 DESCRIPTION OF THE PROPOSED FACILITY AND MINING PROCESS

3.1 Introduction

The surface facilities at the Gas Hills Project will include the Carol Shop building, well-fields, well-field header houses, satellite ion exchange facility, waste water disposal facilities (evaporation ponds), pipelines, pump stations, power lines and access roads. The Carol Shop building will house the central ion exchange and waste water treatment facilities as well as office, warehouse, maintenance, fabrication, and staging areas. A layout of the facilities and equipment in the Carol Shop building is provided in Figure A-4.

3.2 Well-Field Design and Operation

3.2.1 Well-Field Design

Each of the well-fields for the five mine units will be developed with interconnected groups of "5-spot" well patterns consisting of a central production well surrounded by a square array of four injection wells. The injection wells will be spaced on the order of 75 to 100 feet apart. Further delineation drilling of the ore body within each mine unit will determine the actual configuration of the well-fields to be developed. Underground piping will direct production and injection flow both to and from a header house for each well-field. Buried trunk-lines will carry production and injection flow to and from the site processing facilities in the Carol Shop building or satellite facility. Various monitoring wells will be installed within, above, below, and around each well-field for hydrologic testing, water sampling, and detection of migration of lixiviant. To minimize the potential for lixiviant migration, injection wells will be tested for mechanical integrity prior to use and every five years thereafter or after any repair work.

3.2.2 Well-Field Operations

The mine units at the Gas Hills Project will be developed in sequence or phases over an approximate twenty year period but the concept for well-field operations will be the same for each unit. The proposed lixiviant for the leaching process will consist of local groundwater fortified with sodium bicarbonate and/or carbon dioxide and an oxidant consisting of oxygen or hydrogen peroxide. The lixiviant will be pumped down the injection wells and into the ore body where it will dissolve the uranium from the mineralized zones as it is drawn towards the production wells. The resultant uranium-bearing solution (pregnant lixiviant) will be recovered by pumping from the production wells to the processing facility (Carol Shop building or satellite facility). In the processing facility, the dissolved uranium in the pregnant lixiviant will be stripped from solution in ion-exchange columns by adsorption onto the column resin beads. The barren lixiviant from the ion-exchange columns will then be recharged with chemicals and injected back into the well-fields to repeat the uranium leaching process. A small portion (approximately 1 per cent) of the barren lixiviant from the ion-exchange columns will be removed as "production bleed." Production bleed is necessary to generate hydraulic gradients which confine the lixiviant within the well-field production zone. The bleed stream will be treated by reverse osmosis and filtration and the reverse osmosis concentrate will be disposed in an evaporation pond. Six evaporation ponds will be constructed at the Gas Hills Project for waste water disposal. The purified stream from the reverse osmosis unit will be returned to the ore zone aquifer whenever feasible. Overall, approximately 99 per cent of all water withdrawn from the ore zone during leaching operations will be returned to the ore zone.

3.3 Uranium Recovery Process

Pregnant lixiviant will be passed through the ion-exchange columns until the column resin beads become saturated with uranium. At that point, the column will be taken off-line and the uranium-laden resin will be flushed from the column into a tank truck for transport to the Highland Uranium Project for final processing into yellowcake (U_3O_8). A flow schematic of the well-field operations and uranium recovery process is provided in Figure A-5.

As a satellite facility, there will be no final processing of uranium into yellowcake at the Gas Hills Project. Gas Hills Project operations will be limited to uranium recovery as described above.

3.4 Generation and Management of Wastes

3.4.1 Gaseous Wastes

Radon-222 is the most significant radioactive gaseous effluent as a result of operations. The radon is found in the ore body and the lixiviant. Potential release points are the well-fields, satellite building operations, and the evaporation ponds. Emissions directly to the atmosphere are expected to disperse rapidly and not represent a human health hazard. Forced ventilation to the atmosphere will be used to dissipate radon sources within the satellite buildings. These sources include non-sealed tanks, resin transfer from the ion exchange vessels into the resin trailers, and water sumps. Buildings will be monitored for radon buildup during operations and corrective

actions will be taken as necessary.
Other emissions such as fugitive dust and exhaust from diesel drilling rigs, gasoline powered vehicles, and other miscellaneous internal combustion engine powered equipment are not expected to be significant. These emissions are discussed further in Section 5.2.1.

3.4.2 Liquid Wastes

There will be four primary process waste water streams at the project during operations: well-field bleed, reverse osmosis (RO) brine fluids, well work-over water, and satellite wash down water. The water treatment facilities are concentrated in the Carol Shop Facility. All waste water will undergo filtration to remove suspended solids; volume reduced using RO, ultra-filtration, nano-filtration and/or brine concentration (brine concentration); solar evaporation of the concentrated brine; and re-injection into the aquifer. Surface discharge of the treated water is an available option but is not expected to be used. The restoration phase of the project first involves a ground water sweep phase, to create a cone of depression around the affected areas to minimize the escape of contaminated water from the area, followed by a RO sweep that treats the groundwater using RO and re-injects the treated clean water back into the aquifer.

Table 3.4-1 lists the water volumes estimated for Mine Unit Nos. 1 through 4 over the life of the planned operations. Sufficient hydrologic data does not yet exist to estimate the water volume for Mine Unit No. 5. The reverse osmosis brine fluids from all phases of the project will be sent to the evaporation ponds. It is estimated that the maximum annual volume of treated groundwater that will require disposal will be approximately 26 million gallons (Mgal). Approximately 203 Mgal of treated groundwater is expected to be disposed of in the evaporation ponds over the projected 20-year life of the project. Two ponds will have an active evaporation surface area of one acre each and the other four ponds will have active evaporation surface areas of three and a quarter acres each.

Domestic sewage will be handled by conventional septic/leach field systems. In addition to the existing permitted system at the Carol Shop building, others will be constructed at alternate satellite locations. These systems are only intended to receive non-contaminated wastes from restrooms, shower facilities and miscellaneous sinks located within the project facilities. An existing well provides the source of water for the showers and other sanitary facilities at the Carol Shop building. Temporary chemical toilets will be used in well-field and drilling areas when use of the satellite facilities is time consuming or inconvenient.

3.4.3 Solid Wastes

Non-contaminated wastes generated during operations will include office and food wastes, paper and wood products, and steel. These wastes will be temporarily stored on site and periodically transported to a municipal landfill by a contract waste disposal operator.

Radiologically contaminated wastes will be generated during the uranium recovery operations. These wastes will include process pipe and equipment, tanks and vessels, ion exchange resin, filter media, and the solid residue and liners from the evaporation ponds. Approximately 50 to 300 cubic yards of contaminated waste is expected to be generated per year at the project. PRI currently has a contract disposal agreement with Pathfinder Mines Corporation to dispose of these Gas Hills byproduct wastes at their Shirley Basin tailings facility.

During decommissioning and restoration, the evaporation pond residues, equipment removal, and building demolition wastes will be addressed. The evaporation pond residues and primary liner, along with any contaminated underlying soil, will be disposed of at an NRC licensed facility. The underlying leak detection system and secondary liner will be analyzed for contamination. Portions of these latter systems which do not meet NRC decommissioning criteria will be excavated and removed for disposal at an NRC licensed facility. Those portions that do meet the decommissioning criteria will be covered and reclaimed in place.

All equipment will be removed before building and structure demolition. The affected structures include the Carol Shop facility, header houses, pump stations, and the additional satellite building. Equipment to be removed are the process and water treatment facilities that include tanks, piping (above and below ground including all well-field piping and those connecting all facilities), pumps, and related equipment. All contaminated materials will either be decontaminated or removed for disposal at an NRC licensed facility. Non-contaminated material will be disposed of at an appropriately licensed facility or salvaged. Buildings and structures will either be salvaged or disposed of at an appropriately licensed solid waste facility. The remaining concrete floors will be broken up and the concrete debris buried in place. Estimated disposal volumes for buildings and equipment are presented in Table 3.4-2.

Table 3.4-1 Estimated Volumes of Water Requiring Treatment During the Gas Hills Project

	Mine Units			
	No. 1	No. 2	No. 3	No. 4
Total Contacted Volume (Mgal)	180.0	293.3	148.5	160.0
Required GWS Volume (Mgal)	194.4	294.5	155.7	214.5
Required RO Sweep Volume (Mgal)	232.5	483.6	232.5	288.3

Mgal = million gallons
Source: Gas Hills Project License Amendment Application

Table 3.4-2 Estimated Building and Equipment Waste Disposal Volumes for the Gas Hills Project

	Volume (ft^3)
Building Demolition (Remote Satellite and IC Pump Station)	326,912
Concrete Demolition (Remote Satellite and IC Pump Station)	13,376
Onsite Concrete Disposal	6,696
Mine Unit No. 1 Headerhouses	40,000
Process Facility Equipment	1,391
Process Facility Piping	144
Booster Station No. 1	56
Mine Unit 1 Buried Piping	
Pattern Piping	3,312
IC/PC Piping	19,899

3.5 Monitoring Programs

3.5.1 Ground Water

Ground water monitoring will be conducted prior to, during, and after ISL operations in each mine unit to characterize baseline water quality conditions, establish upper control limits (UCLs) for selected ground water parameters in each mine unit for detection of lixiviant migration during operations, and establish restoration target values (RTVs) for ground water quality in each mine unit upon the cessation of operations. Following ground water restoration in each mine unit, a stability monitoring program will be implemented to ensure that ground water quality remains in compliance with restoration target values.

3.5.1.1 Water Quality Monitoring

Numerous water quality monitoring wells will be located in and around the various well fields. Baseline water quality will be established from samples collected from the ore zone monitor wells, the underlying and overlying aquifer monitor wells (where present), and the mineralized zone monitor wells. The collected samples will be analyzed for the parameters listed in Table 3.5-1. The system of monitoring wells will provide the capability to determine whether mining solutions are being contained within the desired mining zone. Monitoring wells provided in aquifers both underlying and overlying the mineralized zone will be able to detect vertical excursions. For detection of horizontal excursions, an extensive set of monitoring wells within the mineralized zone will encircle the mining units. The UCL parameters that PRI has selected to monitor for lixiviant migration are ground water electrical conductivity and chloride and bicarbonate concentrations.

The UCL values for electrical conductivity and bicarbonate concentration will be the baseline mean plus five standard deviations. The UCL value for chloride concentration will be the baseline mean plus five standard deviations, or the baseline mean plus 15 mg/L, whichever is greater. An excursion will be confirmed if two of the three UCL parameters are exceeded. For the restoration of ground water following the cessation of operations within a mine unit, the RTVs will be based on the averaged baseline data for ground water quality for that mine unit.

Table 3.5-1. Baseline Water Quality Parameters.

Alkalinity
Ammonium
Arsenic
Barium
Bicarbonate
Boron
Cadmium
Calcium
Carbonate
Chloride
Chromium
Copper
Electrical Conductivity @ 25 degrees C
Fluoride
Iron
Lead
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Nitrate
pH
Potassium
Radium-226
Radon-222
Selenium
Sodium
Sulfate
Total Dissolved Solids
Uranium
Vanadium

3.5.1.2 Evaporation Pond Leak Detection Monitoring

PRI plans to construct six evaporation ponds for the temporary storage of process waste streams at the Gas Hills Project. All six ponds will be designed with primary and secondary liners and leakage detection and collection capability. The ponds will be constructed in pairs and designed with sufficient capacity to empty the contents of one pond into another in the event of a leak.

3.5.2 Environmental Monitoring

Surface waters will be routinely monitored in three locations when they have the potential for being impacted by the onset of ISL operations in that area of the site. These locations are the Cameron Spring Reservoir, the Section 32 Stock Pond, and the West Canyon Creek. The surface waters at these locations will be sampled and monitored for conductivity, pH, natural uranium, and radium-226. Additionally, the Carol Building Well will be routinely sampled (conductivity, pH, natural uranium, and radium-226) with well-field installation in Mine Unit No. 4.

4.0 GROUNDWATER RESTORATION, SURFACE RECLAMATION, AND PLANT DECOMMISSIONING

4.1 Groundwater Restoration

ISL operations at the Gas Hills Project will result in the enrichment of various constituents (uranium, chloride, bicarbonate, sulfate, trace minerals) in the groundwater. When ISL operations in a mine unit indicate that continued uranium recovery is no longer technically and economically practical, PRI will initiate groundwater cleanup to restore the affected groundwater to appropriate standards. In this regard, PRI's primary goal will be to return the groundwater within the mine unit to its pre-mining average water quality. If this primary goal is not attainable, PRI's secondary goal will be to restore the groundwater to pre-mining State of Wyoming class-of-use water quality standards. Baseline average groundwater quality in each mine unit will be established prior to the onset of ISL operations.

Groundwater restoration in a non-producing mine unit will occur concurrently with uranium recovery operations at other mine units at Gas Hills. Groundwater restoration will be conducted in a phased manner and will include the following steps, as necessary: groundwater sweep to pull back the edge of the affected groundwater to the peripheral wells in each mine unit pattern group, groundwater treatment by reverse osmosis and re-injection of the treated water (reverse osmosis permeate) to reduce the concentrations of the elevated constituents in the affected groundwater, addition of chemical reducing agents to the treated re-injection water to promote precipitation of dissolved uranium and any other trace heavy metals present in the groundwater, and addition of chemicals to the treated re-injection water for pH adjustment to assist in the removal of elevated constituents in the groundwater. Active restoration efforts will continue until both NRC and WDEQ agree that PRI has satisfied the restoration goals for groundwater quality. Following the cessation of active restoration efforts, PRI will implement a six month restoration stability monitoring program to determine that the groundwater remains in compliance with the restoration goals or, in the event of non-compliance, that further restoration efforts are needed. At the end of the stability monitoring program, both NRC and WDEQ will determine whether restoration has been successful or if further action is necessary (continued monitoring or additional restoration).

4.2 Surface Reclamation and Plant Decommissioning

PRI's general goals for surface reclamation and plant decommissioning will be to return the Gas Hills site to as near the pre-mining conditions and characteristics as are feasible and practical. The activities involved in the reclamation and decommissioning effort will include well plugging and abandonment, radiological surveying and sampling of all facilities and process related equipment and materials, decontamination of contaminated equipment and materials, dismantlement and removal of all buildings and structures, release or re-use of decontaminated equipment and materials, disposal of contaminated equipment and materials in an NRC licensed facility, radiological surveying of excavated building sites and the removal of any contaminated soil to an NRC licensed disposal facility, backfilling and re-contouring excavated areas with salvaged topsoil, and the reestablishment of vegetation on all disturbed areas.

Following the successful completion of groundwater restoration and acknowledgment of success by NRC and WDEQ, PRI will abandon all wells in accordance with State of Wyoming requirements. A detailed abandonment report will be completed for each well and this report will be filed with the State of Wyoming.

The facilities to be decommissioned will include all buildings and structures (Carol Shop facility, satellite building, header houses, and pump stations) and the process and water treatment components (pumps, piping, tanks, and related equipment) within these structures, all buried piping associated with the mine units and the process and water treatment facilities, and the evaporation ponds. Lastly, all roads utilized on the Gas Hills Project site will be reclaimed unless landowners and lessees request that roads be left in place.

Following the completion of the surface reclamation and plant decommissioning activities, PRI will perform a final soil gamma survey of the mine units and former building or surface equipment sites to ensure compliance with NRC cleanup criteria in 10 CFR Part 40, Appendix A, Criterion 6(6). As noted in Section 2.11, PRI conducted a radiological survey and soil sampling program at Gas Hills to establish the baseline radiological characteristics over the project site. The baseline radiological characteristics will serve as a basis for comparison with the post-reclamation and decommissioning results to confirm the acceptability of the cleanup effort or the need for further reclamation.

The final activity in the reclamation effort will be the reestablishment of vegetation in the affected areas of the project site. In this regard, PRI will utilize a seed mix to establish a vegetative cover consistent with the pre-operational land use for livestock grazing and wildlife habitat.

5.0 EVALUATION OF ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1 Introduction

The Gas Hills Project is located within the Gas Hills Uranium District, an area that has undergone extensive conventional uranium mining and recovery in the past. PRI proposes to operate the Gas Hills Project as a satellite ISL uranium recovery facility to the Highland Uranium Project. As a satellite facility, both the facility design and the operational activities will be limited to that needed to support uranium recovery. ISL uranium extraction has been practiced for more than 30 years and represents the state of the art in uranium recovery. In comparison with conventional uranium mining, ISL uranium recovery is the least invasive methodology with fairly minimal disturbance to the site surface area. In this regard, PRI estimates that less than 1275 acres will be disturbed at the 8500 acre Gas Hills Project site. As a licensee, PRI has significant experience in operating ISL uranium recovery facilities. Nonetheless, there are human health and environmental concerns associated with the proposed Gas Hills Project, including potential impacts from ISL operations on groundwater quality in the ore zone, storage of byproduct material wastes in, and leakage from, the evaporation ponds, and transportation of uranium-laden ion exchange resin to the Highland Uranium Project for final processing into yellowcake. The estimated environmental impacts from the construction, operation, reclamation, and decommissioning of the proposed Gas Hills Project are discussed in the following sections.

5.2 Air Quality and Noise

5.2.1 Air Quality Impacts

Air pollutant emissions associated with the construction, operation, reclamation, and decommissioning activities at the Gas Hills Project site will include emissions from fuel combustion and fugitive dust emissions from the following sources:

- Construction equipment and vehicles for site preparation, reclamation, and decommissioning of surface facilities,
- Well-drilling equipment and vehicles for drilling production and monitor wells,
- Natural gas- or propane-fired heating units for the satellite facility,
- Trucks for transporting construction materials as well as the product of the Gas Hills Project (uranium-laden ion exchange resin), and
- Light-duty vehicles for commuting by construction crew and employees.

The capacity and number of equipment and machines, and frequency and duration of operation for each of these emission sources are provided in Table 5.2-1. The maximum hourly air pollutant emission rates for the stationary sources (satellite facility heaters) and off-road construction equipment and machines during various phases of the Gas Hills Project are listed in Table 5.2-2. As shown in the table, the total hourly rates of emissions from these emission sources during various phases of the Gas Hills Project are estimated to be rather small. Therefore, their potential impacts on ambient air quality in the vicinity of the Gas Hills site are expected to be minor, and would not result in any violation of applicable Federal and State ambient air quality standards.

Air quality impacts of the exhaust emissions from operating vehicles associated with various phases of the Gas Hills Project are also estimated to be minor because only a small number of vehicles, most of them traveling only once a day, are involved in employee commuting and transporting construction materials and the product of the Gas Hills Project.

Fugitive dusts will be generated from construction sites and stockpiles of topsoil as well as from unpaved road surfaces especially during dry periods and under windy conditions. Plumes of fugitive dusts will be visible under these conditions. However, such visible plumes will be local and temporary, and would occur infrequently, as the size of disturbed areas surrounding individual well sites will be small and vehicle uses will be limited.

Unlike conventional mine sites, dirt-moving equipment, haul roads and large excavations are not used at ISL sites. Disturbed areas in each mine unit will be re-vegetated during the first available seeding window after construction is complete to minimize soil loss and fugitive dust emissions.

To minimize fugitive road dust emissions, the onsite speed limit for vehicular traffic will be restricted to 10 miles per hour. Water spraying will be employed to control fugitive dust emissions if it becomes excessive under unfavorable weather conditions. Therefore, no significant impacts on ambient air quality are anticipated from such fugitive dust emissions.

Table 5.2-1 Air Pollutant Emission Sources Associated with the Gas Hills Project during the Periods of Construction, Operation, Reclamation, and Decommissioning

Period	Stage/Purpose	Equipment Name	Model #/ Capacity	No. of Units	Freq. of Operation	Duration of Operation
Construction	Initial Construction/Well Field Road Construction	Scraper	CAT 651	1	8 hrs/day, 5 days/wk	2 months
		Bulldozer	CAT D9	1	"	"
		Motor Grader	JD 570B	1	"	"
	Well Preparation	Truck-mounted Rotary Drilling Rig, Semi-type Diesel Tractor Truck	GD1500	4 - 8	8 hrs/day, 5 days/wk	12 mo/yr
		Pump Pulling Vehicle	1-ton gas or diesel	2	"	"
		Motor Grader	JD 570B	1	"	3 mo/yr
		Backhoe	JD 710D	3	"	12 mo/yr
		Forklift	Case 586D	2	"	"
		Cementer	6 Cylinder Gas.	4	"	"
		Light-duty Truck		8 - 10	8 hrs/day, 7 days/wk	"
	Const. Material Transport	Heavy-duty Water Truck	1500 gal	4 - 8	"	"
		Heavy-duty Truck – Material Transport	Diesel	1	1 trip/day	2 mo/yr
	Commuting	Light-duty Vehicle from Riverton	Pickup/pass. car	15	"	6 mo/yr
		Light-duty Vehicle from Casper	"	15	"	"
Operation	Satellite Facility	Natural Gas- or Propane-fired Heater	0.4-0.5x10^6 Btu/hr	6	24 hrs/day	6 mo/yr
	Product Transport	Truck to Highland Uranium Project site via Riverton	Diesel Semi-Tractor and Trailer	2	1 trip/day	12 mo/yr
	Commuting	Light-duty Vehicle from Riverton	Pickup/pass.car	15-18	"	"
		Light-duty Vehicle from Casper	"	10-12	"	"
Decomm./ Reclamation	Reclamation	Scraper	CAT 651	1	2 x 8 hr shift/day*	2 – 3 yrs
		Motor Grader	JD 570B	1		
		Backhoe	CAT 245	2		
		Heavy-duty Truck	Diesel	3		
		Light-duty Truck	Pickup	15		
	Commuting	Light-duty Vehicle from Riverton	Pickup/pass. car	10	1 trip/day	"
		Light-duty Vehicle from Casper	"	10	"	"

* From May through October. One 8-hr shift per day from November through April.

Table 5.2-2 Estimated Maximum Hourly Air Pollutant Emissions from Stationary Sources and Off-road Construction Equipment and Machines during Various Phases of Gas Hills Project Mining Activity

	Maximum Hourly Emission Rate (lbs/hr)[a]			
Pollutant	Equipment and Machines during Initial Period of Construction/Well Field Road Construction	Equipment and Machines during Well Preparation Phase of Construction	Natural Gas- or Propane-fired Heaters during Operational Period	Equipment and Machines during Decommissioning / Reclamation Period
SO_2	0.7	0.9	0.0	0.9
NO_x	5.8	10.0	0.3	8.3
CO	1.8	3.2	0.2	2.6
VOC	0.4	1.1	0.2	0.8
PM[b]	0.6	0.9	0.2	0.8

[a] Emissions do not include vehicular emissions. Estimated based on the type, capacity, and number of equipment and machines listed in Table 5.2-1 and applicable emission factors from EPA (1985, 1999) .
[b] Emissions of particulate matter from combustion sources are estimated to be identical for TSP, PM_{10} and $PM_{2.5}$.

Table 5.2-3 Estimated Noise Levels of Off-road Construction Equipment and Machines to be Operated During Various Phases of Mining Activities

Equipment Name	Model #/Capacity	Sound Pressure Level (dBA)[a]
Scraper	CAT 651	88
Bulldozer	CAT D9	87
Motor grader	JD 570B	83
Drilling rig	GD1500	85
Backhoe	JD 710D	82
Forklift	Case 586D	80
Cementer	6-Cylinder Gasoline Engine	62

[a] Sound pressure level estimates are made at a distance of 50 ft from the equipment or machine based on the equipment capacity and data from Barnes et al. (1977) and FHWA (1978).

5.2.2 Noise Impacts

The major sources of noise during the construction, operation, reclamation, and decommissioning phases of the Gas Hills project are the off-road construction equipment and machines listed in Table 5.2-1. Estimated noise levels of these equipment and machines are listed in Table 5.2-3. Table 5.2-1 also indicates that the greatest number of equipment will be operated during the well preparation phase of the construction period.

Because noise-generating equipment and machines will be operated only during the daytime hours (8 hours/day, except for the warm seasons during the reclamation period when 16 hours/day activity is planned), there will be no noise impacts during other hours of the day. Workers at the site could be subjected to noise levels up to 95 dBA or higher at a location where several individual sources are simultaneously operating close together. Potential impacts on workers are expected to be minimal, however, because ANSI-approved and appropriately rated hearing protection will be utilized to protect these workers as required. Noise from the equipment and machines listed in Table 5.2-3 is expected to decrease to about 50 dBA within approximately 2 miles from the site. As stated in Section 2.5.3, there are no schools, hospitals, sport facilities, residences or parks within 2 miles of the Gas Hills site boundary.

5.3 Geology and Soils

Construction and operation of the Gas Hills ISL project will have no impacts on regional or local geology. Impacts from potential earthquakes and impacts to soils are discussed below.

5.3.1 Impacts from Seismic Activity

As discussed in Section 2.6.2, the Gas Hills Mining District is located in a region that has had a moderate level of earthquake activity compared to the rest of the State of Wyoming. Notwithstanding the moderate level of activity, the Gas Hills area is in Seismic Zone 1 of the Uniform Building Code seismic zone classification system and the area can be characterized as a region of low seismic hazard with regard to the potential for strong earthquake ground motion. A review of the seismic history of the region supports this classification as the record indicates that most of the seismic events in the region have been relatively low intensity of Intensity III, IV, and V on the Modified Mercalli Intensity Scale. Within a 65 mile radius of the Gas Hills Project, there has been only one recorded event as high as Intensity VI-VII (in Casper, 62 miles away) which caused considerable damage to a few buildings. Based on the seismic history of the Gas Hills Mining District over the past 150 years and a combination of deterministic predictions, Uniform Building Code maps, “floating earthquake” analyses, and USGS ground motion acceleration maps, an acceleration of 7.5per centg would provide an adequate basis for design of structures for the Gas Hills Project to protect the health and safety of workers and the environment. By following this design criterion, impacts from earthquakes would be expected to be minimal.

While ISL uranium recovery facilities can generally be characterized as low risk facilities and these risks can be further minimized with appropriate standards for facility seismic design as discussed above, there remains the potential for impacts to the environment from seismic activity at the Gas Hills Project. A seismic event could result in well-field pipeline systems leakage or failure. In this regard, all pipeline systems will have alarms to alert operations staff of upset conditions and flow sensors to shut the systems down on flow deviation from an expected range. A seismic event could also result leakage from evaporation ponds and leakage or rupture of tanks located either inside or outside of the facility buildings (Carol Shop and satellite). Evaporation ponds will be provided with leakage detection systems and design provisions in the form of berms around appropriate outside storage tanks and curbs, drains, and sumps for inside tanks will serve to mitigate impacts from tank leakage or failure. Most importantly, any impacts from seismic events would be expected to be temporary and localized as PRI will implement immediate remedial action as part of its Emergency Action Procedures to reclaim any affected areas. Thus, the staff concludes that environmental impacts from seismic activity at Gas Hills will be minimal with no long-term consequences.

5.3.2 Impacts to Soils

Construction of the Gas Hills project will disturb the local soils. Table 5.3-1 lists the soil types within the project, their associated areas, their disturbed areas, and the percent of total areas disturbed. Of the total 8,500 acres within the project, about 1,082 acres would be disturbed (13 per cent). Of the disturbed soils, the Blackhall-Rock Outcrop Complex (Soil mapping unit 116) would have the largest number of disturbed acres (371 acres). Because there are about 2,427 acres of this soil type present, the percentage disturbed would be about 15 per cent. The largest percentage of disturbance would occur for Soil mapping unit M (unnamed Torrifluvent - 36 per cent). However, there are only 28 acres of this soil type within the project area.

During the delineation drilling, well-field installation, and installation of the ring of monitor wells, topsoil would be segregated and replaced as the well patterns developed outward from their initial locations. Following the delineation drilling phase, well-field designs would be prepared to define the limits of the ore body. The well-field design will include injection, recovery, monitor well locations and surface facilities (e.g., header houses, pipelines, and power lines).

Because the areas disturbed are small relative to the total land area available and the soils would be replaced, impacts to the soils would range from small during construction and operation to negligible after reclamation.

Table 5.3-1. Soil disturbance estimates from mining activities on the Gas Hills Project Site

Soil unit	Name	Acres present	Acres disturbed	Percent disturbed
116	Blackhall-Rock Outcrop Complex, Steep	2,427	371	15
131	Coalmont-Milren-Cragosen Complex, Rolling	1,605	129	8
136	Cragosen-Carmody-Blazon Complex, Hilly	245	57	23
137	Brownsto-Lupinto Complex	492	93	19
142	Diamondville-Forelle Association, Rolling	266	47	18
148	Forelle-Poposhia Association	73	0	0
158	Havre-Forelle-Glendive Complex	1,168	240	21
174	Milren-Bosler-Rock River Sandy Loams	808	0	0
186	Poposhia-Blazon-Carmody Complex, Hilly	216	0	0
229 (D)	Disturbed	318	41	13
229 (R)	Reclaimed	837	94	11
M	Unnamed Torrifluvent	28	10	36
R	Water surface (Reservoir)	17	0	0
Total		8,500	1082	13

5.4 Water Resources

5.4.1 Surface Water

The surface waters and drainage areas at Gas Hills consisting of West Canyon Creek and various springs, ponds, and reservoirs have the potential for being impacted by piping failures and leaks during well-field operations. However, these impacts are expected to be minimized with the protective features employed in well-field design. Production and injection wells will be instrumented with pressure-sensitive switches to shut down the well-field in the event of a piping failure. Additionally, instrumentation will be installed in each header house to detect fluids on the floor of the house and terminate electrical power to the production wells.

5.4.2 Groundwater

The expected impacts to groundwater from operational activities at Gas Hills are primarily related to groundwater consumption and the degradation of groundwater quality within the ore zone, including degradation resulting from any excursions (the unintended migration of lixiviant beyond the expected confines of a well-field or mining unit). However, any impacts from both consumption and degradation will be temporary and localized.

Groundwater will be consumed during both ISL production and well-field restoration activities with the bulk of this groundwater being returned to the environment from which it was withdrawn. A small amount of the groundwater withdrawn will be evaporated as a bleed stream from production and restoration operations. The estimated groundwater consumption at the Gas Hills Project is 80 acre-feet per year. For a projected 20 year project life, approximately 1600 acre-feet of groundwater will be consumed. This consumption could result in the temporary lowering of water levels in the immediate vicinity of the well-fields.

During ISL uranium recovery operations, the groundwater quality within the ore zone well-field will be significantly degraded. However, this degradation will be temporary as PRI's primary goal will be to restore the groundwater quality to baseline conditions by subsequent well-field restoration. If groundwater baseline conditions are unattainable, PRI will restore the groundwater to at least the pre-mining State of Wyoming class-of-use water quality standards. Groundwater beyond the confines of the well-field may also become degraded from excursions which may occur one or more times during the 20 year project life. In this regard, groundwater monitor wells surrounding each well-field will provide the capability to detect these excursions before they can migrate a significant distance from the well-field. Upon detection, corrective action will be applied by controlling flows from the production and injection wells and modifying the production bleed flow rate. Any areas impacted by excursions will also be restored to baseline water quality. As such, expected impacts would be both temporary and localized and there are no nearby domestic or irrigation wells that could be impacted by excursions.

5.5 Socioeconomics

5.5.1 Economic Activity

Tax Revenues. During construction and operation, the proposed facility will pay a variety of taxes to Federal, State and local governments, including employee income taxes, severance taxes, property, and sales taxes. On an annual basis, royalties are expected to amount to $3.6m, with the remaining taxes contributing $2.6m to Federal, State and local government finances.

Employment and Income. The project will employ a mix of temporary contractor and full-time personnel throughout the life of the project. During the construction of each mine unit approximately 50 contractor drilling personnel will be employed, with an additional 15 to 20 full-time employees. During operations, only a small number of contractor installation personnel will be required, together with approximately 30 full-time employees. On an annual basis, the project workforce will produce $3.0m in payroll that will be spent in the local economy.

It is expected that the majority of contractors and full-time employees will live in Fremont County, primarily in Riverton, with the remainder living in Natrona County, mainly in Casper. A significant amount of overall employment during construction would be of a temporary nature as the construction of each mine unit would be undertaken mainly by local drilling contractors. In addition to the direct benefits of payroll spending in the two communities, indirect benefits will also occur as payroll dollars circulate throughout the remainder of the economy. Table 5.5-1 indicates the extent of the overall impact of the project on local employment and income calculated using the IMPLAN model (IMPLAN 1999). Shown are the average annual impacts of the project compared to the local economic baseline in each county in 1998.

In Fremont County, where the majority of employees would reside, the project would support, on average, 30 direct and 30 additional indirect jobs. In Natrona County 20 direct and 10 indirect jobs would occur. In addition to employment, payroll generated by the project would also produce, on average, an additional $0.4m in income in Fremont County and $0.2m in Natrona County in each year of project life. Employment and income that would be generated as result of the project would provide moderate benefit to regional productivity measured in terms of both private and public investment that would likely occur.

Table 5.5-1. Potential Socioeconomic Impacts* from Mining Activity on the Gas Hills Project Site.**

	Fremont County		Natrona County	
	Impact	Percent change over baseline	Impact	Percent change over baseline
Employment				
Direct	30		20	
Indirect	30		10	
Total	60	0.3	30	0.1
Income ($m)				
Direct	2.0		1.0	
Indirect	0.4		0.2	
Total	2.4	0.6	1.2	0.1

*Average annual impacts of construction and operating employee spending, not including impacts of procurement of material and services, royalties and taxes.
**Calculated using the IMPLAN Model (IMPLAN, 1999)

5.5.2 Housing and Community Infrastructure

It is likely that construction and operation of project facilities will be undertaken primarily with a workforce already resident in Fremont and Natrona County with little if any in-migration from elsewhere in the state or country. In 1996, 9.6 per cent of total housing units were vacant, with almost 17 per cent vacant in the county as a whole. In Natrona County the vacancy rate was even higher at 18 per cent. It is likely therefore that the housing markets in both Riverton and Casper will be able to absorb any new in-migrants that might move to the area as a result of the project.

It is also likely that the local school systems and public service infrastructures in Riverton and Casper will be capable of accommodating any additional demand for their services. However, if additional infrastructure were needed, tax dollars flowing back to the two communities as a result of revenues collected from the project would likely be adequate to cover any small increases in infrastructure demand.

5.6 Land Use of Proposed Site and Surrounding Area

Recreation. There would likely be a small decline in recreation opportunities like hunting in the Gas Hills Project area as acreage is taken out of public use for project construction and operation. In addition to the fencing that will be provided around all well fields, evaporation ponds, and satellite facilities to prevent livestock damage, PRI will post signs, as appropriate, to prevent hunting in the area for the protection of the workforce. In this regard, PRI will coordinate with the BLM for the placement of signs. Well-field reclamation and re-vegetation policies are likely to enhance big game and other wildlife habitats in the area close to the proposed facility location following completion and shutdown of the project. As a result, recreation opportunities in the area, particularly big game hunting, should not be affected in the long term (PRI 1998).

Transportation. With the improvement and maintenance of local roads in the Gas Hills area as a result of the project, access to the Gas Hills area and Beaver Rim are likely to be improved (PRI 1998).

Property Values Approximately 1,100 acres would be removed from other economic uses for the proposed facility. During construction and operation it is likely that the effect of the facility on property values would be positive, with the required land currently used for livestock grazing, at fairly low utilization rates. At the end of the life of the project all land removed from grazing use would be re-vegetated and restored, and returned to its former use with no effect on real long term property values. Grazing land adjacent to land used for the project would not likely lose value as it is likely that current use patterns would continue if the project were approved.

5.7 <u>Cultural Resources</u>

5.7.1 Section 106 of the National Historic Preservation Act

Pursuant to the requirements of Section 106 of the National Historic Preservation Act of 1966 and the Advisory Council on Historic Preservation regulations provided in 36 CFR Part 800, the NRC, in consultation with the BLM, WY SHPO, and PRI, has developed a Programmatic Agreement to ensure that identified cultural resources are appropriately managed and protected at the Gas Hills Project (NRC 2003b). The PA includes provisions to ensure that all areas of the site potentially affected by construction activities will be adequately surveyed for cultural resources prior to disturbance. Treatment plans will be developed for any properties found to be eligible for the National Register and incorporated into PRI's Operations Plan. Treatment plan implementation and results will be documented in cultural resources reports. With these provisions, the PA will serve to minimize the potential for adverse impacts to cultural resources at the Gas Hills Project. Discussion of potential impacts to specific cultural resource sites at the Gas Hills Project is provided in the following sections.

5.7.2 Archaeological Sites

Of the nine sites recorded by Pronghorn Archaeological Services that are eligible or potentially eligible for the National Register, four are located outside of the mine unit boundaries and would not be impacted by project activities (i.e., Sites 48FR144, 48FR3235/48NA2151, 48FR3236, and 48FR3239). Site 48FR3874 is located outside of the mine unit boundaries but in the vicinity of a proposed power corridor to one of the alternative satellite facilities and the Carol Shop Road. Although no direct impact to this site is anticipated, additional care should be taken to ensure that the site is avoided and PRI has agreed to physically avoid this site during access road or pipeline construction. PRI has also agreed to avoid Site 48FR3232 (see Section 5.7.3).

Two of the three remaining sites are located in one of the mine units (Sites 48NA419 and 420). Site 48NA421 is located just outside of the Mine Unit IV boundary and would not be impacted.

Because Sites 48NA419 and 48NA420 are located near the boundary of Mine Unit IV, it may be possible to avoid these sites. If avoidance is not possible, further evaluation of the sites will be conducted to determine whether they contain buried prehistoric deposits and whether they meet eligibility criteria for listing on the National Register. If the sites are determined not eligible in consultation with the Wyoming State Historic Preservation Office (WY SHPO), no alteration of the proposed mine unit would be necessary. If the sites are determined eligible, and avoidance is still not possible, mitigation measures would have to be determined in consultation with the WY SHPO, and could include data recovery.

There is one standing structure from historic mining operations that is extant near Mine Unit V. The structure is outside the proposed mine unit boundary and should not be impacted by the proposed action. No impacts to cultural resources are anticipated within Mine Unit V because of the extent of prior disturbance. However, further survey of any undisturbed areas within the mine unit may be required by the WY SHPO.

5.7.3 Native American Sites

Eastern Shoshone and Arapaho Elders were consulted regarding the proposed project (Kelly 1998). One site, Site 48FR3232, was determined to be potentially threatened by the project, and the Eastern Shoshone Elders requested that all surface disturbances be kept at least 50 ft away from the site. PRI agreed to avoid this site during its activities. The Native American Elders expressed no other concerns related to the project. None of the proposed activities appear to encroach on any area within 50 ft of Site 48FR3232; therefore no impacts are anticipated to sacred sites, traditional cultural properties, or resource collecting localities as identified by the Native American Elders.

5.8 Ecology

5.8.1 Terrestrial Ecology

5.8.1.1 Flora

PRI estimates that approximately 1,275 acres within the 8,500 acre site would be disturbed during mining activities. The greatest impact to native vegetation will occur in the well-field areas during construction of injection and extraction wells, pipelines, header houses and vehicles access areas (hereafter secondary access roads). The bottomland sagebrush and rough breaks communities would experience the most significant impacts from construction and operation with 552 and 245 acres of disturbance respectively. Upland grassland vegetation would experience the most potential disturbance, in proportion to its abundance on the permit area, estimated to be 42 of the 131 total acres. The estimated disturbance to all vegetation communities occurring on the site is provided in Table 5.8-1. The reclaimed areas to be disturbed are mostly dominated by wheat grasses (*Agropyron,* spp.), and Indian ricegrass (*Oryzopsis hymenoides).* No shrubs have become established in these areas.

PRI intends to re-vegetate all disturbed areas with a seed mixture that complies with the guidelines established by the WDEQ, Land Quality Division. Once the well-fields are constructed, all disturbed areas will be graded, covered with stored topsoil, and seeded. The mixture will include three species of wheatgrass (*Agropyron*, spp.) Indian ricegrass, green needlegrass (*Stipa virdula*), Gardner saltbush (*Atriplex gardneri*), shadscale saltbush (*Atriplex* *confertifolia*), yellow sweetclover (*Melilotus officinialis*), and cicer milkvetch (*Astragalus cicer*). Substitutions to the seed mixture may be necessary when seed is unavailable or cost prohibitive, subject to WDEQ approval. The NRC staff believes that the amount of grading required at each disturbed well-field location should be evaluated on a case by case basis to avoid removal of shrubs and shrub rootstock that can readily become established after seeding. This approach can improve the potential for re-establishing the structural diversity of vegetation present before the disturbance. Experience at the Jim Bridger Coal Mine in the Red Desert of Wyoming showed that re-vegetation success was greatest where shrub root material was present in the topsoil (Dvorak (ed), 1984).

Noxious weeds that may invade areas disturbed by construction or operation will be controlled on a regular basis. PRI will use herbicides to control noxious weeds both on disturbed areas as well as other portions of the site. Application will be by hand sprayers or broadcasting using truck-mounted spraying equipment. The types of herbicides used will depend on target species and recommendations of the Fremont County Weed and Pest Control Office. Noxious weeds known to occur on the site are listed in Section 2.8.1.2.

No trees are expected to be disturbed by mining operations in the rough breaks vegetation community or elsewhere in the site. Limber pine (*Pinus flexilis*) and junipers present along ridges W of Carol Shop Road approximately 0.5-0.8 mi W of Mine Unit 5 have been used as nest sites by raptors. If the mine plan changes to require tree removal, trees will be replaced in kind, subject to WDEQ, Land Quality Division approval.

Table 5.8-1 Vegetation Types and Habitats Affected by *In-Situ* Leach Uranium Mining in the Gas Hills Project Site

Vegetation Community/ Habitat Type	Acreage in Permit Area	Area Affected	Estimated Percent Affected
Mixed Sagebrush - Grass	4,089	552	13.5
Rough Breaks (West Area)	569	29	5.1
Rough Breaks (East Area)	1,512	216	14.3
Bottomland Sagebrush	991	93	9.4
Upland Grasslands	131	42	32.1
Reclaimed Mined Areas	844	98	11.6
Disturbed Land	319	41	12.9
Wetlands	28	11	64.7
Reservoirs	17	0	0
Total	8,500	1,082	12.7

Source: PRI 1999a

5.8.1.2 Fauna

Construction activities in the well-fields of all five Mine Units would result in some loss of wildlife habitat, however, this loss would be only temporary as disturbed areas will be reclaimed and re-seeded when construction is completed in that area. The impacts are expected to be most extensive in bottomland sagebrush communities where clearing would be required to construct wells, secondary access roads, header houses and pipelines from the well-fields to the header houses. Habitat loss is not expected to reduce local wildlife populations because of the small percentage of land affected compared to the total bottomland sagebrush acreage within the site that would not be disturbed (see Table 5.8-1). Small mammals and songbirds dependent on shrubs for food, nesting, and cover would be impacted in areas where clearing is needed for construction. PRI does not intend to clear shrubs in order to gain vertical clearance for drilling equipment whether in the well-fields or during exploratory drilling to define the spatial characteristics of the uranium ore deposits.

After construction of the well-fields is completed, all disturbed areas will be re-vegetated with a seed mixture of grasses, forbs, and shrubs approved by the WDEQ Land Quality Division. Based on observations at the Highland Uranium Project during site visits in November 1998 and July 1999 where mule deer and pronghorn were observed grazing in re-seeded areas with operating well-fields, re-vegetated areas at the Gas Hills Project are likely to attract species such as the white-tailed jackrabbit, desert cottontail, small rodents and large herbivores.

No impacts to big game species are expected from displacement of individuals in disturbed areas. Available habitat exists within the site and adjacent areas to support displaced individuals. Some localized foraging areas may be avoided by big game during construction periods when workers are present. Noise, dust, and increased presence of workers in or adjacent to foraging areas may temporarily preclude use by wildlife. Big game distribution in this region of Wyoming is limited by availability of winter range and water. Mining operations are not expected to affect either of these habitat requirements. The Wyoming Game and Fish Department indicated that, based on historical data of the Gas Hills area on big game use, the site does not include areas classified as "crucial range," (i.e., vital for survival of local populations) (Wichers, 1999). Movement of pronghorn and mule deer through the area is not expected to be impacted by mining operations. PRI will limit the use of fencing in order not to interfere with mule deer and pronghorn movement through the site. This movement will be facilitated by PRI's intent to avoid the use of long expanses of fencing which might otherwise impede ingress to, and egress from, the site. Further, where fencing is employed, PRI will utilize the fencing preferred by the Wyoming Game and Fish Department which consists of three wires, with a smooth bottom wire 16 inches off the ground, a 12-inch gap between the top two wires, and a total height of 38 inches. This type of fencing will provide for relatively unimpeded movement of big game through the site.

The evaporation ponds are expected to contain various contaminants from *in-situ* leach mining of uranium ore. The U.S. Fish and Wildlife Service (FWS) has expressed concern about the potential impacts to migratory birds and other wildlife from exposure to selenium concentrations and radioactive materials such as Radium-226 in the evaporation ponds (Long 1999). Regarding the presence of radioactive materials in the evaporation ponds, no guidelines have been established concerning acceptable limits for radiation exposure for protection of species other than humans. However, it is generally agreed that radiation protection standards for humans are conservative for other species. The concentrations of radioactive materials in the evaporation ponds are not anticipated to be at levels which could result in significant radiation exposure to biota other than humans. Additionally, as noted below, the evaporation ponds will be lined with a synthetic liner and will not be a favorable environment for growth of aquatic vegetation which might otherwise serve as a potential source of exposure to radioactive materials via a food pathway. Lastly, given the expected transitory and infrequent nature of animal visitation to the evaporation ponds, the staff concludes that potential impacts from the radioactive materials present will be insignificant.

Regarding the selenium issue, the Kendrick Irrigation project located W of Casper documented deformities and low reproduction success of American avocets and eared grebes exposed to water with elevated selenium concentrations. Median concentrations in two irrigation ponds ranged from 38-54 micrograms/liter (See et al., 1992). The extent to which selenium in the evaporation ponds poses a threat to wildlife is a function of concentration and exposure. The evaporation ponds will be lined with 30 mil PVC and are not likely to support rooted aquatic vegetation that would serve as the food base and cover for aquatic invertebrates, waterfowl, and shorebirds that commonly occur in natural pond habitats of the area. Thus, the staff does not believe that selenium presence in the evaporation ponds will have a significant adverse impact on migratory birds and other wildlife. Nonetheless, PRI will monitor wildlife use of the evaporation ponds on a regular basis and record any visible impacts to wildlife. Monitoring data will be submitted to the WDEQ - Land Quality Division. In the unlikely event that waterfowl, shorebirds, or passerine birds are documented to use the evaporation ponds, the FWS and

WDEQ will be contacted for guidance on appropriate mitigation measures to deter wildlife use. Periodic grab samples of water in the ponds will be analyzed for selenium concentration and other contaminants once mining operations begin.

Noise generated during construction activities is expected to have only minimal impacts on wildlife. Noise from drilling equipment will be temporary and of short duration and is not expected to adversely affect wildlife use of areas adjacent to the well-fields.

Well-field operations will require the construction of power distribution lines. Lines will be supported by single pole wood structures with a wooden cross-arm. The conductors will be configured to assure adequate spacing between the shield wire (i.e., ground wire) and conductors to avoid potential electrocution of raptors that land on the cross-arms. Construction of the distribution lines will follow guidance in “Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996" (APLIC 1996).

Raptors breeding in the site may be impacted by construction activities or mining operations. In 1993 golden eagles nested on a high-wall left from past mining in Section 27 about 0.5 miles NE of Mine Unit IV. Surveys in the spring of 1999 produced no evidence of golden eagle nesting on site. However, these surveys recorded five active nests of other raptors; two ferruginous hawk nests in Mine Unit II, a red-tailed hawk nest located along West Canyon Creek S of Mine Unit IV and a prairie falcon nest located adjacent to the S boundary of Mine Unit II. One of the ferruginous hawk nests was new in 1999 but is not in an area slated for disturbance. These species and other birds of prey nesting in the area within 0.5 mi of mining operations may be temporarily impacted depending on the time of year construction activities occur. PRI has committed, where possible, to avoiding mining in areas within 0.5 mi of active raptor nests and prior to fledging of young (PRI 1999a). Mitigation will be carried out in areas that cannot be avoided based on approval by the FWS and the Wyoming Game and Fish Department. Proposed mitigation could include construction of alternate nest sites on natural features (e.g., trees, rock outcrops, and cliffs), on mine high-walls in the site and vicinity, and erection of appropriate nesting platforms on wooden poles.

5.8.2 Aquatic Ecology

The only natural aquatic habitat on the site is in Cameron Spring Reservoir and along West Canyon Creek. Fish are not known to occur in these habitats or in other reservoirs within the site. The West Canyon Creek could be impacted by well-field construction in Mine Unit IV. Impacts or damage to aquatic vegetation (willows and a few cottonwood trees) could occur from construction of pipelines, culverts or secondary access roads, however, these disturbances will be avoided, if possible, to minimize any impacts. Cameron Springs Reservoir is located more than 0.5 mi from the SW corner of Mine Unit I and would not be impacted by runoff from any surface disturbance associated with construction or mining operations. The small livestock pond in Section 32 may be impacted by ephemeral runoff from well-field construction. Impacts to the pond would be minor because of the lack of aquatic vegetation and its natural tendency to dry up during the summer months.

Impacts to aquatic habitats in the four reservoirs resulting from past mining activities are not anticipated. All are located more than 1000 ft from any proposed disturbance associated with the proposed Gas Hills Project (PRI 1999a).

5.8.3 Wetlands

Potential wetlands comprise only 28 acres of the 8500 acre Gas Hills site and, with the exception of the West Canyon Creek, are located outside of the identified production areas (mine units). In general, disturbance of wetland areas will be avoided. However, an estimated 11 acres of the potential 28 wetland acres on the site would be disturbed during mining operations. The 11 acres disturbed would be along portions of the 2 mile segment of West Canyon Creek that traverses Mine Unit IV. Any disturbances will likely be minimal and in the form of road or pipeline crossings. Culverts will be employed where needed to maintain existing surface flow or drainage conditions. The impacts would be minimized with proper mitigation. Should PRI have to construct pipelines or roadways through wetlands the U.S. Army Corps of Engineers (COE) will be contacted prior to any disturbance. In such cases PRI has committed to developing mitigation plans for approval by and coordination with the COE and WDEQ, Land Quality Division (PRI 1999a). The COE indicated that the types of proposed construction that might impact wetlands in the site would be allowable under Nationwide Permits 12 and 14 (Peter, 1998).

5.8.4 Threatened and Endangered Species

No Federally endangered species such as the black-footed ferret and peregrine falcon are documented to occur on the site. The black-footed ferret relies on prairie dog towns as habitat, however, the nearest prairie dog town is about 1.5 miles from Mine Units II and V. The peregrine falcon could use high-walls or cliff sites as resting areas during fall and spring migration through the site. No impacts are expected to the peregrine falcon from mining operations. The bald eagle, a threatened species, is not expected to be impacted by mining operations. The bald eagle is known to be a winter resident in the Gas Hills area but no populations were recorded on the site during past surveys. Given the large home range of bald eagles in foraging throughout the area, mining activities during the winter season are not expected to adversely affect individuals visiting the area. If bald eagles are observed frequenting or nesting in areas within 0.5 miles of mining operations, appropriate mitigation actions will be developed and submitted to the FWS for approval. Mitigation could include establishing buffer zones around nests, and possible timing restrictions of mining construction or operation activities.

The mountain plover is proposed for listing as a threatened species and the FWS will decide later in 2003 about listing the mountain plover as a threatened species. However, its occurrence at the site is unlikely because of the limited upland grassland community (i.e., 131 acres of 8,500 acres in the site). Surveys of the site in 1997 yielded no plovers. The FWS recommends that three surveys to document presence/absence be conducted at 14 day intervals between May and June 15th prior to construction activities (Long 1999). If active nests are found, mining activity should be delayed for at least seven days after hatching.

The swift fox is classified as a candidate for listing and could occur on the site. The Gas Hills area is on the eastern most boundary of its distribution in Wyoming and past surveys showed no evidence of its presence on the site.

Based on the foregoing discussion, the staff concludes that the proposed Gas Hills Project will not likely adversely affect any of the aforementioned threatened and endangered species.

However, based on consultations with the FWS, the staff will condition PRI's license to require additional surveys for prairie dog towns and mountain plover prior to the onset of construction activities at the Gas Hills Project.

5.9 Transportation

Employment at the Gas Hills Project is expected to add commuting and delivery vehicles on the roadways leading to the Gas Hills site from the nearby population centers such as Riverton and Casper. The highest daily volumes of light duty vehicles for commuting purposes are estimated to be about 18 from Riverton and 12 from Casper (see Table 5.2-1). Delivery of construction materials on a heavy-duty truck is expected to occur approximately once per day for about 2 months per year during the construction period. A truck trailer will be used once per day to (a) transport the product of the Gas Hills Project, i.e., the uranium-laden ion-exchange resin, to the Highland Uranium Project site and (b) return the eluted resin, from which most of the uranium is removed, back to the Gas Hills site for further use in the uranium extraction process.

The routes to be taken by these vehicles are described in Section 2.9. These additional traffic volumes are relatively small compared to the existing traffic volumes on these roadways (Table 2.9-1), and, therefore, are not expected to significantly contribute to the congestion or accident rates on these roadways.

5.10 Visual Resources

Although additional temporary and permanent structures, including drilling equipment, storage areas and other ancillary buildings would be built if the project were to proceed, on balance the aesthetic impacts of the project would be small. Much of the land around the proposed site is in the foreground/middleground zone and sensitivity levels to activities at the site would be moderate. However, the scenic quality of the land assigned to the project is designated as being of minimal diversity or interest (Class C) by the BLM VRM guidelines, and the number of visitor days (average annual daily trips) from key observation points (local travel routes) is small. Any adverse effects that do occur will be mitigated through the use of non-contrasting building colors and the well-field reclamation program.

5.11 Radiological and Nonradiological Impacts

Potential radiological or nonradiological impacts to the offsite environment are expected only from gaseous sources as PRI does not anticipate any surface discharges of liquids at Gas Hills and planned discharges to groundwater (re-injection) during restoration activities will consist of treated waste water streams. The disposition of the various liquid waste streams is further addressed in Section 3.4.2.

5.11.1 Radiological Impacts

The primary source of radiological impact to the environment from satellite ISL operations at Gas Hills will be radon-222 released from solutions at the well-fields and from satellite building ventilation. A small amount of radon-222 will also be released from bleed water directed to the evaporation ponds during both uranium recovery and restoration activities. As a satellite ISL uranium recovery facility, the Gas Hills Project will not generate the particulate radioactive material emissions typically associated with conventional uranium mining, milling, and yellowcake production.

The radiological effects of radon gas release from the well-fields, satellite buildings, and evaporation ponds during both recovery and restoration operations were modeled by PRI using MILDOS-AREA, a computer code approved by NRC for estimating potential radiological impacts resulting from air emissions. The source terms developed for the radon analysis conservatively assumed that all of the radon absorbed in groundwater during recovery and restoration operations was released to the environment. The concentrations of released radon were calculated at potential receptor locations which included the 16 compass points of the Gas Hills Project site boundary, the nearest residence (approximately 11 miles from the site), and the nearest communities of Jeffrey City and Waltman. The calculated concentrations of radon in equilibrium with its daughter radionuclides at all receptor locations were below the Effluent Concentration Limit of 0.1 pCi/L for radon-222 with daughters in Table 2 of Appendix B to 10 CFR Part 20. The highest estimated dose from radon exposure is 7 mrem/yr to a hypothetical individual at the eastern boundary of the Gas Hills site. This value is well within the 100 mrem/yr dose limit in 10 CFR Part 20 for individual members of the public. The highest estimated dose to the population living within 50 miles of the Gas Hills Project is 0.29 person-Rem/yr. This small value reflects the fact that approximately 99.7 per cent of this population lives 25 miles or more from the site. These results indicate that radiological impacts to individuals and the population around the Gas Hills Project will be negligible.

5.11.2 Nonradiological Impacts

The impacts to the offsite environment from the release of nonradiological gasses and particulates at the Gas Hills Project were addressed in Section 5.2.1.

5.12 In-Plant Safety

Pursuant to 10 CFR Part 20, the NRC requires a radiation safety program that contains the basic elements needed to assure that exposures are kept low, or, in any event, as low as is reasonably achievable (ALARA). Accordingly, an in-plant radiation safety program which includes the following is required for the Gas Hills Project:

- Qualified management of the radiation safety program and appropriate training of personnel,
- Written radiation protection procedures,
- Airborne and surface contamination sampling and monitoring,
- Internal and external radiation monitoring programs,
- An approved respiratory protection program, and
- An annual ALARA audit and frequent in-house inspections.

In addition, during routine radiation safety inspections, the NRC staff observes in-plant industrial safety for deficiencies and brings any identified deficiencies to the attention of facility management.

The NRC considers the program for in-plant safety, as required by Federal regulations, and the radiation safety program, as defined by 10 CFR Part 20, to be sufficient to protect the workers during normal facility operations. With the implementation of this in-plant safety program, there should be no significant impacts to the workforce from sources of radiation at the Gas Hills Project.

5.13 Waste Disposal Impacts

Pursuant to NRC regulations (10 CFR Part 40, Appendix A, Criterion 2), to avoid the proliferation of waste disposal sites, byproduct material from ISL uranium recovery operations must be disposed at existing uranium mill tailings disposal sites, unless such offsite disposal is shown to be impracticable or the benefits of onsite disposal clearly outweigh those of reducing the number of waste disposal sites. Consistent with these requirements, radioactively contaminated material from Gas Hills Project operations that cannot be decontaminated for unrestricted release will be stored in labeled and covered containers and periodically transported for disposal at an NRC licensed disposal facility. The byproduct material collected in the evaporation ponds and pond liners will be disposed at an NRC licensed facility when the Gas Hills Project is decommissioned. PRI currently has a contract disposal agreement with Pathfinder Mines Corporation to dispose of Gas Hills byproduct wastes at its Shirley Basin tailings facility. Transportation of all byproduct material for offsite disposal will be conducted in accordance with U.S. Department of Transportation and NRC regulations (49 CFR Part 173.389 and 10 CFR Part 71, respectively).

As the handling, storage, transportation, and disposal of byproduct materials from Gas Hills Project activities will be performed in accordance with Federal regulations and an established radiation safety program, the impacts from such activities are expected to be small.

5.14 Cumulative Impacts

The staff has evaluated the impacts from the proposed Gas Hills Project in the context of other past, present, and foreseeable future actions in the nearby environs of the project to determine if there might be any significant cumulative impacts to the environment from the combination of actions at, and around, the project. In this regard, past and present actions around the Gas Hills Project have been in relation to prior conventional uranium mining and milling and the subsequent reclamation of the affected sites, respectively. Reclamation of the former mill sites, which is ongoing, will have a beneficial impact on the environment. Future actions around the Gas Hills Project site would likely involve additional ISL uranium recovery activities. The impacts to the environment from ISL uranium recovery activities at, and around, the Gas Hills Project site, including impacts to the groundwater, will be temporary and localized. Further, these disturbances will be corrected when the sites are reclaimed to return the affected areas to their pre-mining conditions. Accordingly, the staff concludes that there will be no significant cumulative impacts to the environment from the Gas Hills Project and other past, present, and foreseeable future actions in the nearby areas of the project.

5.15 Mitigation Measures

In the foregoing sections of Chapter 5 of this EA, the staff has described the mitigation measures, as appropriate, that will be implemented to reduce or eliminate the potential adverse impacts from the Gas Hills Project. Additionally, the SER that was developed along with this EA to address the safety aspects of the Gas Hills Project describes the license conditions necessary to protect public health and safety and the environment. These license conditions will also serve to mitigate potential impacts to the environment.

6.0 SUMMARY AND ENVIRONMENTAL FINDINGS

This EA has been prepared to evaluate the environmental impacts associated with PRI's proposal to operate an ISL uranium recovery facility at the Gas Hills Project site as a Satellite to the existing licensed uranium recovery facility at the Highland Uranium Project site. Further, this EA has been prepared to determine if an environmental impact statement is required for this action or if a Finding of No Significant Impact is warranted.

Based upon the foregoing evaluation, the staff has determined that the proposed action will not have a significant impact on the environment. Accordingly, the NRC is making a Finding of No Significant Impact. This determination is supported by the following findings from the staff's evaluation:

- As a satellite ISL uranium recovery facility to the Highland Uranium Project, the facilities and activities at the Gas Hills Project will be limited to those needed to support well-field, ion exchange, and water treatment operations.

- Radiological effluents from the proposed operation of the well-field, ion exchange, and water treatment facilities will be a small fraction of regulatory limits and an acceptable environmental and effluent monitoring program will monitor all releases.

- The proposed groundwater monitoring program is sufficient to detect both horizontal and vertical excursions of lixiviant.

- The evaporation ponds constructed for the temporary storage of process waste streams will be provided with both primary and secondary liners and leakage detection and collection capability.

- To avoid the proliferation of small waste disposal sites, all radioactive waste generated by facility operations will be disposed offsite at a licensed disposal site for Atomic Energy Act of 1954 Section 11e.(2) byproduct material.

- There will be no significant adverse impacts to the regional surface water or groundwater.

- As a primary goal, groundwater impacted by uranium recovery operations will be restored to baseline water quality conditions on a mine unit average. If the primary goal cannot be met, the restoration goal will be to restore affected groundwater to pre-mining class of use water quality.

- Standard operating procedures will be established for all operational process activities involving radioactive materials that are handled, processed, or stored.

- A radiation protection program will be established at the Gas Hills Project site to ensure that exposures will be kept ALARA.

As this EA indicates that the proposed action to operate a satellite ISL uranium recovery facility at the Gas Hills Project will not have a significant impact on the environment, the staff concludes that PRI's request to amend the Highland Source Material License SUA-1511 to permit uranium recovery at the Gas Hills site is acceptable from an environmental perspective. The acceptability of the proposed action from the safety perspective is addressed in the SER that was developed along with this EA. The SER also addresses the license conditions that are considered necessary to protect public health and safety and the environment from the proposed operational activities at the Gas Hills Project.

7.0 CONSULTATIONS WITH OTHER AGENCIES

This EA evaluates the environmental impacts associated with the PRI proposal. The environmental effects that were considered include all impacts related to Gas Hills Project construction, operation, decommissioning, and reclamation. In developing this EA, the staff interacted or consulted with the U.S. Department of the Interior Bureau of Land Management (BLM), the U. S. Department of the Interior Fish and Wildlife Service (FWS), the State of Wyoming Game and Fish Department (WGFD), the State of Wyoming State Historic Preservation Office (WSHPO), the Wyoming State Geological Survey (WSGS), and the State of Wyoming Department of Environmental Quality (WDEQ).

The land surface within the proposed Gas Hills Project is managed primarily by BLM and BLM was a cooperating agency in the development of this EA, providing information needed for assessing potential impacts to identified surface (cultural) resources (BLM 2000a, BLM 2000b, BLM 2000c). As a cooperating agency, BLM contributed to the development of this EA with general and specific commentary provided to clarify BLM's regulatory role in the permitting of the Gas Hills Project and to enhance various sections of the EA (BLM 2003). The FWS provided information on potential impacts to threatened or endangered animal species and recommendations for mitigating impacts to those species (Long 1999, Long 2003). The WGFD also provided information on potential impacts to threatened or endangered animal species (WGFD 1996, Wichers 1997, Wichers 1999). The WSHPO provided information on potential impacts to cultural resources (Wolf 1999,Currit 2000a, Currit 2000b, Currit 2000c). The WSGS provided information on seismic design considerations for the Gas Hills Project (Case 1999). Lastly, the WDEQ provided a technical review of the entire proposed Gas Hills Project (Moxley 1997, Moxley 1999). Additional contributions to the development of this EA were provided by the State of Wyoming Office of Federal Land Policy which coordinated comments on the EA from the Wyoming State Engineer's Office (WSEO), the WGFD, and the WSHPO (Kozlowski 2003). The WSEO commented on the need for PRI to obtain well permits for the project. The WGFD commented on terrestrial considerations for the project. The WSHPO commented on the cultural resource documentation required by Section 106 of the National Historic Preservation Act and 36 CFR Part 800, "Protection of Historic Properties." Lastly, PRI submitted comments to clarify various sections of the EA (PRI 2002b).

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APPENDIX A

FIGURES