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3.9 VISUAL AND SCENIC RESOURCES

The Antelope and JAB License Area is located in the far northeast portion of Sweetwater County, Wyoming, on public lands managed by the Bureau of Land Management (BLM). The License Area is comprised of two sites the Antelope and JAB. The BLM Lander Field Office is responsible for overseeing activities on public lands within the Antelope and JAB License Area. The BLM policy is that it has a basic stewardship responsibility to identify and protect visual values on public lands. The BLM has inventoried the visual resources of all lands within the boundaries of the Lander Field Office using a Visual Resource Management (VRM) system.

3.9.1 Visual Resource Management Classes

The elements used to determine the visual resource inventory class are the scenic quality, sensitivity levels, and distance zones. Each of the elements used to identify the VRM Class is defined below:

Scenic Quality - Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are assigned an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the rating process, each of these factors is ranked comparatively against similar features within the physiographic province.

Sensitivity Level – A degree or measure of viewer interest in the scenic qualities of the landscape. Factors to consider include 1) type of users; 2) amount of use; 3) public interest; 4) adjacent land uses; and 5) special areas. Three levels of sensitivity have been defined:

- Sensitivity Level 1 – The highest sensitivity level, referring to areas seen from travel routes and use areas with moderate to high use.
- Sensitivity Level 2 – An average sensitivity level, referring to areas seen from travel routes and use areas with low to moderate use.
- Sensitivity Level 3 – The lowest sensitivity level, referring to areas seen from travel routes and use areas with low use.

Distance Zones – Areas of landscapes denoted by specified distances from the observer, particularly on roads, trails, concentrated-use areas, rivers, etc. The three categories are foreground-middle ground, background, and seldom seen.

- Foreground-Middle ground – The area visible from a travel route, use area, or other observer position to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape and vegetation is apparent only in pattern or outline.
- Background - The viewing area of a distance zone that lies beyond the foreground and middle ground. This area usually measures from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 8 miles or increase it beyond 15 miles.
- Seldom Seen – The area is screened from view by landforms, buildings, other landscape elements, or distance.

The visual resource inventory classes are used to develop visual resource management classes, which are generally assigned by the BLM through the resource management plan process[i]. VRM objectives are developed to protect scenic public lands, especially those lands that receive the greatest amount of public viewing. The following VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.
- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.
- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.
- Class IV Objective: To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

The Scenic Quality, Sensitivity Level, and Distance Zone inventory levels are combined to assign the VRM Class to inventoried lands as shown in the following matrix:

Determining BLM Visual Resource Inventory Classes								
Visual Sensitivity		High			Medium			Low
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III/IV	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
Distance Zones		f/m	b	ss	f/m	b	ss	ss

f/m = foreground-middleground
b = background
ss – seldom seen

Affected Environment

The visual resources of both sites were inventoried and classified according to the VRM system defined in the Lander Resource Management Plan (RMP) (BLM 1986a). In the Lander RMP, the BLM defined the scenic quality based on the degree of harmony, contrast, and variety within a landscape. The Scenic Quality Class of the Antelope and JAB License Area is Class C, having low scenic value. The Antelope and JAB License Area is designated as VRM Class IV based on the existing visual resources. The management objective of VRM Class IV is to provide for activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. Modification of the landscape character is acceptable, including changes that may subordinate the original composition and character of the landscape. Changes should reflect what could be a natural occurrence in the characteristic landscape.

Scenery in the Antelope and JAB License Area is typical of the Great Divide Basin, with expansive views across flat to moderately undulating terrain. Vegetation in the area is a mix of low, mat-forming plants and low sagebrush on open, exposed areas, and Wyoming big sagebrush and greasewood in draws and lowlands. Numerous small drainages dissect the landscape and provide topographic diversity. Existing visual modifications to the landscape in and near the Antelope and JAB License Area include unimproved roads, evidence of past uranium exploration and development, and some oil and gas production facilities.

Most of the Antelope and JAB License Area are not visually sensitive given the remoteness of viewpoints used by the public or the screening of views by terrain. Motorists traveling U.S. Highway 287/Wyomnig State Highway 789 cannot view the Antelope and JAB License Area because the viewing distance is too great and intervening topography obscures the view. BLM

Road 3321, Sweetwater County Road 22 (Bairoil Road), and the Wamsutter-Crooks Gap Road are the primary sensitive viewing areas that could be visited by the public.

There is a low concentration of users near the Antelope and JAB License Area (BLM 2005). Potential viewers include hunters, oil and gas operators, and ranchers with grazing allotments. Some portions of the proposed project facilities may be visible from existing roads, including Sweetwater County Road 22 and the Crooks Gap Road. In general, users of the region are accustomed to viewing mineral resource development; however, visual quality is an important part of the recreational experience for many users.

Environmental Consequences

Some project facilities may be visible from BLM Road 3321, Sweetwater County Road 22, or Wamsutter-Crooks Gap Road. Potential viewers of the contrasts of proposed project facilities with the surrounding landscape would be few (BLM 1986a) and would include hunters and other recreationists, ranchers, and oil and gas industry workers.

Short-term Effects

Short-term effects to visual resources would occur from construction of the processing plant and well drilling in the Antelope and JAB License Area: Effects to visual resources would typically be associated with drilling rigs, construction equipment, service trailers, and the general industrial character of drilling and the construction of well pads, access roads, pipelines, power lines, and plant buildings. Additional short-term effects may result from fugitive dust generated during the construction phase. Fugitive dust would be controlled by applying water, chemical dust suppressants, or other means when air quality is impaired.

The severity of effects with the BLM VRM rating system is related to the scenic quality, sensitivity level, and distance zone of the affected environment. In general, short-term effects would be most severe where the level of contrast is high and is highly visible to the most viewers. The short-term effects would be considered acceptable in a Class IV area. Because of a low concentration of users, the contrasts during construction would be seen by relatively few viewers. In addition, effects associated with construction at each well location would be visible only for a short time (7 to 14 days).

Long-term Effects

Long-term effects to visual resources would occur as a result of permanent production facilities, as described in Section 2 of the Technical Report, and would be evident in the landscape over the life of the Antelope and JAB Project. The plant buildings, roads, pipeline corridors, wellheads, and other aboveground facilities would be screened to the extent feasible. All permanent aboveground structures that would remain longer than 6 months would be painted Carlsbad Canyon Brown or other standard colors required by the BLM. This measure would not apply to structures that require safety coloration, as prescribed by the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA).

During the production and maintenance phase, permanent facilities would create contrasts in line, form, color, texture, and overall pattern in the landscape that would remain for the duration of the project. Effects from fugitive dust as part of ongoing operations would also persist but could be reduced by using appropriate dust abatement measures. However, as noted for short-term effects, these contrasts would not be visible to many viewers. The level of contrast would not exceed Class IV standards if the mitigating measures as described below are implemented. Levels of contrast would, however, detract from the recreation experience of visitors to the Antelope and JAB License Area

The objective of VRM Class IV is to provide for activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape resulting from the Antelope and JAB Project should be moderate and consistent with the BLM objective of VRM Class IV. The existing rural/agricultural landscape would be retained, but would be modified with a noticeable, but minor, industrial component. Line and textural contrasts of the well houses, the plant, and associated access roads and distribution lines would be visible from sensitive viewing areas; however, contrasts would be low to moderate. The VRM Class IV objectives would be met by proposed long-term project facilities.

With the implementation of mitigitative measures described in Section 2.4.2.5, effects to visual and scenic resources as a result of the construction and operation of the Antelope and JAB Project are expected to be negligible.

3.9.2 Mitigation

Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. The measures should be applied to all facilities, even those that meet VRM objectives. Mitigation would enable proposed project facilities to harmonize with the surrounding landscape to the extent feasible.
In addition to selecting paint colors that harmonize with the surrounding landscape, several other measures would minimize adverse effects of project facilities in the landscape.

- Using existing vegetation and topographic features to screen wells, facilities, and roads;
- Painting facilities with non-reflective paint that harmonizes with the surrounding landscape;

- Avoiding straight line-of-sight road construction;
- Aligning roads with the contours of the topography rather than cutting straight across contours to well houses, although this method of aligning the roads may result in a greater area of disturbance;
- Constructing clearings to appear as natural clearings by rounding corners and feathering the vegetation interface between the clearing and the surrounding grasses and shrubs (In those areas where the existing vegetation is dense, clearings should be irregular in shape); and
- Removing construction debris immediately because it creates undesirable textural contrasts with the landscape.
-

In general, resource protection measures proposed for erosion control, road construction, rehabilitation and re-vegetation, and wildlife protection would mitigate effects to visual quality.

3.9.3 References

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 1986a. Lander Field Office EIS/Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

BLM. 1986b. Visual Resource Inventory (VRM). BLM Manual Handbook 8410-1.

BLM. 1986c. Visual Resource Contrast Rating. BLM Manual Handbook 8431-1.

BLM. 1985. Rawlins Field Office EIS/Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

BLM. 2005. Draft Environmental Assessment for the Pappy Draw Coalbed Natural Gas Pilot Project. U. S. Department of Interior Bureau of Land Management Lander Field Office. August 2005.

[i] United States Department of the Interior (USDOI), Bureau of Land Management (BLM). Buffalo Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

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3.10 SOCIOECONOMICS

Information presented in this section concerns those demographic and social characteristics of the counties and communities that may be affected by the proposed development of a uranium in-situ recovery facility at the Antelope / JAB Projects (Projects) in Sweetwater County, Wyoming. Data were obtained through the 1980, 1990, and 2000 U.S. Census of Population, the 2005 and 2006 Census Population Estimates program, and various State of Wyoming government agencies. All tables discussed in section 3.10 are presented at the end of the section.

3.10.1 Demography

3.10.1.1 Regional Population

The area within an 80-kilometer (km) radius of the project site includes portions of four counties in central and south central Wyoming, which include Sweetwater County, Fremont County, Carbon County, and Natrona County, as shown on Figure 3.10-1. The proposed Antelope / JAB License Area (License Area) is located in northeast Sweetwater County. The nearest community is Bairoil, a small Sweetwater County incorporated town located east on Bairoil Road, which is a primary access route to the Antelope Area. East of Bairoil, the small communities of Muddy Gap and Lamont are located along State Highway 287, which is the primary north-south transportation route through the region. Jeffrey City, in Fremont County, is located nearly 17 miles north of the License Area. South of the License Area, several communities are located along the Interstate 80 (I-80) highway corridor, including Rawlins, in Carbon County, and the towns of Riner, Creston, Latham, Wamsutter, Frewen, and Table Rock in Sweetwater County.

Historical and current population trends in counties and communities within an 80-km distance reflect past growth trends in the counties relative to state population trends between 1980 and 2006 (Table 3.10-1). During the 1980's, Sweetwater County was the only one of the four-county area (Carbon County, Fremont County, Natrona County, and Sweetwater County) that did not experience a decline in population. This is because the Sweetwater County economy is strongly dependant on trona (soda ash) mining and processing, which was a relatively stable industry during the 1980s and 1990s. The Sweetwater County annual population growth rates have declined since 2000; a direct result of stagnant growth in the soda ash market, and the elimination of jobs in soda ash mining and processing (C. Thomas, et al 2004). In contrast, the economies of Carbon, Fremont, and Natrona counties are more closely tied to other mineral resource development, primarily coal, oil, and natural gas production. The largest growth rates since 2000 occurred in these counties as coal production and coal bed methane development have increased the resident labor force in the counties. The overall state economy is more diverse in the current decade than it was during the 1980s.

3.10.1.2 Population Characteristics

The 2005 population by age and sex for counties within 80 km of the License Area is shown in Table 3.10-2. Overall, the 40- to 64-year age group (which includes the 'baby boom' cohort (defined by the U.S. Census as a group of individuals born in the same calendar year or group of years) is the largest age group in each of the counties. According to the Wyoming Economic and Demographic Forecast: 2005 to 2014 (Wyoming Economic Analysis Division 2005), the early baby boom population in Wyoming is one of the highest in the nation as a result of the in-migration of workers during the oil boom years in the late 1970s and early 1980s. In contrast, the population in the 27- to 42-year age group is relatively low because there was a high net out-migration (outflow greater than inflow) in this age group between 1995 and 2000 as young adults left the state during a declining economy. The aging population is expected to affect the economy through changes in the labor supply as retiring baby boomers reach retirement age and are replaced by fewer new workers. The older population would also require different types of goods and services, requiring a shift in local economic sectors to accommodate the changing demographics.

In 2005, 91.8 percent of the population in the four counties within a 50-mile radius of the License Area was classified as white. Indians and persons of Hispanic origin comprised 5.6 percent and 7.0 percent, respectively, of the total four-county population of 146,474. The populations in all other racial categories account for less than 1 percent of the total population. The racial characteristics of Carbon, Natrona, and Sweetwater Counties county were similar to the racial characteristics of the state. The Indian population of Fremont County accounted for 20.6 percent on the total county population, which was a considerably large proportion than the 2.4 percent American Indian proportion of the state population. This is because the Wind River Indian Reservation is located within Fremont County. The reservation is outside of the 50-mile region that is centered on the License Area.

3.10.1.3 Population Projections

The projected population for selected years by county within the 80-km radius of the proposed License Area is shown in Table 3.10-3. The population projections between 2000 and 2020 anticipate that the relatively stable population trends evident between 2000 and 2006 will continue for the county and the state. It is not expected that there will be the large in-migrations of population that were typical of the 1980s. However, the projected growth of Sweetwater County of 9.6 percent between 2003 and 2010 would result in a population increase of 3,461 people, which would be an average annual population increase of 494 people.

3.10.1.4 Seasonal Population and Visitors

A primary source of seasonal population in the four-county area is short-term labor for mineral resource development, construction, and service industries engaged in tourist/recreation activities. A review of reports from the Wyoming Economic Analysis research program indicates that these workers are most likely to relocate temporarily from neighboring counties and states, including Montana, Nebraska, Colorado, and South Dakota. The seasonal labor force for these economic sectors is not included in any available population or labor force data for the counties.

Tourism is also a source of seasonal population and visits to the four counties for a variety of outdoor recreation activities. The proposed License Area consists of public lands in northeast Sweetwater County. The surrounding area within an 80-km radius contains mostly public lands. In general, the lands adjacent to the License Area are public lands, while private lands are mostly located at distances of 10 to 15 miles from the Permit Area boundaries. This is reflected in the sectorial population data, which shows that there are no residents close to the License Area, and that the number of residents in each sector tends to increase with distance from the center of the License Area. Public lands provide open space for a variety of outdoor recreation opportunities. Several recreation facilities and areas are located within an 80 km distance of the License Area. Visitor statistics are not available for most of these sites. Recreation opportunities offered by the private sector consist of community facilities in urban areas and the infrastructure of tourist services and facilities.

The recreational facility that would be a destination for tourists that is closest to the License Area is the Continental Divide National Scenic Trail. The Recreation Management Information System estimates that the portion of the Continental Divide National Scenic Trail in the Lander Field Office receives 45 visits annually, and visitors use the trail in a linear manner (BLM 2005).

The Seminoe State Park is 42 miles east-southeast of the east boundary of the License Area. Approximately 21,176 people visited the park in 2005, which was a decrease of 43 percent from the 37,385 people who visited the park in 2001. Visits to the park were the lowest in 2005 for the years 1998 through 2005 (Wyoming Economic Analysis Division 2006). Comparison of the park visitor fluctuations over this period with other parks and facilities in Wyoming did not reveal a trend or pattern that would account for the annual fluctuations.

Visitor statistics for the Independence Rock State Historic Site, located 36 miles northeast of the License Area, were last compiled in 1998 when 30,960 people visited the site.

3.10.1.5 Schools

The License Area is located within Sweetwater County School District 1, which serves all of Sweetwater County within 80 km; however, the schools closest to the License Area that would likely serve the project labor force are located in Carbon County School District #1. The nearest Sweetwater County community that provides education services to residents in the vicinity of the License Area is the Bairoil Elementary School, which had a 2005 fall enrollment of 10 students. The school is located in Sweetwater County, but is administered through Carbon County School District #1. Rawlins is the closest city to the License Area that provides a full range of education facilities, including three elementary schools (total 2005 fall enrollment of 685) one middle school (2005 fall enrollment of 349), and one high school (2005 fall enrollment of 431) (Carbon County School District #1 2007).

Historic enrollment data indicates a fairly steady decline in school enrollment in the Carbon County School District #1 in the years 1996 to 2005, from a high of 2,216 students in the fall of 1996, to a low of 1,664 in the fall of 2004. The fall enrollment of 1,727 in 2005 was the first year in the reported years of 1996 through 2005 that there was any increase in the number of students enrolled in district schools.

Families moving into the school district as a result of the proposed operations in the License Area would not significantly stress the current school system because it is presently under capacity.

3.10.1.6 Sectorial Population

Existing population in an 80-km radius centered on the combined License Area was estimated for 16 compass sectors, by concentric circles of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the center of the Permit Area, for a total of 208 sectors. Sectorial population was estimated with data from the U.S. Census Bureau's Population Estimates Program. Subtotals by sector and compass points, as well as the total population, are shown in Table 3.10-4.

The most recent available population data was acquired from Geographic Data Technology, Inc., a division of the Environmental Systems Research Institute (ESRI). The data was created using U.S. Census 2000 boundary and demographic information for block groups within the United States, and intercensal population estimates for 2004 from the Population Estimates Program.

ArcInfo Geographic Information System (GIS) was used to extract data from U.S. Census 2004 population estimates for Census Tract Block Groups located wholly or partially within the 80 km radius from the approximate center of the License Area. Urban areas within each county were generally assigned their own block group. To assign a population to each sector, a percentage area of each sector within one or more block groups was calculated for all of the block groups.

The sectorial populations calculated using the percentage areas were modified for the sectors within a 20-mile distance because the GIS calculations are averages that do not accurately reflect the distribution of urban and rural populations within the 20-mile (32-km) radius. In addition, many sectors throughout the 80-km radius contain mostly BLM-administered federal lands, particularly those near the License Area, and do not contain any residents. These sectors were assigned a zero population. Most of the area within the 80-km radius is rural, with the majority of the population residing in the small communities near the License Area, or in larger urban areas in the sectors furthest from the License Area center. Urban areas are located mostly along the I-80 corridor to the south of the License Area, and include the city of Rawlins and the towns of Wamsutter and Table Rock.

The total population within the 80 km radius was estimated to be 12,247, once individual sectors were modified to better represent the distribution of urban and rural populations within the area.

3.10.2 Local Socioeconomic Characteristics

3.10.2.1 Major Economic Sectors

The License Area is located in Sweetwater County; however, social and economic characteristics are described for Carbon in addition to Sweetwater County because communities in Carbon County, primarily Rawlins, provide a relatively large resident labor force for mineral extraction and construction industries in south central Wyoming. A substantial portion of the Project labor force is likely to be based in Rawlins. Table 3.10-5 summarizes unemployment rates and employment in Sweetwater and Carbon Counties.

The economy of Sweetwater County depends on trona (soda ash) mining and production. The Carbon County economy depends on the energy sector, primarily coal mining, oil and gas extraction, crude, petroleum-natural gas, and supporting oil and gas field services.

A report prepared by the Wyoming Department of Employment, Research and Planning (2003) analyzes labor supply in Wyoming by place of residence. The analysis concluded that a portion of the available labor pool in Wyoming consists of non-residents. According to the report, the construction sector is one of the industry's most dependent upon seasonal and short-term workers. Of all persons working in heavy construction in 2000, 38.4 percent did not work in Wyoming in 1999.

Table 3.10-5 also shows the labor force characteristics in Sweetwater and Carbon Counties in 2005. In general, unemployment rates were highest in the early 1990s and have decreased overall by 2005 because of renewed energy development in south-central Wyoming. Annual fluctuations in unemployment rates are driven primarily by short-term changes in production due to changing prices for trona, coal, oil, and coal bed methane gas.

Per capita personal income is the income that is received by persons from all sources, including wages and other income over the course of one year. In 2005, personal income in Sweetwater County was $38,039, which was 102 percent of the state average of $37,305. The county ranks fifth out of 23 counties in the state (BEA 2006). Carbon County had a lower per capita income of $30,961, which was 83 percent of the state average and ranked 18th in the state. Sweetwater County has a higher per capita personal income because of relatively high-paying jobs in the trona mining industry.

3.10.2.2 Housing

The nearest substantial housing stock is located in the town of Rawlins, in Carbon County. Nearby communities such as Bairoil (Sweetwater County) and Jeffrey City (Fremont County) are small, with correspondingly small numbers of available housing. According to the U.S. Census 2000 (the most recent year for which housing data were available for communities), there were 78 housing units in Bairoil. Of these units, 42 units were occupied, and the vacancy rate was 46.2 percent. In Jeffrey city, there were 112 housing units in 2000, and a 59.8 percent vacancy rate. In Rawlins, there were 3,860 housing units in 2000, including 540 vacant units for a vacancy rate of 13.4 percent.

It is likely that current vacancy rates in these communities have decreased since 2000 as a result of increasing in-migration of workers for employment in ongoing mineral resource development. A rental vacancy survey summarized in the Wyoming Community Development Authority report shows that rental vacancy rates in Carbon County decreased to 0.98 percent from a post-U.S. Census 2000 high of 16.08 percent in 2001. A more modest decrease in rental vacancy rates occurred in Sweetwater County, from a high of 8.16 percent in 2000, to the 2006 rate of 0.63 percent. This has occurred because the influx of labor into these counties, as a result of economic growth stimulated by mineral production, has outstripped the available rental housing supply.

The housing needs forecast included in the above cited report projects an increase of 11,932 households (a household is defined as all the persons who occupy a housing unit) in Sweetwater County from 14,105 in 2000 to 26,037 in 2030. The number of renters in Sweetwater County is projected to increase from 3,519 in 2000, to 5,472 in 2030. In Carbon County, the number of households is projected to increase by 2,389, from 6,129 in 2000, to 8,518 by 2030. The number of renters is expected to increase from 1,775 in 2000, to 1,967 in 2030.

3.10.2.3 Temporary Housing

Temporary housing options in the vicinity of the License Area include hotels, motels, and campgrounds. Vacancy rates are not currently available for temporary accommodations in Sweetwater and Carbon Counties. Available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons. There is also a high level of occupancy by coal bed methane gas workers. Many motels and recreational vehicle (RV) campgrounds in the region provide accommodation for long-term visits by the week or month.

The temporary lodgings closest to the License Area are in Rawlins and smaller communities along the I-80 corridor to the south. Accommodations in Rawlins include 867 rooms in 14 hotels/motels, and 230 spaces in 5 campground/RV parks (Wyoming Tourism 2007).

TABLES

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Table 3.10-1 1980 – 2006 Historical and Current Population Change for Counties and Towns within 80 km of the Antelope / JAB License Area

Note – Population estimates for 2006 are not available for cities and towns.

State/County/City	Year						Average Annual Percent Change				
	1980	1990	2000	2002	2004	2006	1980/ 1990	1990/ 2000	2000/ 2002	2002/ 2004	2004/ 2006
State of Wyoming	469,557	453,588	493,782	498,973	505,534	515,004	-0.3%	0.9%	0.5%	0.7%	0.9%
Carbon County	21,896	16,659	15,639	15,382	15,346	15,325	-1.9%	-0.9%	1.1%	-0.2%	0.0%
Rawlins	11,547	9,380	8,538	8,725	8,692	-	-1.4%	0.6%	0.3%	0.3%	-
Fremont County	38,992	33,662	35,804	36,032	36,218	37,163	-1.5%	0.9%	0.7%	1.1%	1.0%
Natrona County	71,856	61,226	66,533	67,519	68,988	70,401	-0.7%	-0.3%	-0.4%	0.4%	1.6%
Sweetwater County	41,723	38,823	37,613	37,294	37,570	38,763	0.7%	-5.7%	-0.5%	0.0%	0.0%
Bairoil	214	228	97	96	96	-	-6.5%	0.9%	0.0%	0.6%	-
Wamsutter	681	240	261	261	264	-	-0.3%	0.9%	0.5%	0.7%	-

Sources: U.S. Bureau of the Census Decennial, 2000 Decennial; U.S. Bureau of the Census Population Estimates Program, 2007.
- = Not available

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Table 3.10-2 2005 Population by Age and Sex for Counties within the 80 km Radius of the Antelope / JAB License Area

Area	Age	Male	Female	Total	Total Percent Breakdown
State of Wyoming	Under 5	16,247	14,818	31,065	6.1%
	5 - 19	51,074	48,270	99,344	19.5%
	20 - 34	53,964	49,387	103,351	20.3%
	35 - 64	107,479	106,018	213,497	41.9%
	65+	27,962	34,075	62,037	12.2%
	Total	256,726	252,568	509,294	100.0%
Carbon County	Under 5	16,247	14,818	31,065	6.1%
	5 to 19	51,074	48,270	99,344	19.5%
	20 to 39	69,455	64,312	133,767	26.3%
	40 to 64	91,988	91,093	183,081	35.9%
	65+	27,962	34,075	62,037	12.2%
	Total	256,726	252,568	509,294	100.0%
Fremont County	Under 5	847	444	403	5.6%
	5 to 19	2,629	1,383	1,246	17.4%
	20 to 39	3,576	2,019	1,557	21.7%
	40 to 64	6,229	3,326	2,903	40.5%
	65+	2,050	998	1,052	14.7%
	Total	15,331	8,170	7,161	100.0%
Natrona County	Under 5	2,398	1,216	1,182	6.4%
	5 to 19	2,608	3,826	3,591	19.5%
	20 to 39	8,479	4,313	4,166	22.6%
	40 to 64	13,007	6,339	6,668	36.1%
	65+	5,190	2,348	2,842	15.4%
	Total	36,491	18,042	18,449	100.0%
Sweetwater County	Under 5	2,350	2,208	4,558	6.5%
	5 to 19	7,002	6,680	13,682	19.6%
	20 to 39	9,267	9,080	18,347	26.3%
	40 to 64	12,103	12,245	24,348	34.9%
	65+	3,828	5,036	8,864	12.7%
	Total	34,550	35,249	69,799	100.0%

Source: U.S. Bureau of the Census 2007

Table 3.10-3 2005-2025 Population Projections for Counties within the 80 km Radius of the Antelope / JAB License Area

Area	Census 2000	Projected 2005	Projected 2010	Projected 2015	Projected 2020
State of Wyoming	494,078	506,184	519,595	529,352	533,534
Carbon County	15,594	15,047	14,671	14,345	13,965
Fremont County	35,841	36,138	36,872	37,251	37,135
Natrona County	66,550	68,965	70,529	71,685	72,151
Sweetwater County	37,487	36,654	35,567	34,293	32,759

Note: Population projections for the years after 2020 are not available.
Source: Wyoming Department of Administration and Information, Economic Analysis Division 2007.

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Table 3.10-4 2004 Population within the 80 km Radius of the Antelope / JAB License Area

	Radius in km													
Sector	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	Total
N	0	0	0	0	0	0	0	19	27	0	42	50	57	195
NNE	0	0	0	0	0	0	0	106	27	0	42	52	60	287
NE	0	0	0	0	0	0	0	0	0	0	51	62	71	184
ENE	0	0	0	0	0	0	0	0	24	31	42	54	66	217
E	0	0	0	0	0	0	0	96	21	27	34	40	46	264
ESE	0	0	0	0	0	0	0	0	18	27	34	40	46	165
SE	0	0	0	0	0	0	0	0	15	23	32	289	8,658	9,017
SSE	0	0	0	0	0	0	0	0	0	13	13	40	103	169
S	0	0	0	0	0	0	0	0	0	0	10	45	71	126
SSW	0	0	0	0	0	0	0	0	14	0	10	12	14	50
SW	0	0	0	0	0	0	0	0	0	0	10	18	31	59
WSW	0	0	0	0	0	0	0	0	0	0	19	28	33	80
W	0	0	0	0	0	0	0	0	0	0	28	34	39	101
WNW	0	0	0	0	0	0	0	0	0	0	42	50	57	149
NW	0	0	0	0	0	0	0	0	0	0	42	182	358	582
NNW	0	0	0	0	0	0	0	0	27	34	42	153	346	602
Total	0	0	0	0	0	0	0	221	173	155	493	1,149	10,056	12,247

Notes: Current population living between 10 and 80 km of the mine site were estimated using 2004 census block data. Field reconnaissance was conducted in 2007 to verify data collected within 2 miles (3.22 km). The population between 3 and 30 km was estimated with the average household size in 2000 and aerial photos to count the number of housing units in each sector.

Table 3.10-5 2005 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming for Sweetwater and Carbon Counties

	State of Wyoming		Sweetwater County		Carbon County	
	# of Work Force	Percent Change	# of Work Force	Percent Change	# of Work Force	Percent Change
Labor Force	284,538	-	23,596	-	7,939	-
Employment	274,362	-	23,008	-	7,670	-
Unemployment	10,176	-	588	-	269	-
Unempl. Rate	3.6	-	2.5	-	3.4	-
Total employment	360,558	100.0%	27,628	100.0%	10,015	100.0%
Farm employment	12,096	3.4%	194	0.7%	528	5.3%
Nonfarm employment	348,462	96.6%	27,434	99.3%	9,487	94.7%
Forestry, fishing, related activities, and other 3/	2,780	0.8%	46	0.2%	151	1.5%
Mining	25,578	7.1%	5,225	18.9%	(D)	-
Utilities	2,422	0.7%	(D)	-	65	0.6%
Construction	29,356	8.1%	2,257	8.2%	815	8.1%
Manufacturing	11,352	3.1%	1,236	4.5%	(D)	-
Wholesale trade	8,784	2.4%	(D)	-	228	2.3%
Retail trade	40,188	11.1%	3,106	11.2%	1,025	10.2%
Transportation and warehousing	12,842	3.6%	1,479	5.4%	553	5.5%
Information	5,088	1.4%	261	0.9%	105	1.0%
Finance and insurance	11,247	3.1%	565	2.0%	230	2.3%
Real estate and rental and leasing	13,837	3.8%	867	3.1%	392	3.9%
Professional and technical services	16,000	4.4%	727	2.6%	301	3.0%
Management of companies and enterprises	970	0.3%	97	0.4%	(D)	-
Administrative and waste services	11,871	3.3%	920	3.3%	(D)	-
Educational services	2,985	0.8%	135	0.5%	27	0.3%
Health care and social assistance	26,555	7.4%	1,273	4.6%	594	5.9%
Arts, entertainment, and recreation	6,612	1.8%	(D)	-	243	2.4%
Accommodation and food services	31,964	8.9%	2,327	8.4%	1,087	10.9%
Other services, except public administration	19,524	5.4%	1,216	4.4%	563	5.6%
Government and government enterprises	68,507	19.0%	4,242	15.4%	2,074	20.7%
Federal, civilian	7,491	2.1%	238	0.9%	213	2.1%
Military	6,138	1.7%	215	0.8%	87	0.9%
State and local	54,878	15.2%	3,789	13.7%	1,774	17.7%
State Government	14,942	4.1%	279	1.0%	521	5.2%
Local Government	39,936	11.1%	3,510	12.7%	1,253	12.5%

(D) = Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
- = Not Available

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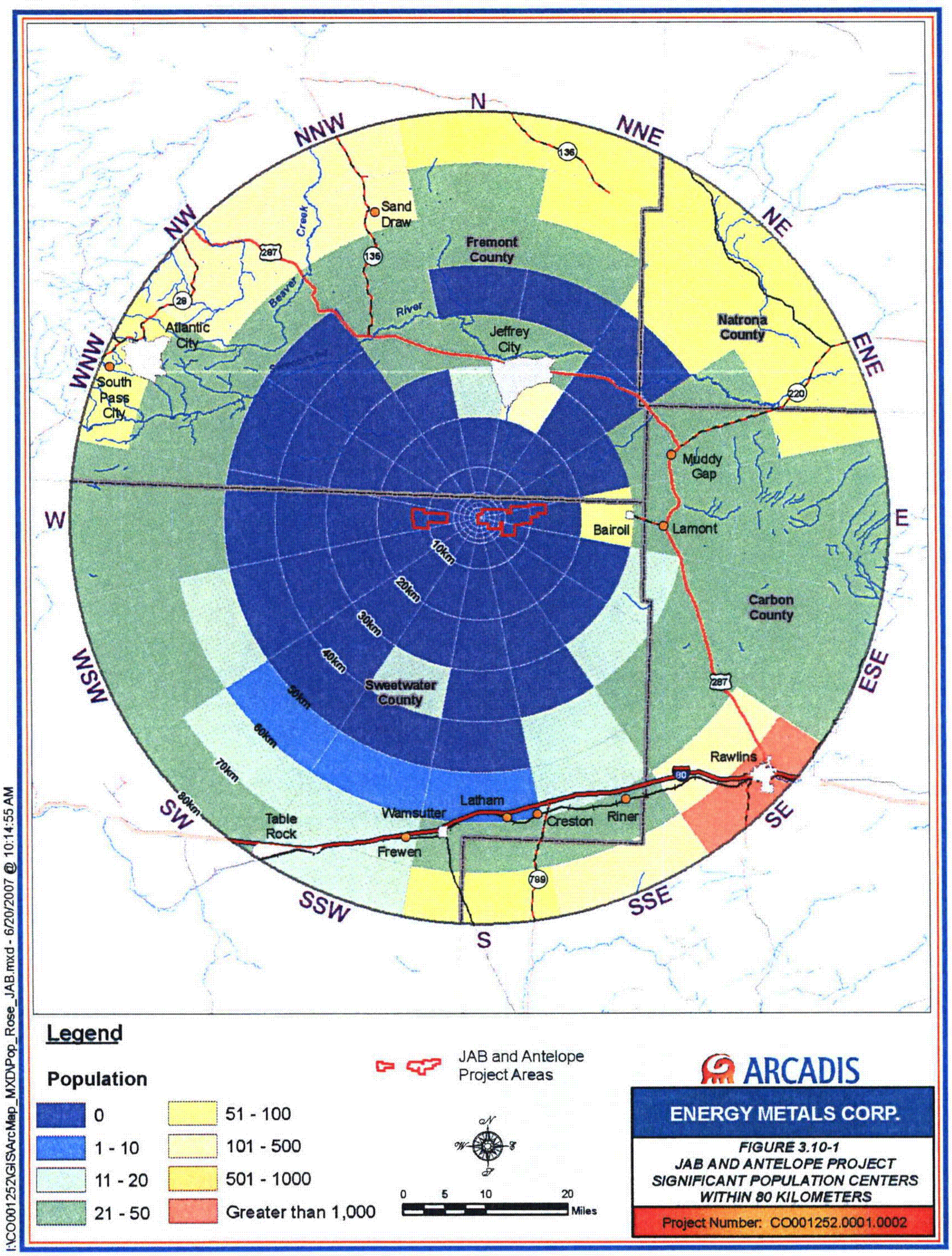
Table 3.10-6 Race and Poverty Level Characteristics of the Population in the Antelope / JAB License Area Census Tracts

	State of Wyoming	Percent of Total State Population	Census Tract 9716, Sweetwater County	Percent of Census Tract 9716	Block Group 1, Census Tract 3, Fremont County	Percent of Census Tract 3	Total
Total	493,782	100.0%	1,702	100.0%	2,224	100.0%	3,926
Urban:	322,073	65.2%	0	0.0%	0	0.0%	0
Inside urbanized areas	125,706	25.5%	0	0.0%	0	0.0%	0
Inside urban clusters	196,367	39.8%	0	0.0%	0	0.0%	0
Rural	171,709	34.8%	1,702	100.0%	2,224	100.0%	3,926
White alone	454,095	92.0%	1,588	93.3%	2,091	94.0%	3,679
Black or African American alone	3,126	0.6%	2	0.1%	0	0.0%	2
American Indian and Alaska Native alone	11,363	2.3%	16	0.9%	52	2.3%	68
Asian alone	2,972	0.6%	5	0.3%	17	0.8%	22
Native Hawaiian and Other Pacific Islander alone	232	0.0%	1	0.1%	0	0.0%	1
Some other race alone	12,595	2.6%	44	2.6%	11	0.5%	55
Two or more races	9,399	1.9%	46	2.7%	53	2.4%	99
People who are Hispanic or Latino	31,384	6.4%	127	7.5%	67	3.0%	194
Median household income in 1999	37,892	-	49,544	-	38,095	-	-
Per capita income in 1999	19,134	-	19,350	-	20,133	-	-
Population with income in 1999 below poverty level:	54,777	-	150	-	136	-	**286**
Percent below poverty level	11.1%	-	8.8%	-	6.1%	-	**0**

Source: U.S. Bureau of Census 2000

Figure 3.10-1 Significant Population Centers within an 80 km Radius (50 miles) of the Moore Ranch License Area



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3.11 PUBLIC AND OCCUPATIONAL HEALTH

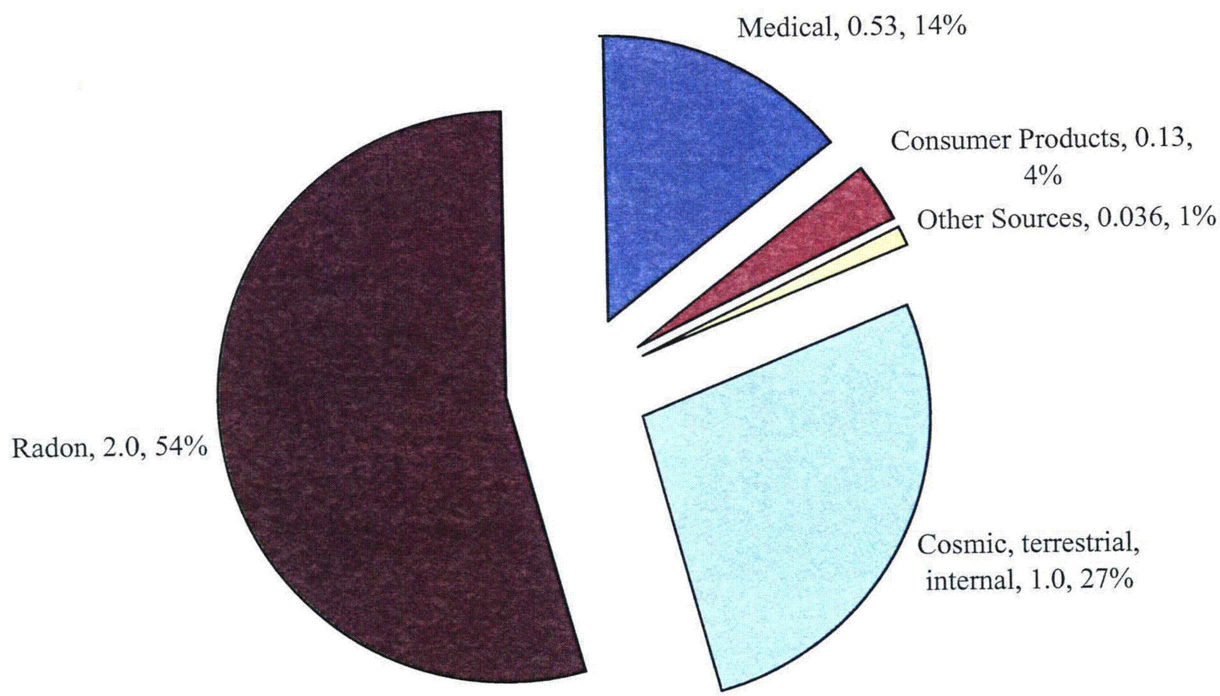
3.11.1 Background Exposure to Ionizing Radiation

Everyone is exposed to a certain level of background radiation from naturally occurring radioactive substances in the ground (terrestrial radiation), radiation from outer space (cosmic radiation), and from naturally occurring radiation in our bodies. This is commonly referred to as background radiation. The combined annual dose from these sources is thought to range from 1 to 2 millisievert [mSv]. In addition, the same level of radiation is received annually from radon gas.

Levels of natural or background radiation can vary greatly from one location to the next. People residing in Wyoming are exposed to more natural background radiation because of higher levels of cosmic radiation at higher altitudes and more terrestrial radiation from soils enriched in naturally occurring uranium. This naturally occurring uranium in the soil also results in a higher exposure to radon gas.

Shown in the Figure 3.11-1 are the average annual radiation doses received per capita in the United States from naturally occurring and manmade sources of radioactivity. The total yearly dose is approximately 0.0036 Sv (i.e., 3.6 mSv or 360 mrem).

Figure 3.11-1, Annual Background Radiation Doses in the United States (Source, mSv per year, Percent of Total)



As discussed in Section 4.12.2, the maximum total effective dose equivalent (TEDE) calculated by MILDOS-AREA for the Moore Ranch project is 0.53 mrem/yr. This dose is located at the northwest property boundary and is a 0.14 percent increase over the annual average dose to the general public. The closest resident to the Antelope and JAB would be the residents in Bairoil (approximately 12 miles east of the Antelope plant site). Since the annual TEDE at the east property boundary of the Antelope site is 0.2 mrem (0.2 percent of the regulatory dose limit to the general public from NRC-licensed operations of 100 mrem/yr), then the TEDE to the residents of Bairoil would be much less. Expressed another way, the maximum radiological effect of the Moore Ranch operation would be to increase the TEDE of continental population by 0.000036 percent.

3.11.2 Occupational Health and Safety

Addendum 3-11A contains the incident rates of nonfatal occupational injuries and illnesses by industry and case type in the State of Wyoming for 2006 taken from the Wyoming Department of Employment, Wyoming Labor Force Trends, Volume 44 No.12 (Davis, V.A. 2007). The incident rate is calculated using the following formula:

$$\left(N/_{EH}\right) \times 200{,}000$$

Where:

N	=	number of injuries and illnesses
EH	=	total hours worked by all employees during a calendar year
200,000	=	base for 100 equivalent full-time workers

The incident rates for mining are contained under NAICS code 21 and include oil and gas extraction, mining, and support activities for mining. ISR uranium mining would be included in metal/nonmetal mining.

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ADDENDUM 3.11-A

Incident Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Type in the State of Wyoming for 2006

Table 1: Incidence Rates[a] of Nonfatal Occupational Injuries and Illnesses by Selected NAICS[b] Industries and Average Annual Employment[c] in Wyoming, Private Industry, 2005 and 2006

NAICS[b] Industry	2005 AAE[c] (000s)	2005 Total Recordable Cases	2006 AAE (000s)	2006 Total Recordable Cases
Private Industry[d]	191.0	5.8	202.6	4.8
Agriculture, Forestry, Fishing, & Hunting[d]	1.1	11.0	1.1	7.7
Animal Production[e]	0.7	13.5	0.7	9.2
Mining[e]	22.0	4.9	25.6	3.3
Oil & Gas Extraction	3.7	4.7	4.0	3.1
Mining (Except Oil & Gas)[e]	7.6	3.2	8.5	2.7
Coal Mining[e]	4.9	1.7	5.7	1.6
Nonmetallic Mineral Mining & Quarrying[e]	2.5	5.7	2.6	4.7
Other Nonmetallic Mineral Mining & Quarrying[e]	1.8	5.5	1.9	4.2
Support Activities for Mining	10.6	6.0	13.1	3.8
Drilling Oil & Gas Wells	2.8	11.7	3.7	5.1
Support Activities for Oil & Gas Operations	7.4	4.2	9.0	3.4
Construction	20.1	7.5	23.1	6.1
Construction of Buildings	4.3	11.6	4.8	9.8
Heavy & Civil Engineering Construction	5.4	4.7	6.8	4.7
Utility System Construction	3.0	3.1	4.4	4.5
Highway, Street, & Bridge Construction	1.9	8.4	1.9	5.7
Specialty Trade Contractors	10.4	7.7	11.6	5.5
Building Equipment Contractors	3.9	10.6	4.3	6.1
Electrical Contractors	1.9	11.4	2.1	4.6
Manufacturing	9.6	13.6	10.0	6.3
Food Manufacturing	--	--	0.7	11.1
Wood Product Manufacturing	0.8	16.3	0.9	15.5
Fabricated Metal Product Manufacturing	--	--	1.6	7.2
Wholesale Trade	7.6	7.3	8.1	4.5
Merchant Wholesalers, Durable Goods	4.6	7.4	4.9	4.7
Machinery, Equipment, & Supplies Merchant Wholesalers	3.1	6.2	3.4	5.0
Merchant Wholesalers, Nondurable Goods	2.6	5.9	2.7	4.6
Retail Trade	30.2	5.4	30.7	5.3
Motor Vehicle & Parts Dealers	4.3	6.0	4.4	4.6
Furniture & Home Furnishings Stores	0.8	2.6	0.8	6.9
Building Material & Garden Equipment & Supplies Dealers	2.5	6.0	2.7	9.6
Food & Beverage Stores	4.7	3.0	4.6	6.2
Gasoline Stations	4.1	8.7	4.0	5.3
General Merchandise Stores	5.9	6.8	6.0	7.2
Transportation & Warehousing[f]	7.5	4.5	8.3	8.0
Rail Transportation[f]	--	2.5	--	2.9
Truck Transportation	3.6	2.7	3.9	7.2
Utilities	2.3	3.4	2.3	4.4
Electric Power Generation, Transmission, & Distribution	2.0	3.2	2.0	4.3
Information	4.3	1.7	4.2	2.7
Publishing Industries (Except Internet)	1.3	1.7	1.3	4.4
Newspaper, Periodical, Book, & Directory Publishers	--	1.7	--	4.4
Newspaper Publishers	1.1	2.0	1.1	4.1
Telecommunications	1.4	2.3	1.4	2.6
Finance & Insurance	6.8	0.8	6.9	0.4
Real Estate & Rental & Leasing	3.9	5.9	4.1	3.3

Table 1: Incidence Rates[a] of Nonfatal Occupational Injuries and Illnesses by Selected NAICS[b] Industries and Average Annual Employment[c] in Wyoming, Private Industry, 2005 and 2006

NAICS[b] Industry	2005 AAE[c] (000s)	2005 Total Recordable Cases	2006 AAE (000s)	2006 Total Recordable Cases
Professional, Scientific, & Technical Services	8.1	2.1	8.8	0.7
Administrative & Support & Waste Management & Remediation Services	6.8	6.1	7.1	5.2
Administrative & Support Services	6.2	6.0	6.6	5.1
Waste Management & Remediation Services	0.5	7.5	0.6	5.9
Educational Services	1.3	8.5	1.4	4.6
Health Care & Social Assistance	19.7	6.3	20.0	6.4
Ambulatory Health Care Services	7.4	2.2	7.6	2.2
Hospitals	2.8	10.6	2.9	11.2
Nursing & Residential Care Facilities	4.4	10.4	4.4	10.5
Social Assistance	5.2	5.9	5.2	6.0
Arts, Entertainment, & Recreation	2.7	3.0	2.8	3.8
Accommodation & Food Services	29.2	5.9	29.6	5.2
Accommodation	10.9	7.6	11.3	7.7
Other Services, Except Public Administration	7.1	4.6	7.5	4.7
Repair & Maintenance	3.1	5.0	3.5	4.6
Automotive Repair & Maintenance	2.0	4.2	2.0	4.7
Personal & Laundry Services	1.8	3.8	1.8	5.7
Religious, Grantmaking, Civic, Professional, & Similar Organizations	2.2	4.5	2.2	3.8

[a]Incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as: (N/EH) x 200,000, where

N = number of injuries and illnesses

EH = total hours worked by all employees during the calendar year

200,000 = base for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year).

[b]North American Industry Classification System, 2002 Edition.

[c]Average annual employment – employment is expressed as an annual average and is derived primarily from the Bureau of Labor Statistics (BLS)-State Quarterly Census of Employment and Wages.

[d]Excludes farms with fewer than 11 employees.

[e]*Data for mining (sector 21 in the North American Industry Classification System Manual, 2002 edition) include* establishments not governed by the Mine Safety and Health Administration (MSHA) rules and reporting, such as those in oil & gas extraction and related support activities. Data for mining operators in coal, metal, & nonmetal mining are provided to BLS by *MSHA, U.S. Department of Labor. Independent mining contractors are excluded from the coal, metal, & nonmetal mining* industries. These data do not reflect the changes Occupational Safety and Health Administration made to its recordkeeping requirements effective January 1, 2002; therefore estimates for these industries are not comparable to estimates in other industries.

[f]Data for employers in railroad transportation are provided to BLS by the Federal Railroad Administration, U.S. Department of Transportation.

-- Indicates data not available.

Source: Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses in cooperation with participating state agencies.

Table 2: Incidence Rates[a] of Nonfatal Occupational Injuries and Illnesses and Employment[b] in the Mining Industry, Wyoming, Private Industry, 2003-2006

Industry	NAICS[c]	2003 AAE[b] (000s)	2003 Incidence Rate	2004 AAE (000s)	2004 Incidence Rate	2005 AAE (000s)	2005 Incidence Rate	2006 AAE (000s)	2006 Incidence Rate
Total Mining	21	18.4	4.5	20.2	4.2	22.0	4.9	25.6	3.3
Oil & Gas Extraction	211	3.2	4.6	3.4	4.4	3.7	4.7	4.0	3.1
Mining (Except Oil & Gas)	212	7.4	3.3	7.4	3.3	7.6	3.2	8.5	2.7
Coal Mining	2121	4.9	1.7	4.8	1.7	4.9	1.7	5.7	1.6
Nonmetallic Mineral Mining & Quarrying	2123	2.4	5.6	2.5	5.6	2.5	5.7	2.6	4.7
Other Nonmetallic Mineral Mining & Quarrying	21239	1.7	5.4	1.7	6.1	1.8	5.5	1.9	4.2
Support Activities for Mining	213	--	--	9.3	4.7	10.6	6.0	13.0	3.8
Drilling Oil & Gas Wells	213111	2.0	6.2	2.4	7.9	2.8	11.7	3.7	5.1
Support Activities for Oil & Gas Operations	213112	--	--	6.4	3.7	7.4	4.2	9.0	3.4

[a]Incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as (N/EH) x 200,000 where:

N = number of injuries and illnesses

EH = total hours worked by all employees during the calendar year

200,000 = base for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year).

[b]Average annual employment — employment is expressed as an annual average and is derived primarily from the Bureau of Labor Statistics-State Quarterly Census of Employment and Wages.

[c]North American Industry Classification System, 2002 Edition.

— Indicates data not available.

Source: Bureau of Labor Statistics, U.S. Department of Labor, Survey of Occupational Injuries and Illnesses in cooperation with participating state agencies.

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3.12 WASTE MANAGEMENT

There are no current waste generation activities since this is a proposed action for a new facility. Waste management impacts for the proposed action are discussed in Section 4.12

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4 ENVIRONMENTAL IMPACTS

4.1. LAND USE IMPACTS

As discussed in Section 2.2, Grazing land and Wildlife habitat is the primary land use within the proposed License Area and the surrounding 2.0-mile review area. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area, however no oil and gas production facilities are located within the License boundaries. Based on a site reconnaissance conducted in May 2007 and a 2006 aerial photo, there are no occupied housing units in the License Area. Figure 2.2-1 depicts land use in the review area.

Construction of the Antelope Central Plant, JAB Satellite Plant, and associated structures will encompass approximately 15 acres. Wellfield areas and roads will likely encompass a maximum of 1,400 acres. As a result of site preparation and construction, use of the land as rangeland will be excluded from the area that is under development. Oil and gas production facilities will not be affected as none are located within close proximity. Considering the relatively small size of the area impacted by construction, the exclusion of grazing from this area over the course of the Antelope and JAB Projects will have an insignificant impact on local livestock production.

4.1.1. Land Use Impacts of Operations

As discussed in Section 2.2 and 0, Grazing land and Wildlife Habitat is the primary land use within the Antelope and JAB License Areas and within the surrounding 2.0-mile areas. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area. Operation of the Antelope and JAB Projects will potentially encompass approximately 1,400 acres. As with site preparation and construction, use of the land as rangeland will be excluded from this area during the life of the project. Oil and gas production facilities will not be affected. Considering the relatively small size of the area impacted by operations, the exclusion of grazing from this area over the course of the Antelope and JAB Projects will have an insignificant impact on local livestock production.

4.2. TRANSPORTATION IMPACTS

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve either vehicles delivering bulk chemical products, transporting resin to the Antelope Central Plant from the JAB satellite plant, transporting radioactive contaminated waste from the Antelope and JAB facilities to an approved disposal site, or from vehicles carrying yellowcake slurry or dried yellowcake product from the Antelope Central Plant.

All chemicals and products delivered to or transported from the site will be transported in accordance with DOT regulations. Emergency response procedures will be developed and implemented as part of Uranium One's Environmental Management Programs to insure a rapid response to the situation. All appropriate personnel will be trained to the level required in the emergency response procedures to facilitate proper response from Uranium One employee.

4.2.1. Effects to Traffic

The most heavily used public road segments would be Bairoil Road west of the town of Bairoil, State Highway 73 between Lamont and Bairoil, and State Highway 287 between I-80 through Rawlins north to State Highway 73 at Lamont. Most construction traffic, the construction workforce, and the operations workforce would access the License Area via these road segments. The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) percent increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, track hoes, trenchers, and front-end loaders), and heavy- and light-duty trucks. It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours.

4.2.2. Transportation Accident Risk

Transportation of hazardous materials to and from the Antelope and JAB Projects can be classified as follows:

- Shipments of uranium-laden resin from the JAB Satellite to the Antelope Central Plant for processing and return shipments of barren, eluted resin. Resin will be transported in tank trucks to the Antelope Central Plant facility for elution, precipitation, and drying.

- Shipments of dried yellowcake. Yellowcake will be transported in 208-L (55-gal.) drums to a distant conversion facility for refining and conversion. Conversion facilities are currently located in Metropolis, Illinois and Port Hope, Ontario, Canada.

- Shipments of process chemicals or fuel from suppliers to the site.

- Shipment of radioactive waste from the site to a licensed disposal facility.

Accident risks involving potential transportation occurrences and mitigating measures are discussed in the following sections.

4.2.2.1. Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the Antelope and JAB Projects is the transfer of the ion exchange resin to and from the plant. Loaded ion exchange resin would be transported from the JAB Satellite in a 4,000 gallon capacity tanker trailer. It is currently anticipated that up to two loads of uranium-laden resin may be transported for elution at the Antelope Central Plant and up to two loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to a central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[1].

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.

- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.

- Properly licensed and trained drivers will transport the resin between the Antelope and JAB Projects.

Uranium One will develop an emergency response plan for yellowcake and other transportation accidents to or from the Antelope and JAB Projects. Uranium One personnel will receive training for responding to a transportation accident.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, Uranium One will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help.

- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.

- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin.

- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident.
- Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

4.2.2.2. Accidents Involving Yellowcake Shipments

NUREG-0706 concluded that the probability of a truck accident involving shipments of yellowcake in any year is 11 percent for each uranium extraction facility. This calculation used average accident probabilities (4.0 x 10^{-7}/km for rural interstate, 1.4 x 10^{-6}/km for rural two-lane road, and 1.4 x 10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative.

As with resin shipments, yellowcake shipments will be made in accordance with DOT and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material and will follow the same general shipping procedures as outlined for ion exchange resin shipments in Section 4.2.2.1.

The worst case accident scenario involving yellowcake transportation would be an accident involving the transport truck where the integrity of one or more drums containing yellowcake was breached, resulting in a release to the environment. Unlike ion exchange resin shipments, ISR operators do not typically transport their own yellowcake to conversion facilities but rather contract with transport companies that specialize in shipments of yellowcake. These companies have extensive emergency response programs including spill response equipment on board, drivers trained in radiological emergency response, constant monitoring of truck location and operating parameters, and standing contracts with environmental emergency response contractors for cleanup of spills. As with ion exchange resin, the primary environmental impact associated with an accident involving the spill of yellowcake would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure.

4.2.2.3. Accidents Involving Shipments of Process Chemicals

It is estimated that approximately 4 bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, salt, soda ash, hydrogen peroxide, ammonia, sulfuric acid, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

4.2.2.4. Accidents Involving Radioactive Wastes

Low level radioactive 11(e).2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

4.2.2.5. Pipeline Ruptures

Since no existing oil or gas pipelines exist within the current areas of development on the Antelope and JAB properties, the risk of oil and gas pipeline ruptures due to ISR operations is negligible. Risk associated with ISR pipeline ruptures are described in Section 4.12.

4.3. GEOLOGY AND SOILS IMPACTS

4.3.1. Geology Impacts

4.3.1.1. Geology Impacts of Operations

Geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of 1 percent or less. Further, once mining and restoration operations are completed, groundwater levels will return to near original conditions under a natural gradient.

4.3.2. Soil Impacts

4.3.2.1. Soil Impacts of Operations

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the Antelope and JAB License Area varies from slight to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the sandy loam, loam, and gravelly texture of the surface horizons throughout the majority of the Antelope and JAB License Area, the soils are more susceptible to erosion from wind than water. See Tables 2.6-12 and 2.6-13 for a summary of wind and water erosion hazards within the Antelope and JAB License Area.

The Antelope and JAB License Area is underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. All topsoil will be stripped, stockpiled and maintained in accordance with WDEQ-LQD rules and regulations, the surface will be graded, and stormwater will be routed. These measures will help reduce the effect of construction on soil erosion.

The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped and stockpiled long term from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment. All areas are reseeded as soon as possible to keep the duration of bare soil to a minimum. Reseeding will help mitigate the increased erosion potential from the construction disturbance.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the Antelope and JAB Projects include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means;
- Salvage and stockpiling of topsoil from the central plant facility area and from secondary wellfield access roads in a manner to avoid wind and/or water erosion. This is accomplished by grading stockpiles to the appropriate slopes, avoiding excessive compaction, establishing a temporary vegetative cover, using appropriate fencing and signs, and installation of sedimentation catchments;
- Reestablishment of temporary or permanent native vegetation as soon as possible after disturbance; and
- Constructing roads to minimize erosion through practices such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation, and providing adequate road drainage with runoff control structures and revegetation.

Implementation of Best Management Practices (BMPs) will minimize the effects to soils associated with the construction and operation of the Antelope and JAB Projects.

4.4. WATER RESOURCES IMPACTS

4.4.1. Surface Water Impacts

4.4.1.1. Impacts on Surface Waters and Wetlands

The Antelope and JAB License Area had 0.268 acres of PUB wetland ponds present. All of the wetlands presented in this study are recommended to be non-jurisdictional because the wetlands are all isolated and the Great Divide Basin is a closed basin and does not have a significant nexus. As described in Section 2.8.5, no wetlands will be impacted due to the construction within the wellfield sites based on the planned wellfield locations.

No drainages or bodies of water will be significantly modified or altered within the Antelope and JAB Projects area during project construction or operations. If significant changes or alterations were to occur, the impact to the wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

4.4.1.2. Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, process plant, and along the pipeline courses and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short term impact. Since well field decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, plant facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed License Area. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations in areas where discharge to surface waters is possible. Best management practices will be implemented to reduce erosion impacts according to storm water management plans developed for those permits.

4.4.1.3. Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 4.4.2. discusses measures to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

4.4.2. Groundwater Impacts

The potential groundwater impacts of ISR mining are related to the consumption of groundwater and short-and long-term changes to groundwater quality. Perhaps the most significant environmental impact that can occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer.

4.4.2.1. Groundwater Consumption

Based on the limited drawdown observed during pump test operations, potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed License Area are expected to be negligible.

As shown in Figure 2.7-22 few water wells are present in the vicinity of the Antelope and JAB Projects, and there is little use of shallow ground water in the immediate vicinity of these project areas. The limited drawdown that likely will be induced from mining, groundwater restoration and plant operations will have little if any impact on local water users.

To assess the impacts from mining and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in the private domestic or livestock water wells surrounding the project area before mining and every three months during operations; and,
- Measure background water levels in regional monitoring wells installed by Uranium One before mining and every three months during operations

It is likely that the wells surrounding the Antelope and JAB sites License Area may provide stock water for private or public (BLM) leases. If significant impacts to those wells are observed (e.g., water levels drop to a point that impairs the usefulness of the wells), the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or,
- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

4.4.2.2. Impacts on Ore Zone Groundwater Quality

During ISR mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Contamination of groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents will be appreciably higher than their concentrations in the original groundwater.

Uranium One has estimated the post-mining water quality based on the experience of Cogema Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin[2]. The Irigaray data was selected because of the similar geologic conditions to the Antelope and JAB Projects. Cogema employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 4.4-1. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations. Thirty-five of the thirty-six parameter concentrations in the post-mining means exceeded the baseline means. Twenty-two of these parameters did not meet Restoration Target Values (of the twenty-nine with established RTVs).

Table 4.4-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

In general, these post-mining concentrations are within the range of those projected by NRC for ISR operations at the Crownpoint Uranium Project[3]. Uranium One expects similar baseline and post-mining water quality at the Antelope and JAB sites site.

4.4.2.3. Potential Groundwater Quality Impacts from Accidents

4.4.2.3.1. Lixiviant Excursions

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, or hydrofracturing of the ore zone or surrounding units. Past experience from other commercial scale in-situ recovery projects in the Powder River Basin has shown that when proper steps are taken in monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered and that serious impacts on the groundwater are prevented.

Excursions of lixiviant at ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected excursion indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers.

The State of Wyoming and the NRC require restoration of affected groundwater in the mining zone following production activities. Uranium One will be required to return the groundwater in the mining zone to baseline water quality conditions as a primary goal or to class of use standards. The mining aquifer must be exempted by the WDEQ and the EPA from protection under the Safe Drinking Water Act (SDWA) before mining can occur. One of the criteria for exemption is that the water is not currently used as an underground source of drinking water (USDW) and will not be used as a USDW in the future. By restoring the exempted aquifer, Uranium One ensures that adjacent, non-exempted aquifers will not be affected in the future.

Successful groundwater restoration has been demonstrated using the same methods proposed by Uranium One as discussed in Section 5.4.2. Therefore, long term impacts on groundwater quality are expected to be minimal.

4.4.2.3.2. Potential Groundwater Impacts from Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an uncontrolled wellfield release occur, there would be a potential for contamination of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact.

The potential environmental impacts from spills and mitigative measures are discussed in further detail in Section 4.12

4.5. ECOLOGICAL RESOURCES IMPACTS

4.5.1. Vegetation

Wellfield and production facilities will be constructed within the five vegetation communities in the Antelope Area and the three vegetation communities in the JAB Area. Direct impacts include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types.) Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual asthetics. An estimated 1,400 acres of the Antelope and JAB Area would be affected by the construction disturbance under current development plans.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become and increasingly important result of previous and current disturbance in Wyoming. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with the surrounding undisturbed vegetation. Uranium One will conduct weed control as needed to limit the spread of undesirable and invasive, non-native species on disturbed areas.

No threatened or endangered vegetation species were observed within the Antelope and JAB Projects areas; therefore, no impacts are anticipated.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent seed mix typically contains native wheatgrasses, fescues, and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

4.5.2. Wildlife and Fisheries

A detailed description of effects to wildlife, fisheries, and threatened and endangered species is contained in Section 3.5.5. As with other energy extraction industries, ISR operations can have direct and indirect impacts on local wildlife populations. These impacts are both short-term (until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). Indirect impacts typically affect more than a single individual and often persist longer than direct impacts.

Direct, project-related impacts of ISR operations may be experienced by all wildlife species to varying degrees. Individuals may be injured or killed due to collisions with heavy drilling and/or construction equipment and related traffic. Topsoil stripping required for construction of drill pads, access roads, plant facilities, and other infrastructure may also result in injury and mortality to some wildlife species, particularly small and young burrowing species such as rodents and herptiles that have limited mobility to escape the equipment. The likelihood for impacts resulting in injury or mortality is greatest during the initial construction phase of each aspect of the project, when traffic is heaviest and machinery is actively disturbing new areas. Disturbance would also be greatest during construction of facilities and supporting infrastructure, which would require more equipment and cover a larger area.

Because few vertebrate species of concern occupy the Antelope and JAB License/Permit Area, the potential for direct impacts to those individuals during drilling exploration activities would be low. Sage-grouse would be at the greatest risk for direct impacts, as that species is known to breed in the area. Suitable habitat exists in the license/permit area for other uses (nesting, brood-rearing, etc.) by grouse, as well. No raptor nests were present within one-half mile (the standard BLM disturbance buffer) of the license/permit area in 2007 or 2008, though birds could forage there. No pygmy rabbits were documented in the area, though potential habitat is present.

Noise, dust, and human and mechanical presence would all be considered indirect effects. These elements can cause wildlife to avoid the disturbance area within their territories and/or result in their displacement into adjoining habitats. The latter result can negatively impact both the animals leaving the affected area as well as the population of animals upon which newly displaced individuals encroach. Because they are the most common of the species of interest, sage-grouse would also be most likely to experience indirect affects related to exploratory drilling. No raptor nests are present in or within one-half mile of the entire Antelope and JAB License/Permit Area, so nesting raptors would not be displaced or otherwise impacted by exploratory drilling or operations and foraging raptors could potentially avoid the disturbance area. No crucial big game habitat is present in the license/permit area. Potential pygmy rabbit habitat is present, but no rabbits of this species have ever been documented in the survey area.

Overcrowding can result in increased competition for limited resources, which could result in starvation and/or dehydration. Increased stress associated with overcrowding can also lead to physical altercations, resulting in injuries or fatalities. Habitat alteration, fragmentation, and loss of cover and forage are expected to occur in varying degrees as a result of the proposed project. Wyoming big sage communities, the dominant habitat type in the survey area, can be difficult and time-consuming to reestablish. Consequently, pre-construction vegetation communities (i.e., shrub-steppe) may be different than post-construction communities (i.e., grass-dominated) for several years, or possibly decades, which could alter the composition and abundance of both plant and wildlife species in the area. Reclamation or regeneration of native shrubs species could be further hindered by year-long grazing pressure. Large ungulates (wild and domestic) are attracted to the more succulent and younger plants, and often concentrate in newly seeded locations during the critical early-growth stage.

The potential for impacts associated with drilling operations would be largely mitigated by the relatively small area of surface disturbance associated with exploration activities. Surface disturbance associated with each drill site consists of an area measuring approximately 15 feet by 25 feet, or 0.01 acre, with drill sites spaced at regular intervals within each claim. Consequently, the maximum potential disturbance associated with exploratory drilling in the Antelope and JAB License/Permit Area would likely be no more than 20 non-contiguous acres (less than 0.001 % of the total license/permit area acreage) along with some limited potential disturbance from drill site access. This type of disturbance will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. Additionally, all drill sites will be reclaimed following either the completion of drilling or uranium recovery operations, depending on the location of, and results from, each drill site. Impacts would also be partially mitigated by the low proportion (10%) of the total license/permit area expected to be impacted by future construction of well fields, processing facilities, and associated infrastructure. Once those structures are completed, regular disturbance would be reduced to only that needed to operate and maintain the operations. Traffic will persist during production, but should occur at a reduced and predictable level. Limited habitat disturbance also results in fewer displaced animals from existing territories into other, potentially occupied, areas, which reduces competition and stress on animals in both locations.

Given the factors outlined above, and the limited use of the Antelope and JAB Survey Area by most vertebrate species of concern, impacts to those species from exploratory drilling and ISR operations are expected to be minimal. Nevertheless, regulatory guidelines and requirements designed to prevent or reduce impacts to wildlife would include one or more of the following, as directed by the various regulating and permitting agencies:

1. Fencing designed to permit big game passage to the extent possible;

2. Use of existing roads when possible, and location of newly constructed roads to access more than one drill site;

3. Enforced speed limits to minimize collisions with wildlife, especially during the breeding season;

4. Adherence to timing and spatial restrictions within specified distances, as determined by appropriate regulatory agencies, of active sage-grouse leks during the breeding season (March 1 – June 15);

5. If direct impacts to raptors or other migratory bird species of management concern could result from operations, then a Monitoring and Mitigation Plan for those species must be prepared and approved by the US Fish and Wildlife Service (USFWS), including one or more of the following provisions:

   i. Relocation of active and inactive raptor nests that would be impacted by drilling, construction, or operation activities in accordance with the approved raptor monitoring and mitigation plan;

   ii. Creation of raptor nests and nesting habitat through enhancement efforts such as nest platforms to mitigate other nest sites impacted by ISR operations;

   iii. Obtaining appropriate permits for all removal and mitigation activities;

   iv. Establishing buffer zones protecting raptor nests where necessary and restricting mine-related disturbances from encroaching within buffers around active raptor nests from egg-laying until fledging to prevent nest abandonment, or injury to eggs or young;

   v. Reestablishing the ground cover necessary to attract and sustain a suitable raptor prey base after drilling, construction, and future mining; and

   vi. Required use of raptor-safe construction for overhead power lines according to current guidelines and recommendations by the Avian Power Line Interaction Commission (APLIC) and/or USFWS;

6. Restoration of sagebrush and other shrubs on reclaimed lands and grading of reclamation to create swales and depressions for sage-obligates and their young;

7. Restoration of pre-drilling and pre-mining native habitats for species that nest and forage in those vegetative communities;

8. Restoration of diverse landforms, direct topsoil replacement, and the construction of brush piles, snags, and/or rock piles to enhance habitat for wildlife;

9. Restoration of habitat provided by jurisdictional wetlands; and

10. Reclamation of creek channels and restoration of surface water flow quantity and quality after mining to approximate pre-mining conditions.

Another effective way to minimize impacts related to drilling in the Antelope and JAB License/Permit Area would be to use a systematic drilling pattern that affects only one area at a time, working from one side the license/permit area to another. Reclamation would be completed in the same manner, with activity occurring in just one area at a time after drilling is complete. Agency standards for reclamation would be followed. This systematic approach would allow more mobile wildlife species to relocate into adjoining, undisturbed habitat and then return following completion of drilling in a particular area. These efforts, in conjunction with the mitigation measures outlined above, would decrease direct and indirect impacts for all wildlife species.

Given the seasonal use of the area by those vertebrate species of concern that were documented in the survey area, the impacts described above could be fully mitigated with the delay of all surface disturbing activity within established buffer zones during the recognized breeding and nesting season (February 1 through July 31, annually) for those species (seasonal restrictions and buffer zones apply to surface disturbance activities only, operations will be conducted year-round in occupied areas). Given the timing of the current application process, this timing is likely to occur for much of the proposed drilling project. The fact that most of the crews work only during daylight hours would further reduce impacts to year-round residents, particularly more nocturnal species such as some reptiles; that timing also reduces potential impacts to these less mobile species due to moving equipment and vehicles.

4.6. AIR QUALITY IMPACTS

4.6.1. Air Quality Impacts of Construction

Construction activities at the Antelope and JAB Projects will cause minimal short term effects on local air quality. Increased suspended particulates from vehicular traffic on unpaved roads, fugitive dust caused by wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment would be the primary air quality impacts. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

4.6.1.1. Air Quality Impacts of Operations

Uranium One estimated fugitive dust emissions from operation of the Antelope and JAB Projects based on projected activity levels and emission factors supplied by the WDEQ. Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions for Antelope and JAB operations is 202.93 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas. The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed an emission rate of 202.93 tons per year. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on this order result in insignificant impacts to ambient air beyond a distance of a several hundred yards from the sources. Significant impact for PM_{10} is defined as 1.0 μg/m3 or more. For reference purposes, the national ambient standard for annual average PM_{10} is 50 μg/m3.

It is important to note that no control factors were assumed for the emission calculations. Periodic watering or chemical treatment of the unpaved roads, if necessary, would reduce emission factors by half or more.

4.7. NOISE IMPACTS

There are no occupied housing units in the vicinity of the proposed Antelope and JAB Projects. Open Grazingland is the primary land use within and in the surrounding 2.0-mile area. As a result of the remote location of the Project and the low population density of the surrounding area, impact to noise or congestion within the Project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Sweetwater or other neighboring counties

4.7.1. Noise Impacts of Operations

As noted in the previous section, there are no occupied housing units in the vicinity of the proposed Project. Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Other land uses include oil and gas production facilities, as well as pastureland located to the west of the Project area.

4.8. HISTORIC AND CULTURAL RESOURCES IMPACTS

4.8.1. Archeological Resources Impacts of Operations

As discussed in Section 3.8, the Class III Inventory investigations on the Antelope Project found 10 sites and 81 isolates. Three of the sites are considered significant under Criteria D, and are therefore potentially eligible for listing on the National Registry of Historic Places (NRHP). The other sites are not considered significant because they are small in areal extent, lack features, and exhibit poor integrity. The three sites considered significant will be avoided for development and therefore no impacts to these sites are anticipated.

Class III Inventory investigations on the JAB Project found a total of 25 sites and 29 isolates. Of the 25 sites, one is currently listed on the NRHP. No development is currently planned near the location of this listed site. Therefore no impacts to this site from operations at JAB is expected.

4.9. VISUAL SCENIC RESOURCES IMPACTS

The visible surface structures proposed for the Antelope and JAB Projects include wellhead covers, wellhouses, electrical distribution lines, and the central plant facility. The project will use existing and new roads to access each wellhouse and the central plant.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately 3 feet high and 2 feet in diameter. Each wellhouse is a small metal building. The Antelope central plant building will be approximately 350 feet by 100 feet in size for the initial phase. The JAB satellite building will be approximately 100 feet in width by 180 feet in length. In addition, maintenance, warehouse, and office structures are planned. A disturbance area around each wellhouse is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Electric distribution lines would connect wellhouses to existing electric distribution lines. The distribution poles are approximately 20 feet high and are wooden so that their natural color harmonizes with the landscape.

Temporary and short-term visual effects during the construction period in each wellfield would result from wellhouse construction, well drilling, and construction of access roads and electric distribution lines. Following completion of wellfield installation, temporarily disturbed areas will be reclaimed. Only long-term effects associated with operations and maintenance will remain following post-construction reclamation.

Long-term effects will result from the addition of structures to the landscape, such as the central plant and associated structures, wellhouses, wellhead covers, access roads, and electric distribution lines. Effects from long-term activities will occur over the life of the project.

As noted in Section 3.9, the total score of the scenic quality inventory for the Antelope and JAB License Areas is 4. According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no further evaluation is required. Therefore, no further evaluation of changes to scenic resources from the proposed Antelope and JAB Projects is required.

Despite the low scenic quality rating for the proposed project site, Uranium One intends to implement measures to lessen the visual impact from the project. Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. One method to minimize these contrasts is the selection of paint colors for structures that harmonize with the surrounding landscape. To the extent possible, topographic features may be used to screen wellheads, plant facilities, and roads. Roads may be aligned with the contours of the topography, although this measure may result in a greater area of disturbance. Construction debris will be removed from new construction areas as soon as possible.

4.10. SOCIOECONOMIC IMPACTS

The construction and operating work force for the Antelope and JAB Projects is anticipated to come from the surrounding region, primarily Sweetwater and Carbon Counties in south-central Wyoming. At least 50 percent of the work force would likely be located in Rawlins, which provides labor for a number of large-scale energy related projects in the region. The proposed project is located in Sweetwater County, which would experience effects to housing, public and other community services, recreation, county and municipal finances, crime, and the local transportation network. The adjacent Carbon County would also experience effects to housing and community services, as some of the project workforce would likely reside in Carbon County communities.

It is anticipated that the overall effect of the proposed facility operations on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economies provided by the proposed Antelope and JAB Projects would continue for the life of the facility, estimated to be 15 years for the well field operation and 25 years for the Central Plant operations.

4.10.1. Construction

The construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services in rural Sweetwater County or the nearby town of Bairoil, such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

An estimated 50 percent of the construction work force would be based in Sweetwater County, which contains the License Area. The workforce hired outside of the county would likely be based in Rawlins, located in the neighboring Carbon County, as Rawlins is a regional economic hub that provides a variety of construction services and labor for projects located throughout Wyoming.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed Projects from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located throughout Wyoming typically hire the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the entire construction labor pool of 6,268 (2005 estimate; the construction labor pool as of 2007 is likely to be larger), as construction activities from some active projects would conclude so that workers would be available for future projects.

4.10.2. Operations Workforce

An estimated 40 to 60 people would be required for the operation of the proposed Antelope and JAB Projects. It is not known how many of the required operations workforce would be hired from outside of Sweetwater and Carbon Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 151, based on the 2005 average household size of 2.52 in Wyoming. This increase would account for 0.1 percent of the population of Sweetwater and Carbon Counties, and is smaller than the projected annual growth rate; therefore, there would be little to no effect to the vacancy rates of any type of housing in the Rawlins area or Sweetwater County.

4.10.3. Effects to Housing

The License Area lies within commuting distance of Rawlins and other communities along the I-80 corridor in Sweetwater and Carbon Counties, so that workers from these counties would likely commute from their homes. There would be no impact to temporary housing located within commuting distance (an estimated 1 to 2 hours) of the License Area.

In the event that workers from other states are hired for construction of the proposed Antelope and JAB Projects, temporary housing such as motel/hotel rooms and RV sites located within commuting distance would be required, as no on-site housing (man camp) would be available. The available stock of motel/hotel rooms would accommodate relocating workers.

It is recognized, however, that mineral industries are presently a dominating factor for temporary housing availability in the area, and the workforce employed in these industries occupy much of the temporary housing that becomes available.

It is anticipated that few of the construction work force during construction of any phase of the Antelope and JAB Projects would purchase or rent housing of any type; therefore, there would be no effects on the costs of any type of housing in the counties. Because rental housing usually require a long-term lease (generally a minimum of 6 months), only operations employees would likely enter into this type of lease agreement.

At least 50 percent of the operations workforce is expected to come from Sweetwater and Carbon counties. Those not located within commuting distance of the Antelope and JAB Projects would likely rent or purchase housing. In the unlikely event that the entire operations workforce are non-local and relocated to these counties, a maximum of 180 housing units would be required to accommodate relocating workers. Under this extreme scenario, the available housing units in Sweetwater and Carbon counties would not meet the demand for housing. On the other hand, the population increase would be a maximum 454 (180 workers times 2.52) based on the 2005 average household size of 2.52 in Wyoming. This increase would account for about one percent of the population of Sweetwater County as of 2006, and is within the county's annual projected population increase of 494 people per year between 2003 and 2010.

Household projections estimate a threefold increase in households from 2000 to 2030 as 291 percent in Sweetwater County, and 39 percent in Carbon County. The existing housing stock would not accommodate the projected households. Local communities in general are aware of the pressing need for the new residential development.

4.10.4. Effects to Services

It is likely that both the construction and operating work force would be from the Sweetwater and Carbon Counties, or other nearby counties in central Wyoming, and would not require permanent or temporary housing. In the event that up to 50 percent of the construction and operating workforce are non-local workers, it is anticipated that there would be a less than one percent increase in the population of Sweetwater and Carbon counties from the permanent relocation of the workers and their families. Most non-local workers would use temporary housing. Man camps or other housing would not be constructed for the project workforce, so no new water, sewer, electrical lines, or other infrastructure would be required. There would be no additional demands of increases in service levels for local infrastructure, such as police, fire, water, or utilities. In addition, there would be little measurable increase in non-basic employment, as these jobs are generated from ongoing employment of the existing base of construction workers, and would be maintained through the continued employment of local construction workers. Therefore, construction and operation of the Antelope and JAB Projects would not significantly affect the various public and non-public facilities and services described above from the in-migration of workers for non-basic employment opportunities.

4.10.5. Effects to Traffic

The most heavily used public road segments would be Bairoil Road west of the town of Bairoil, State Highway 73 between Lamont and Bairoil, and State Highway 287 between I-80 through Rawlins north to State Highway 73 at Lamont. Most construction traffic, the construction workforce, and the operations workforce would access the License Area via these road segments. The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) percent increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, track hoes, trenchers, and front-end loaders), and heavy- and light-duty trucks. It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours.

4.11. ENVIRONMENTAL JUSTICE

The U.S Census 2000 Decennial Population program provides race and poverty characteristics for Census Tracts and Block Groups, which are subdivisions of Census Tracts. The License Area and the surrounding 2.0-mile buffer are contained within Census Tract 9716 in Sweetwater County, and in Block Group 1, Census Tract 3 in Fremont County. There is no population within the License Area or the surrounding 2.0-mile buffer.

The State of Wyoming was selected to be the geographic area to compare the demographic data for the population in the affected Census Tracts. This determination was based on the need for a larger geographic area encompassing affected area Census Tracts in which equivalent quantitative resource information is provided. The population characteristics of the affected Census Tracts are compared with Wyoming population characteristics to determine whether there are concentrations of minority or low-income populations in the Census Tracts relative to the state.

As summarized in Table 4.11-1, the combined population within the Census Tracts that encompass the License Area buffer was 3,926. Minority populations accounted for a small proportion of the total population, with percentages of minorities generally similar to or smaller than those of the state as a whole, with the exception of the Hispanic population and the portion of the population that are racially characterized as two or more races. The proportion of the Hispanic population to the total population was slightly larger in Census Tract 9716 than in the state. Those people who are two or more races were also a slightly higher proportion of the total population in both census tracts than in the state.

No concentrations of minority populations were identified as residing near the License Area, as residents nearest are rural populations. There would be no disproportionate impact to minority population from the construction and implementation of the Antelope and JAB Projects.

The populations within the Tracts exhibit lower rates of people living below the poverty level than the state. Both Tracts contain rural populations; therefore, there is no concentration of people living below the poverty level in these Tracts. No disproportionate adverse environmental impacts would occur in populations living below the poverty level within the Census Tracts from proposed Project activities.

Table 4.11-1 **Race and Poverty Level Characteristics of the Population in the Antelope and JAB License Area Census Tracts**

	State of Wyoming	Percent of Total State Population	Census Tract 9716, Sweetwater County	Percent of Census Tract 9716	Block Group 1, Census Tract 3, Fremont County	Percent of Census Tract 3	Total
Total	493,782	100.0%	1,702	100.0%	2,224	100.0%	3,926
Urban:	322,073	65.2%	0	0.0%	0	0.0%	0
Inside urbanized areas	125,706	25.5%	0	0.0%	0	0.0%	0
Inside urban clusters	196,367	39.8%	0	0.0%	0	0.0%	0
Rural	171,709	34.8%	1,702	100.0%	2,224	100.0%	3,926
White alone	454,095	92.0%	1,588	93.3%	2,091	94.0%	3,679
Black or African American alone	3,126	0.6%	2	0.1%	0	0.0%	2
American Indian and Alaska Native alone	11,363	2.3%	16	0.9%	52	2.3%	68
Asian alone	2,972	0.6%	5	0.3%	17	0.8%	22
Native Hawaiian and Other Pacific Islander alone	232	0.0%	1	0.1%	0	0.0%	1
Some other race alone	12,595	2.6%	44	2.6%	11	0.5%	55
Two or more races	9,399	1.9%	46	2.7%	53	2.4%	99
People who are Hispanic or Latino	31,384	6.4%	127	7.5%	67	3.0%	194
Median household income in 1999	37,892	-	49,544	-	38,095	-	-
Per capita income in 1999	19,134	-	19,350	-	20,133	-	-
Population with income in 1999 below poverty level:	54,777	-	150	-	136	-	**286**
Percent below poverty level	11.1%	-	8.8%	-	6.1%	-	**0**

Source: U.S. Bureau of Census 2000

4.12. PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

4.12.1. Nonradiological Impacts

4.12.1.1. Effects of Accidents

Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the Antelope and JAB sites facility and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG–0706[iv] and specifically at ISR uranium facilities in NUREG/CR-6733[v]. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Antelope and JAB facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in NUREG/CR-6733. Uranium One will develop emergency management procedures to implement the recommendations contained in the NRC analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs were discussed in detail in Section 5 of the Technical Report.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISR facilities, such as transportation accidents. NUREG/CR-6733 specifically addressed risks at ISR facilities and identified the "risk insights" that are discussed in the following sections.

4.12.1.2. Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. Industrial safety aspects associated with the use of hazardous chemicals at Antelope and JAB sites is regulated by the Wyoming Occupational Safety and Health Administration (OSHA).

Sulfuric Acid

Sulfuric acid is used to split the uranyl carbonate complex from rich eluate into carbon dioxide gas and uranyl ions in preparation for precipitation using hydrogen peroxide. The sulfuric acid will be stored in a tank located outdoors and piped to the central plant for use in the precipitation circuit. The concentration of sulfuric acid fumes that are immediately dangerous to life and health (IDLH) is 15 mg/m^3. In the risk analysis from NUREG/CR-6733, a spill of 93 percent sulfuric acid was not deemed a significant inhalation hazard to workers as long as normal air dilution is available from the facility ventilation system. NUREG/CR-6733 also noted that sulfuric acid reacts vigorously with ammonia, sodium carbonate, and water, all of which will be present at the Antelope Central Plant. To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the sulfuric acid storage tank will be located away from other process tanks.

The use of sulfuric acid is subject to Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds. As discussed in Section 2.2, the Antelope and JAB sites design includes a sulfuric acid tank with a capacity of 6,000 gallons. Based on the design capacity, Uranium One will be subject to the Emergency Response Plan requirements.

Anhydrous Ammonia

Anhydrous ammonia is used for pH adjustment during the precipitation process. The ammonia will be stored in a tank located outdoors and piped to the Central Plant for use in the precipitation circuit. Ammonia in the liquid form is not the primary hazard. The liquid will evaporate to a gaseous state. The IDLH concentration of ammonia is 300 parts per million (ppm). NUREG/CR-6733 identified an ammonia leak as a significant risk factor within a plant structure because ventilation rates adequate to dilute ammonia fumes in a localized area to maintain concentrations below the IDLH in the event of a leak would not be feasible. An additional hazard associated with ammonia is that it reacts vigorously with sulfuric acid, which will also be present in the precipitation circuit.

To minimize the probability and consequence of an ammonia accident, the Uranium One system design and operating procedures will be consistent with American National

Standards Institute (ANSI) recommendations[vi]. These recommendations include 1) providing an excess flow valve located as close to the storage tank as possible that automatically closes if the flow rate exceeds a specific value; 2) the use of appropriate ANSI and American Society of Material Evaluation (ASME) standard codes for norrefrigerated pressure piping; and 3) provision of positive pressure, self-contained, full face respirators in the immediate vicinity of the ammonia piping and process operations. The ammonia piping will be placed so as to minimize the potential for impact from vehicles or other objects that might cause ruptures.

The use of anhydrous ammonia is subject to various regulatory programs including the following:

- Risk Management Planning (RMP) required in 40 CFR Part 68 for threshold quantities (TQs) in excess of 10,000 pounds;
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 500 pounds; and
- Reportable Quantities (RQs) for spills from the Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) in 40 CFR § 302.4 for spills in excess of 100 pounds.

As discussed in Section 2.3, the Antelope Central Plant design includes the potential use of an anhydrous ammonia tank with a capacity of 90,000 pounds with the potential for expansion to correspond to expansion of the central plant. Based on this design capacity, Uranium One will be subject to all of the aforementioned regulatory programs.

In addition to the listed regulatory programs, the Process Safety Management (PSM) of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 applies to anhydrous ammonia for TQs in excess of 10,000 pounds. In the State of Wyoming, industrial safety at ISR mines is now regulated by Wyoming OSHA. Therefore, the PSM standard will apply to the ammonia system design and operating procedures.

Hydrogen Peroxide

Hydrogen peroxide will be used in the precipitation phase at the Antelope Central Plant. A 50-percent solution of hydrogen peroxide will be added to the acidified uranium-rich eluant to form an insoluble uranyl peroxide compound. Hydrogen peroxide is a strong oxidizer and is a reactive, easily decomposable compound. Its hazardous decomposition products include oxygen and hydrogen gas, heat, and steam. Decomposition can be caused by mechanical shock, incompatible materials including alkalies, light, ignition sources, excess heat, combustible materials, strong oxidants, rust, dust, and a pH above

4.0. When sealed in strong containers, the decomposition of hydrogen peroxide can cause excessive pressure to build up which may then cause the container to burst explosively.

As noted in NUREG/CR-6733, a hydrogen peroxide piping system leak in a process building has the potential to result in localized vapor concentrations in excess of the IDLH value of 75 ppm within several minutes. A leak in a confined space has the potential to generate lethal concentrations of vapor at an even faster rate. Uranium One will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of local ventilation with explosion-proof fans to control vapors in the event of a leak of hydrogen peroxide.

The use of hydrogen peroxide at concentrations greater than 52 percent is subject to the following regulatory programs:

- Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 for TQs in excess of 7,500 pounds; and
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds.

As discussed in Section 2.3, the Antelope site design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with a capacity of 6,000 gallons. With the design hydrogen peroxide concentration and capacity, Uranium One will not be subject to the aforementioned regulatory programs.

<u>Oxygen</u>

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to Antelope and JAB sites by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be allowed to evaporate and will be added to the barren lixiviant upstream of the injection manifold. The design and installation of underground and above-ground gaseous oxygen piping at the Antelope and JAB facilities including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4[vii]. Headerhouses will be equipped with an exhaust ventilation system.

Combustibles such as oil and grease will burn in oxygen if ignited. Uranium One will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1[viii].

Uranium One will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems.

Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points will be performed to protect workers from undetected leaks of carbon dioxide within the Antelope Central Plant and JAB satellite plant.

Sodium Carbonate and Sodium Chloride

Sodium carbonate and sodium chloride are primarily inhalation hazards. Soda ash and carbon dioxide will be used to prepare sodium carbonate for injection in the wellfield. Sodium carbonate and sodium chloride are also used for regeneration of ion exchange resin. Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.

Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas. Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided. Sodium sulfide will be stored separately from hydrogen peroxide and sulfuric acid.

4.12.2. Radiological Impacts

Uranium One is proposing to develop a uranium in-situ recovery facility with a production and restoration flow of approximately 3,000 and 1,000 gallons per minute (gpm), respectively at the Antelope Project and a satellite recovery facility with a production and restoration flow of approximately 3,000 and 500 gpm respectively. An assessment of the radiological effects of the Antelope-JAB facility (the Facility) must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The Facility will use fixed-bed pressurized down flow ion exchange columns to separate uranium from the pregnant production fluid and treat restoration solutions. The uranium contained in the regenerant from the production ion exchange columns will be precipitated and subsequently vacuum dried in a central plant at the Antelope site.

In addition to ion exchange treatment, the groundwater restoration process will use reverse osmosis to remove the dissolved solids. Liquid waste disposal will occur via direct deep well injection. No surge water ponds are planned at this time.

The Facility will also consist of a satellite facility at the JAB site where an ion exchange system similar to the one described above will operate. The resin from this satellite facility will be transferred to the main processing plant at the Antelope site for elution. An average of 2 resin transfers per day from this satellite facility is anticipated.

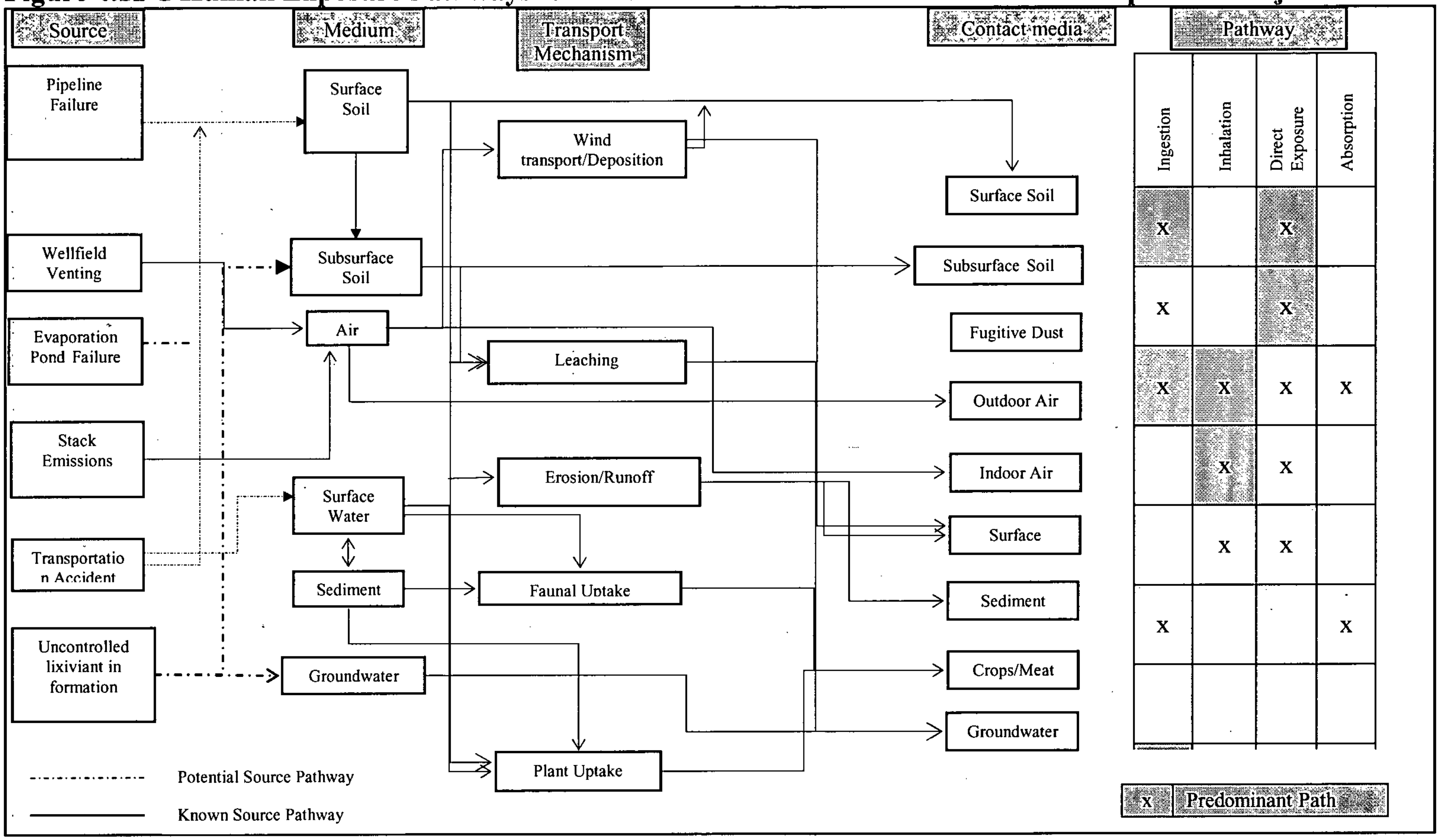
The drying and packaging operation will be conducted under vacuum; as such, the only expected routine emission at the Facility will be radon-222 gas. Radon-222, a decay product of radium-226, is dissolved in the lixiviant as it travels through the ore to a production well where it is brought to the surface. The concentration of radon-222 in the production solution and estimated releases are calculated using the methods found in US NRC Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (March 1987). The details of and assumptions used in these calculations are found in Section 4.12.2.24.

MILDOS-Area is used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site-specific radon-222 release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities are compared to applicable public dose limits as well as naturally occurring background levels.

4.12.2.1. Exposure Pathways

Figure 4.12-1 presents exposure pathways from all potential sources at the Facility. The predominant pathways for planned and unplanned releases are identified. As mentioned above, atmospheric radon-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of Radon-222 releases can be expected in all quadrants surrounding the Facility, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, radon-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.8 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. Figure 4.12-1 shows that all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon-222 are evaluated by MILDOS-AREA.

Figure 4.12-1 Human Exposure Pathways for Known and Potential Sources at the Antelope-JAB Project



4.12.2.2. Exposures from Water Pathways

The mining solutions in the ore zone will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifer will also be monitored.

The primary method of waste disposal at the Facility will be by deep well injection. The deep well will be isolated geologically from underground sources of drinking water. The well will be constructed under a permit from the Wyoming Department of Environment Quality (WDEQ) and all requirements of the US EPA Underground Injection Control (UIC) program will be met.

The uranium ion exchange, precipitation, drying and packaging facilities will be located on curbed concrete pads to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and either pumped back into the processing circuit or disposal well. The pads will be of sufficient size to contain the contents of the largest tank in the event of a rupture.

No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water-related pathways for routine operations exist.

4.12.2.3. Exposures from Air Pathways

The only source of radionuclide emissions is radon-222 released into the atmosphere through a vent system in the main plant areas or from the wellfields. As shown in Figure 4.12-1, atmospheric releases of radon-222 can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure. The Total Effective Dose Equivalent (TEDE) to a hypothetical person living at the property boundary was estimated using MILDOS-Area.

4.12.2.4. Source Term Estimates

The source terms used to estimate radon-222 releases from the Facility include three well fields in production, three restoration well fields, two new well fields, a main processing plant, and a satellite processing facility. The radon-222 releases from these source terms are calculated using methods described below. For the Antelope area, wellfields 1 and 3 where chosen based on their proximity to site boundaries and predominant wind directions. Wellfield 1 in the JAB satellite area was also modeled. The parameters used to characterize and estimate releases are provided in Table 4.12-1.

Table 4.12-1 Parameters used to estimate and characterized source terms at the Antelope-JAB uranium in-situ recovery facility.

Parameter	Site	Value	Unit	Source
Average ore grade	Antelope JAB	0.074 0.074	%	Application
Ore radium-226 concentration	Antelope JAB	206 206	$pCi\ g^{-1}$	Reg. Guide 3.59
Mined area	Antelope JAB	9.7E+05 1.2E+06	$m^2\ y^{-1}$	Application
Average lixiviant flow	Antelope JAB	1.14E+041. 14E+04	$L\ m^{-1}$	Application
Average restoration flow	Antelope JAB	1.89E+03 1.89E+03	$L\ m^{-1}$	Application
Operating days per year	Antelope JAB	365 365	days	Full-time operation assumed
Ore formation thickness	Antelope JAB	6.1 6.1	meters	Application
Ore formation porosity	Antelope JAB	0.25 0.25	NA	Application
Ore formation rock density	Antelope JAB	2.0 2.0	$g\ cm^{-3}$	Estimated
Average residence time for lixiviant	Antelope JAB	7 7	days	Application
Average residence time for restoration solutions	Antelope JAB	35 35	days	Application
Average mass of ore material in mud pit	Antelope JAB	5.2E+05 5.2E+05	g	Estimate based on planned activities
Number of mud pits generated per year	Antelope JAB	300 300	NA	Estimate based on planned activities
Storage time in mud pits	Antelope JAB	14 14	days	Estimate based on planned activities
Radon-222 emanating power	Antelope JAB	0.2 0.2	NA	Reg. Guide 3.59
Radon-222 release rates	Antelope JAB	0.1 0.1	y^{-1}	Estimate based on process
Resin porosity	Antelope JAB	0.4 0.4	NA	NUREG 1569
Ion exchange column volume	Antelope JAB	1.42E+041. 42E+04	L	Estimate based on planned activities
Number of resin transfers per day	Antelope JAB	0 2	NA	Estimate based on planned activities
Stack height	Antelope JAB	16 16	m	Application
Stack diameter	Antelope JAB	0.3 0.3	m	Application
Stack velocity	Antelope JAB	11 11	$m\ s^{-1}$	Application

<u>Production Releases</u>

Currently plans are to have up to three mine areas which potentially could be mined concurrently; one in the JAB satellite area and two in the Antelope area. The potential radon-222 releases from the production well fields were estimated using methods described in Regulatory Guide 3.59 as follows:

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 1:

$$G = R\rho E \frac{(1-p)}{p} x10^{-6} \qquad \text{(Equation 1)}$$

Where:

G	=	radon released (Ci/m^3)
R	=	radium content of ore (pCi/g)
E	=	emanating power
ρ	=	rock density (g cm^{-3})
p	=	formation porosity

The yearly radon released to the production fluid is calculated using Equation 2:

$$Y = 1.44GMD(1 - e^{-\lambda t}) \qquad \text{(Equation 2)}$$

Where:

Y	=	yearly radon released to production fluid (Ci yr^{-1})
G	=	radon released at equilibrium (Ci m^{-3})
M	=	lixiviant flow rate (L min^{-1})
D	=	production days per year (d)
λ	=	radon-222 decay constant (d^{-1})
t	=	lixiviant residence time
1.44	=	unit conversion factor

Using Equations 1 and 2 and the parameters in Table 4.12-1the yearly radon released to production fluid is 1068 Ci yr^{-1}. USNRC RG 3.59 assumes all the radon-222 that is released to the production fluid is ultimately released to the atmosphere, which in the case of ion exchange columns operating at atmospheric pressure in an open system is an appropriate, conservative assumption. In cases where pressurized down-flow ion exchange columns are used and wellfields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. Fugitive radon is released from occasional well field venting for sampling events, small unavoidable leaks in well field and ion exchange equipment, and maintenance of well field and ion exchange equipment. For this reason, annual releases of 10% of the radon-222 from the production fluid are assumed to occur in the well fields. An additional 10% in the ion exchange circuit is assumed. Given these assumptions, the annual radon-222 released from production in the wellfield and the main plant facility is 107 and 96 Ci yr^{-1}, respectively. In the MILDOS-Area model simulations, the wellfield release of 107 Ci yr^{-1} was distributed equally among wellfields 1 and 3 at the Antelope site.

Restoration Releases

Radon-222 releases resulting from wellfield restoration activities were estimated in the same manner as the production activities above (i.e. using Equation 2) but modified for the lower restoration flow rate and the longer restoration fluid residence time, both of which are listed in Table 4.12-1. The assumption of a 10% release in the well field and treatment facility results in releases of 25 and 22 Ci yr^{-1}, respectively. for the JAB property The estimated releases from the well field and treatment facility at the Antelope site is 50 and 44 Ci yr^{-1} respectively. In the MILDOS-Area model simulations, the wellfield release of 25 Ci yr^{-1} was distributed equally among well fields 1 and 3 at the Antelope site.

New Well Field Releases

Radon-222 releases resulting from new wellfield development activities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows:

$$Rn_{nw} = E\lambda[Ra]TmNx10^{-12} \qquad \text{(Equation 3)}$$

Where:

Rn_{nw}	=	Radon-222 release rate from new well field ($Ci\ yr^{-1}$)
E	=	emanating power
[Ra]	=	concentration of radium-226 in ore ($pCi\ g^{-1}$)
λ	=	decay constant of radon-222
T	=	storage time in mud pit (d)
m	=	average mass of ore material in the pit (g)
N	=	number of mud pits generated per year
10^{-12}	=	unit conversion factor ($Ci\ pCi^{-1}$)

Using Equation 3 and the parameters in Table 4.12-1, the yearly radon released from new well field development in each location is 0.02 $Ci\ yr^{-1}$. In the MILDOS-Area model simulations, the new wellfield release was assumed to occur at wellfield 1 in the JAB area, and wellfield 1 in the Antelope area.

Resin Transfer Releases

The radon-222 release resulting from resin transfers from the JAB satellite facility was estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows:

$$Rn_x = 3.65x10^{-10} F_i C_{Rn} \qquad \text{(Equation 4)}$$

Where:

Rn_x	=	Radon release rate from resin transfers ($Ci\ yr^{-1}$)
F_i	=	water discharge rate from resin unloading ($L\ d^{-1}$)
C_{Rn}	=	Steady state radon-222 concentration in process water ($pCi\ L^{-1}$)
$3.65x10^{-10}$	=	unit conversion factor ($Ci\ pCi^{-1}$)($d\ yr^{-1}$)

The steady state radon-222 concentration in process water (C_{Rn}) was estimated from the following expression:

$$C_{Rn} = \frac{Y * 1.9E6}{M} \qquad \text{(Equation 5)}$$

Where:

C_{Rn} = Steady state radon-222 concentration in process water (pCi L^{-1})
Y = yearly radon released to production fluid (Ci yr^{-1})
M = lixiviant flow rate (L min^{-1})
1.9E6 = unit conversion factor (pCi Ci^{-1})(yr min^{1})

The water discharge rate from resin unloading (Fi) was estimated from the following expression:

$$F_i = N_i * V_i * P_i \qquad \text{(Equation 6)}$$

Where:
F_i = water discharge rate from resin unloading (L d^{-1})
N_i = Number of resin transfers per day
V_i = volume of resin in transfer (L)
P_i = porosity of resin

Using Equations 4 through 6 and the parameters in Table 4.12-1, the radon released from resin transfers from the JAB satellite facility is 0.74 Ci yr^{-1}. In the MILDOS-Area model simulations, the resin transfer release was assumed to occur only at the JAB plant site.

Radon-222 Release Summary

A summary of estimated radon-222 releases from the Facility is presented in Table 4.12-2. The source coordinates in Table 4.12-2 are relative to the Antelope main plant area.

Table 4.12.-2 Estimated Radon-222 releases (Ci yr^{-1}) from Antelope-JAB Facility.

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Total
JAB Wellfield 1	-13.6	0.29	107	25	0.02	0	132.02
JAB Plant Stack	-13.6	0.0	96	22	0	0.74	118.7
Antelope Wellfield 1	-1.06	- 0.30	53.5	25	0.02	0	78.52
Antelope Wellfield 3	-2.25	1.41	53.5	25	0.02	0	78.52
Antelope Plant Stack	0	0	96	44	0	0	140.0
Total			406	141	0.06	0.74	547.76

4.12.2.5. Receptors

The receptors used in the MILDOS-AREA simulations are presented in Table 4.12-3 and represent the property boundary in 16 compass directions. The nearest resident to the site is in Bairoil, more that 20 kilometers east of the site.

Table 4.12-3 Antelope-JAB receptor names and locations

Location	X (km)	Y (km)	Distance (km)
1. Antelope Property Boundary- N	0.00	2.22	2.22
2. Antelope Property Boundary- NNE	0.91	2.21	2.39
3. Antelope Property Boundary- NE	1.74	1.74	2.46
4. Antelope Property Boundary- ENE	8.87	3.67	9.60
5. Antelope Property Boundary- E	6.15	0.00	6.15
6. Antelope Property Boundary- ESE	2.97	-1.23	3.21
7. Antelope Property Boundary- SE	1.80	-1.80	2.55
8. Antelope Property Boundary- SSE	0.12	-0.28	3.11
9. Antelope Property Boundary- S	0.00	-2.85	0.30
10. Antelope Property Boundary- SSW	-0.54	-1.30	1.41
11. Antelope Property Boundary- SW	-1.30	-1.30	1.84
12. Antelope Property Boundary- WSW	-2.21	-0.91	2.39
13. Antelope Property Boundary- W	-4.23	0.00	4.23
14. Antelope Property Boundary- WNW	-3.49	1.45	3.78
15. Antelope Property Boundary-NW	-2.29	2.29	3.24
16. Antelope Property Boundary- NNW	-0.96	2.32	2.51
17. JAB Property Boundary- N	-13.56	1.11	13.61
18. JAB Property Boundary- NNE	-13.11	1.10	13.16
19. JAB Property Boundary- NE	-12.45	1.11	12.50
20. JAB Property Boundary- ENE	-10.81	1.14	10.87
21. JAB Property Boundary- E	-10.19	0.00	10.19
22. JAB Property Boundary- ESE	-12.34	-0.51	12.35
23. JAB Property Boundary- SE	-13.20	-0.36	13.20
24. JAB Property Boundary- SSE	-13.36	-0.50	13.57
25. JAB Property Boundary- S	-13.56	-0.50	13.57
26. JAB Property Boundary- SSW	-14.27	-1.72	14.37
27. JAB Property Boundary- SW	-15.29	-1.73	15.39
28. JAB Property Boundary- WSW	-16.61	-1.26	16.66
29. JAB Property Boundary- W	-17.02	0.00	17.02
30. JAB Property Boundary- WNW	-17.04	1.44	17.10
31. JAB Property Boundary- NW	-15.47	1.91	15.59
32. JAB Property Boundary- NNW	-14.02	1.10	14.06

4.12.2.6. Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the Joint Frequency Distribution data presented in Section 3.6 of this application.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 3.10 of this application.

4.12.2.7. Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR §20.1301, Uranium One has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the Antelope-JAB uranium in-situ recovery operation is less than 100 mrem per year. The results of the MILDOS-AREA simulation for each receptor in Table 4.12-3 are presented in Table 4.12-4.

An evaluation of the TEDE follows:

1) The maximum TEDE of 0.53 mrem/yr, located at the -south southeast Antelope property boundary, is 0.53 percent of the public dose limit of 100 mrem/yr.

2) The nearest resident to the site is the town of Bairoil, approximately 20 km to the East. The annual TEDE at the east property boundary of the Antelope site is 0.20mrem. The TEDE to the residents of Bairoil would be much less.

3) The maximum percent Effluent Concentration for radon-222 with daughters present is 0.02.

4) The effect of the Facility operation at any potential resident is less that 1 mrem/yr TEDE.

5) Since radon-222 is the only radionuclide emitted, public dose requirements in 40 CFR Part 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 do not apply.

6) Even if 100% of the radon-222 contained in restoration and production fluids were released to the atmosphere (i.e., 100% released instead of 10%), the TEDE and radon-222 air concentrations at directional receptor locations surrounding the Facility would be less than the 100 mrem public dose limit and Radon-222 Effluent Concentration respectively.

Table 4.12-4 MILDOS-Area predicted Radon-222 concentrations and estimated TEDE at directional receptors surrounding the Antelope-JAB uranium processing facility.

Receptor	Distance (km)	Rn-222 Conc. (μCi ml^{-1})	% Effluent Conc.	TEDE (mrem yr^{-1})
1. Antelope Property Boundary- N	2.22	3.1E-12	0.01%	0.25
2. Antelope Property Boundary- NNE	2.39	2.9E-12	0.01%	0.23
3. Antelope Property Boundary- NE	2.46	3.4E-12	0.01%	0.27
4. Antelope Property Boundary- ENE	9.60	1.5E-12	0.01%	0.12
5. Antelope Property Boundary- E	6.15	2.4E-12	0.01%	0.0.20
6. Antelope Property Boundary- ESE	3.21	2.9E-12	0.01%	0.23
7. Antelope Property Boundary- SE	2.55	2.3E-12	0.01%	0.19
8. Antelope Property Boundary- SSE	3.11	6.9E-12	0.02%	0.53
9. Antelope Property Boundary- S	0.30	3.5E-12	0.01%	0.27
10. Antelope Property Boundary- SSW	1.41	4.6E-12	0.02%	0.35
11. Antelope Property Boundary- SW	1.84	4.3E-12	0.01%	0.33
12. Antelope Property Boundary- WSW	2.39	3.5E-12	0.01%	0.28
13. Antelope Property Boundary- W	4.23	2.6E-12	0.01%	0.21
14. Antelope Property Boundary- WNW	3.78	2.6E-12	0.01%	0.21
15. Antelope Property Boundary-NW	3.24	2.2E-12	0.01%	0.17
16. Antelope Property Boundary- NNW	2.51	3.1E-12	0.01%	0.25
17. JAB Property Boundary- N	13.61	2.3E-12	0.01%	0.18
18. JAB Property Boundary- NNE	13.16	3.7E-12	0.01%	0.29
19. JAB Property Boundary- NE	12.50	5.2E-12	0.02%	0.40
20. JAB Property Boundary- ENE	10.87	4.2E-12	0.01%	0.33
21. JAB Property Boundary- E	10.19	4.1E-12	0.01%	0.32
22. JAB Property Boundary- ESE	12.35	6.6E-12	0.02%	0.50
23. JAB Property Boundary- SE	13.20	5.7E-12	0.02%	0.43
24. JAB Property Boundary- SSE	13.57	3.2E-12	0.01%	0.25
25. JAB Property Boundary- S	13.57	3.3E-12	0.01%	0.25
26. JAB Property Boundary- SSW	14.37	2.5E-12	0.01%	0.19
27. JAB Property Boundary- SW	15.39	2.3E-12	0.01%	0.18
28. JAB Property Boundary- WSW	16.66	1.5E-12	0.01%	0.12
29. JAB Property Boundary- W	17.02	1.2E-12	0.0%	0.01
30. JAB Property Boundary- WNW	17.10	8.2E-13	0.00%	0.07
31. JAB Property Boundary- NW	15.59	9.0E-13	0.00%	0.07
32. JAB Property Boundary- NNW	14.06	1.7E-12	0.01%	0.13

4.12.2.8. Population Dose

The annual population dose commitment to the population in the region within 80 km of the Facility is also predicted by the MILDOS-AREA code. The results are listed in Table 4.12-5, where TEDE is expressed in units of person-rem/yr. For comparison, the dose to the population within 80 km of the Facility due to background radiation is included in the table. Background radiation doses are based on a North American population of 346 million and an average annual TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming. The results of these calculations are included in Table 4.12-5 and also combined with dose to the region within 80 km of the Facility to arrive at the total radiological effects of one year of operation at the Facility.

The maximum radiological effect of the Facility operation would be to increase the TEDE of the continental population by 0.000036 percent.

Table 4.12-5 Total Effective Dose Equivalent to the Population from One Year's Operation at Antelope-JAB Facility

Criteria	TEDE (person-rem/yr)
Dose received by population within 80 km of the Facility	0.01
Dose received by population beyond 80 km of the Facility	4.48
Total Continental Dose	4.48
Background North American Dose	1.2E+08
Fractional increase to background dose	3.7 E-08

4.12.2.9. Exposure to Flora and Fauna

To estimate potential radiological impacts to flora and fauna, the most important pathway for exposure should be identified. Since the only planned atmospheric emissions from the Facility is radon-222, the most important pathway for exposure to flora and fauna is deposition of radon-222 decay products on surface water, surface soils, and vegetation. MILDOS-Area estimates surface deposition rate as a function of distance from the source for the radon-222 decay products and calculates surface concentrations. Table 4.12-6 presents the highest surface concentrations of radon-222 decay products predicted by MILDOS-Area over a 100-year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 4.12-6 Highest Surface Concentrations of Radon-222 Decay Products Resulting From Antelope-JAB uranium ISR operations.

Radionuclide	Distance from site (km)	Direction	Surface Concentration (pCi/m^2)	Soil Concentration in upper 0.5 cm (pCi/g)
Polonium-218	1.5	E	6.3	8 E-04
Lead-214	1.5	E	6.3	8 E-04
Bismuth-214	1.5	E	6.3	8 E-04
Lead-210	45	E	15	2 E-03

Lead-210 represents the radionuclide with the highest concentration (2 E-3 pCi/g), which is at least an order of magnitude below most analytical laboratories detection limits. The increase in soil radioactivity is insignificant compared to site-specific background concentrations discussed in Section 6.1.

It is likely that soil re-suspension from background soils would be the predominant source of lead-210 concentration in vegetation surrounding the site since lead-210 concentrations in vegetation would be similar to that of soil.

From this evaluation, the impact of operations at the Antelope-JAB uranium ISR Facility would be minimal and indistinguishable from current conditions.

4.12.2.10. Potential Radiological Accidents

4.12.2.10.1. Tank Failure

A spill of the materials contained in the process tanks at the Antelope and JAB Projects will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the central plant. The tanks at the Antelope site will contain injection and production solutions, ion exchange resin, pregnant eluant, yellowcake, and liquid waste. The tanks at the JAB site will contain injection and production solutions, ion exchange resin, and liquid waste. The plants will be designed to control and confine liquid spills from tanks should they occur. The central plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central plant building.

All tanks will be constructed of fiberglass or steel with the exception of the hydrogen peroxide storage tank, which will typically be constructed of aluminum. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

NUREG/CR-6733 analyzed the potential impacts of a failure of a yellowcake thickener resulting in a release of 20% of the contents outside the plant structure. This postulated accident scenario was based on an event at the Irigaray ISR facility in 1994. The event in question was caused by the failure of an inadequate concrete pad supporting the thickener. The subsequent release from the building was a result of the proximity of the thickener to the plant wall. NUREG/CR-6733 concluded that, based on conservative calculations of this unlikely event, the dose to the public would be below the limits in 10 CFR Part 20. The calculations resulted in a dose to an unprotected worker in excess of the exposure limits from 10 CFR Part 20 (i.e., 5 rem). However, this dose estimate was based on a number of unlikely, conservative assumptions. The scenario made the unrealistic assumption that no efforts would be made to clean up the spill, allowing the yellowcake to dry and become transportable. The dose was based on lung clearance class Y uranium, which produces the highest dose estimates. No allowance in the dose calculation was made for the use of protective equipment, including protection factors from the use of respiratory protection equipment.

NUREG/CR-6733 also assessed the potential dose from a catastrophic spill from an ion exchange column resulting in the release of the entire contents of the vessel and the resultant release of radon gas. Based on a number of assumptions, the predicted dose was 1.3 rem in a 30-minute period to a worker in the area. Any change to the Rn-222 concentration or exposure time has a linear affect on dose. For example, if the room size is doubled or the exposure time is halved, then the dose will be halved. NUREG/CR-6733 recommended that the use of ventilation or atmosphere-supplying respirators designed to protect against gases would be sufficient to mitigate doses, that unprotected personnel should evacuate spill areas near ion-exchange columns, and that ISR facilities maintain proper equipment, training, and procedures to respond to large lixiviant spills or ion-exchange column failure.

The process plants will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. As discussed in Section 4.13, area ventilation will be provided to control concentrations of airborne radioactive material in the central plant. Finally, Uranium One will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods.

4.12.2.10.2. Plant Pipe Failure

The rupture of a pipe within the central plant will be easily detected by operating staff and can be quickly controlled. Spilled solution will be contained and managed in the same fashion as for a tank failure.

4.12.2.10.3. Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the central plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break. All piping from the central plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each wellfield will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each headerhouse will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the headerhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

4.13. WASTE MANAGEMENT IMPACTS

4.13.1. Gaseous and Airborne Particulates

The primary radioactive airborne effluent at the Antelope and JAB Facilities will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the facility for separation of uranium. The uranium will be separated from the groundwater by passing the solution through fixed bed ion exchange (IX) units operated in a pressurized downflow mode. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the building via an induced draft fan. Venting any released radon-222 gas to atmosphere outside the plant minimizes employee exposure. Small amounts of radon-222 may be released via solution spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The exhaust system in the JAB satellite IX plant and Antelope Central Plant will further reduce employee exposure. The air in the plant is sampled for radon daughters (described in Section 5.7 of the Technical Report) to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

This section describes the gaseous effluent control systems that will be installed in the Antelope and JAB Facilities.

4.13.1.1. Gaseous Effluents-Tank and Process Vessel, and Work Area Ventilation Systems

A separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the process tanks. Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. The venting system from all tanks and sumps consists of 4 to 6-inch PVC piping and function to vent radon gas to the outside atmosphere (see Figures 3-13 and 3-16 for schematic of ventilation systems for Antelope Central Plant and the JAB Satellite). The design of the fans will be such that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Regulatory Guide 8.31[ix]. Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the plant. Tank ventilation systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for minimizing employee exposure.

The work area ventilation systems will be designed to force air to circulate within the JAB Satellite and Antelope Central Plant process areas. The ventilation system exhausts will be located on the north or leeward side of the buildings and will exhaust outside the building, drawing fresh air in from the upwind side of the building. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. The design of the ventilation system will be adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20. The systems for the ion exchange areas and for the precipitation areas will include a minimum of two exhaust fans each. These fans will operate at a minimum rate of 10,000 cfm (at 0" of water) each. Increased operation of these systems will provide adequate ventilation during unfavorable weather conditions. Radon effluent monitoring will be conducted as described in Section 5.7.7 of the Technical Report.

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. Impacts from potential emissions from process chemicals that will be used at the plant is described in Section 4.12. There are no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.13.1.2. Air Particulate Effluents

Potential radiological air particulate effluents consist primarily of dried yellowcake in the drying and processing areas of the central plant. The yellowcake drying facilities at the Antelope Central Plant will be comprised of vacuum dryers. By design, vacuum dryers do not discharge any uranium when operating. The vacuum drying system is proven technology, which is being used successfully in several ISR sites where uranium oxide is being produced. Air particulate controls of the vacuum drying system include a bag house, condenser, vacuum pump, and packaging hood.

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation of water vapor during the drying cycle. It is kept under negative pressure by the vacuum system.

The condenser unit is located downstream of the bag house and is water cooled. It is used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Any particulates that pass through the bag filters are wetted and entrained in the condensing moisture within this unit.

The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture is provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the powder is being transferred.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded as part of routine operations, if currently loaded, or reloaded, if currently empty, until the emission control system is returned to service within specified operational conditions.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

4.13.2. Liquid Waste

Wastewater disposal for the Antelope and JAB Project will be done through deep well injection. Deep injection has been utilized by ISR operations as the primary tool for waste disposal and has been utilized by ISR facilities throughout the Powder River Basin. The deep injection well(s) will be permitted in accordance the WDEQ-WQD Class I UIC rules and regulations.

The operation of the process facility results in three sources of water that are collected on the site. They include the following:

4.13.2.1. Liquid Process Waste

The operation of the process plant and Satellite facility results in two primary sources of liquid waste, an eluant bleed (process plant) and a production bleed (Ion exchange cycles) This water will be injected into the deep disposal well(s).

4.13.2.2. Aquifer Restoration

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The restoration waste is primarily from the first phase of aquifer restoration, groundwater sweep. The second source is brine from the reverse osmosis units, which is sent to the waste disposal systems. The permeate is either re-injected into the well fields or sent to the waste disposal systems. Wastewater from both groundwater sweep and the reverse osmosis phases of restoration are injected into the deep disposal well(s).

4.13.2.3. Water Collected from Wellfield Releases

This water is injection lixiviant or recovery fluids recovered from areas where a liquid release has occurred from a well or pipeline. These occurrences are very infrequent and typically contain small volumes for disposal. The water will be placed into the wastewater disposal systems for deep well injection.

4.13.2.4. Stormwater Runoff

A final source of water is storm runoff. Stormwater management is controlled under NPDES permits issued by the WDEQ-WQD. Facility drainage will be designed to route storm runoff water away or around the plant, ancillary building and parking areas, and chemical storage. The design of the Antelope and JAB facilities and procedural and engineering controls contained in a Best Management Practices (BMP) Plan will be implemented such that runoff is not considered to be a potential source of pollution.

4.13.2.5. Liquid Waste Disposal

Uranium One expects that the liquid waste stream generated at the Antelope and JAB Facilities will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in Wyoming and Nebraska. It is anticipated that the maximum volume of liquid waste stream for disposal at the Antelope project will be approximately 40 gpm during normal operations and approximately 200 gpm of additional flow from maximum restoration. The average disposal waste stream over the Antelope project (operations and restoration) will be approximately 150 gpm. The anticipated maximum volume of liquid waste stream for disposal at the JAB Satellite Project will be approximately 35 gpm during normal operations and approximately 100 gpm of additional flow from restoration. The average disposal waste stream over the JAB project (operations and restoration) will be approximately 90 gpm

Feasibility studies conducted in the Antelope and JAB areas to date indicate several deep sand units exist with favorable porosity and water quality that are potential target zones adequate for deep disposal of liquid effluent. Further seismic data evaluations are currently being conducted to determine the best disposal zone related to storage and faulting. Uranium One plans to install several deep disposal wells at the Antelope Project and the JAB Project as the primary liquid waste disposal method. An adequate number of wells will be installed to provide enough capacity for peak flow conditions plus a backup well to be utilized during maintenance or periods of shutdown of operating wells. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods. All compatible liquid wastes at both project areas will be disposed in the planned deep wells. An application is currently in development and will be submitted to the WDEQ-WQD for the appropriate UIC Permits for deep disposal wells for both facilities in the third quarter of 2008.

4.13.2.6. Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Wyoming. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal.

4.13.2.7. Liquid Waste Monitoring and Reporting

A composite sample of the waste stream will be collected quarterly, or when process change occurs that could significantly alter the chemical composition of the waste stream. Samples will be collected upstream of the high-pressure injection pump. Analyses will be performed using approved methods and in accordance with WDEQ Rules and Regulations, Chapter VIII, Section 7. The proposed parameter list follows:

Ra-226 (pCi/l)
Uranium (mg/l)
TDS (mg/l)
PH (units)
Total Alkalinity (mg/l)

It is understood that WDEQ recently has been requesting an EPA 624 Analysis for the waste stream. If this standard should be required by the WDEQ, Uranium One will comply.

Monitoring records will be submitted to WDEQ quarterly (within 30 days after the end of the quarter) and will include:

1) Date, location and time of sampling
2) Name(s) of sampling personnel
3) Date(s) of analysis
4) Analytical laboratory and name(s) of analytical technician(s)
5) Analytical procedures or methods used
6). Analytical results

Reporting will include injection and annulus pressures. Further, the average reservoir pressure will be determined once per year by conducting a pressure falloff test on one of the Uranium One wells.

4.13.2.8. Disposal Well Mechanical Integrity

After completion of deep disposal well construction, Part I mechanical integrity will be demonstrated for each well before injection commences, in accordance with the procedures specified by WDEQ.

Part II integrity will be demonstrated prior to injection by either (1) a Radioactive Tracer Log and Temperature Survey coupled with a casing pressure check, or (2) an oxygen activation log. Part II MIT will also be demonstrated (1) if any abnormal annulus pressures are observed, (2) every five years at a minimum, and (3) any time the tubing and packer are removed from the well.

4.13.2.9. Potential Pollution Events Involving Liquid Waste

Although there are a number of potential sources of pollution present at the Antelope and JAB facilities, existing regulatory requirements from the NRC and WDEQ, and provisions of Uranium One's Environmental Management Programs have established a framework that significantly reduces the possibility of an occurrence. Extensive training of all personnel is standard policy for Uranium One operations and will be implemented at the Antelope and JAB Facilities. Frequent inspections of waste management facilities and systems will be conducted. Detailed procedures will be included in Uranium One's Environmental Management Programs. Potential sources of pollution include the following:

4.13.2.10. Spills from Wellfield Buildings, Pipelines, and Well Heads

Wellfield buildings or pipelines are not considered to be a potential source of pollutants during normal operations, as there will be no process chemicals or effluents stored within them. The only instance in which these wellfield features could contribute to pollution would be in the event of a release of injection or recovery solutions due to pipe or well failure. The possibility of such an occurrence is considered to be minimal as the piping will be leak checked first. In addition, the flows through the pipe will be at a relatively low pressure and can quickly be stopped, thus any release would not migrate far. Wellfield headerhouses will also be equipped with wet alarms for early detection of leaks. Piping from the wellfields will generally be buried, minimizing the possibility of an accident. Large leaks in the pipe would quickly become apparent to the plant operators due to a decrease in flow and pressure, thus any release could be mitigated rapidly. All piping will be leak checked prior to operation.

In general, piping from the plant, to and within the wellfield will be constructed of PVC or high density polyethylene pipe (HDPE) with butt welded joints or the equivalent. All pipelines will be pressure tested before final operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines will be protected from a major cause of potential failure which is vehicles driving over the lines causing breaks. Typically, the only exposed pipes will be at the central plant, at the wellheads, and in the headerhouses in the wellfield. Trunkline flows and manifold pressures will be monitored for process control.

Engineering and administrative controls will be in place at the Antelope Central Plant and JAB Satellite IX Plant to prevent both surface and subsurface releases to the environment, and to mitigate the effects should an accident occur.

4.13.2.11. Spills from the Antelope Central Plant and JAB Satellite IX Plant

The Antelope Central Plant and JAB Satellite IX Plant will serve as a central hub for the mining operations at both project areas. Therefore, the central plant area will have the greatest potential for spills or accidents resulting in the release of potential pollutants.

Spills could result from a release of process chemicals from bulk storage tanks, piping failure, or a process storage tank failure.

The design of the Antelope Central Plant and JAB Satellite IX Plant buildings will be such that any release of liquid waste would be contained within the structure. A concrete curb will be built around each process building. These pads will be designed to contain the contents of the largest tank within the building in the event of a rupture. In the event of a piping failure, the pump system will immediately shut down, limiting any release. Liquid inside the buildings, both from a spill or from washdown water, will be drained through a sump and sent to the liquid waste system.

4.13.2.12 Spills from Deep Well Pumphouses and Wellheads

The design of the deep well pumphouses and wellheads will be such that any release of liquids will be contained within the building or in a bermed containment area surrounding the facilities. Liquid inside the building will be contained and managed as appropriate.

The wells will be equipped with a high-level shutoff switch on the injection tubing to prevent operation of the pumps at pressures greater than the Limiting Surface Injection Pressure. In addition, the wells will be equipped with a low-pressure shut-down switch on the surface injection line that will deactivate the injection pump in the event of a surface leak. Finally, the wells will include a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This switch will stop the injection pump in the event of either (1) a tubing leak or (2) a casing, packer, or wellhead leak.

4.13.3. Solid Waste

Solid wastes generated consist of spent resin, resin fines, filters, miscellaneous pipe and fittings, and domestic waste. These wastes are classified as contaminated or non-contaminated waste according to radiological survey results. Contaminated 11e.(2) byproduct waste that cannot be decontaminated is packaged and stored until it can be shipped to a licensed waste disposal site or licensed mill tailings facility.

Non-contaminated solid waste is collected on site on a regular basis and disposed of in a sanitary landfill permitted by the WDEQ.

4.13.3.1 Uncontaminated Solid Waste

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste includes solid waste, piping, valves, instrumentation, equipment and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination will be made before releasing the material. Decontaminated materials must have activity levels lower than those specified in NRC guidance[x]. Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 5 of the Technical Report.

Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 4,000 cubic yards (yd^3) of uncontaminated solid waste combined per year. Uncontaminated solid waste will be collected on the sites on a regular basis and disposed of in the nearest sanitary landfill.

4.13.3.2 Byproduct Material

All contaminated items that cannot be decontaminated to meet release criteria will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Solid wastes generated by this project that may become contaminated with radioactive materials consist of items such as rags, trash, packing material, worn or replaced parts from equipment, piping, filters, protective clothing, and solids removed from process pumps and vessels. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers. Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 500 yd^3 of 11e.(2) byproduct material combined per year. These materials will be stored on site inside the restricted area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

4.13.3.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the WDEQ for Class V UIC wells. Disposal of solid materials collected in septic systems must be performed in accordance with WDEQ Solid Waste Management rules and regulations.

4.13.3.3 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Wyoming, hazardous waste is governed by WDEQ Hazardous Waste Rules and Regulations. Based on preliminary waste determinations conducted by Uranium One in consideration of the processes and materials that will be used on the projects, Uranium One will likely be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. Uranium One expects that only used waste oil and universal hazardous wastes such as spent batteries will be generated at the Antelope and JAB Uranium Project.

4.13.3.3 Soil Contaminated as a Result of Wellfield Releases

All piping from the Antelope central and JAB satellite plants, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each wellfield will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, may have high and low flow alarm limits set in the header house. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, leaks (typically small) at pipe joints and fittings in the wellhouses or at the wellheads may occur. Reporting of site releases is discussed in Section 4.13.3.3. Until remedied, these leaks may drip process solutions onto the underlying soil. Surface and subsurface soil at a solution mine may become contaminated by leaks and spills of process solutions. Although the specific concentration of radionuclides in these process solutions is relatively low, the concentration of contamination in the soil may exceed regulatory limits if the solution is confined to a small area or if there are multiple spills in the same location. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic (at a minimum of daily) inspections of each wellfield that is in service or in restoration. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination above cleanup standards. Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented as required by the NRC. The soils potentially impacted by a spill of injection or production fluid are typically sampled and scanned for gamma radiation. The surface extent of any spill will be delineated horizontally by use of a field GPS system. If contamination is detected by gamma surveys, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed immediately if concentrations exceed regulatory requirements or left in place and documented for future clean up (if necessary) during the decommissioning phase of site closure.

In the event of a minor spill where the amount of fluid is limited with minimal chance of significant infiltration of the fluid, samples may be obtained at only the 0-6 inch depth. In the case of significant pooling of fluid, soil samples may be necessary at the 0-6 inch and 6-12 inch intervals. The first steps after a release is discovered will be to immediately stop the source of the leak and limit the horizontal migration of released fluid then initiate the process of recovering any free standing fluids.

The cleanup of surface and subsurface soils is governed by the limits in 10 CFR Part 40, Appendix A. Those limits for the concentration of Ra-226 in soil are 5 pCi/gm above background for the first 15 cm surface layer, averaged over not more than 100 m^2 and 15 pCi/gm above background for each successive 15 cm subsurface layer, averaged over not more than 100 m^2. Soil clean up and survey methods will be designed to meet current requirements of the USNRC and will be described in the Decommissioning Plan required by NRC License Condition.

All site release information and survey results will be maintained as a component of the decommissioning records as required by 10 CFR §20.2103. Documentation of annual releases from the site will be provided with a Map to the WDEQ-LQD in the annual Mine Permit report.

4.13.3.3 Reporting Procedures

Reporting of excursions and corrective actions will be conducted as described in Section 6.2.

The WDEQ-LQD will be verbally notified (per telephone or email) within 24 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the WDEQ-LQD within 5 days of discovery containing the information described in WDEQ-LQD Rules and Regulations, Chapter 11, Section 12(a)(B)(ii).

The NRC will be verbally notified (per telephone or email) within 48 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the NRC within 30 days of discovery containing the information required per NRC License Conditions.

Other unanticipated spills of reportable quantities from chemicals bulk storage areas will be reported to the WDEQ in accordance WDEQ-WQD, Rules and Regulations, Chapter 17, Part E and 40 CFR 302 (CERCLA).

Other operational reporting and applicable requirements include the following:

- Corrective Actions and Compliance Schedules- WDEQ-LQD Rules and Regulations, Section 13 and NRC License Conditions.
- Quarterly Monitoring Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Annual Operations Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Well Abandonment Reports- WDEQ-LQD Rules and Regulations, Section 15
- Deep Disposal Well Monitoring Reports- Done in accordance with UIC injection well permit issued by the WDEQ-LQD.

NRC Semi-Annual Report- Done in accordance with NRC License Conditions

4.14. CUMULATIVE IMPACTS

4.14.1 Cumulative Impacts of Other Uranium Development Projects

The Great Divide Basin has historically been developed for conventional mining operations. The Sweetwater Mill, owned by Kennecott Uranium Company is located approximately 12 miles south of the Antelope and JAB Projects. This mill serviced historic open pit operations such as the Big Eagle Pit (approximately 15 miles north of the Antelope and JAB Projects Areas) and the Sweetwater Pit (adjacent to the Sweetwater Mill). There are no conventional uranium mines currently in operation in the Great Divide Basin and the Sweetwater Mill is on standby status.

Uranium One is aware that several companies are actively investigating the potential for ISR mining in areas near the Antelope and JAB Projects. These projects are in various stages of development. One License and permit application has been submitted to the regulatory agencies at the time of this application by Ur-Energy for the Lost Creek ISR Project approximately 6 miles south of Antelope and JAB. Currently, a NRC License or State Mine Permit has not been granted for this project. As such, it is not possible for Uranium One to accurately predict the cumulative environmental impacts should these uranium projects seek and ultimately gain regulatory approval and be developed. However, some increased traffic on main artery roads would be observed if all projects were to come to fruition.

4.15 REFERENCES

[11] COGEMA Mining, Inc., *Wellfield Restoration Report, Irigaray Mine*, June 2004.

[2] U.S. Nuclear Regulatory Commission, NUREG–1508, *Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico*, February 1997.

[3] U.S. Nuclear Regulatory Commission, NUREG–0706, *Final Generic Environmental Impact Statement on Uranium Milling—Project M–25*, September 1980.

[4] Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*, 2001.

[5] American National Standards Institute, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*, 1989.

[6] Compressed Gas Association, Inc., CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*, 1993.

[7] Compressed Gas Association, Inc., CGA-G-4.1, *Cleaning Equipment for Oxygen Service*, 1996.

[8] U.S. Nuclear Regulatory Commission, NUREG-1508, *Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico*. 1997.

[9] Wyoming State Climate Office, Wyoming Climate Atlas. [Web Page] located at http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/severe_weather.html#74, Accessed August 28, 2007.

NRC, 1987. U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations.*

NRC, 2003. U.S. Nuclear Regulatory Commission (NRC) NUREG-1569, *Standard Review Plan for In-Situ Leach Uranium Extraction License Applications-Final Report, Appendix D, MILDOS-AREA: An Update with Incorporation of In-Situ Leach Uranium Recovery Technologies.*

[1] U. S. Nuclear Regulatory Commission, Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

[2] U. S. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material* (May 1987).

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5 MITIGATION MEASURES

5.1 MITIGATION MEASURES FOR LAND USE IMPACTS

All lands disturbed by the mining project will be returned to their pre-mining land use of livestock grazing and wildlife habitat unless an alternative use is justified and is approved by the state and the BLM. The objectives of the surface reclamation effort is to return the disturbed lands to production capacity of equal to or better than that existing prior to mining. The soils, vegetation and radiological baseline data will be used as a guide in evaluating final reclamation. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the Antelope and JAB Project. The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section **5.1.1**.
- Determination of appropriate cleanup criteria for structures (Section 5.1.7) and soils (Section **5.1.8**).
- Perform radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section **5.1.7**.
- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC.
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.
- Perform final site soil radiation surveys.
- Backfill and recontour all disturbed areas and roads.
- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the Antelope and JAB facilities. Uranium One will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning.

5.1.1 Well Plugging and Abandonment

Wellfield plugging and surface reclamation will be initiated once the regulatory agencies concur that the groundwater has been adequately restored and that groundwater quality is stable. All production, injection and monitor wells and drillholes will be abandoned in accordance with WS-35-11-404 and Chapter VIII, Section 8 of the WDEQ-LQD Rules and Regulations to prevent adverse impacts to groundwater quality or quantity.

Wells will be plugged and abandoned in accordance with the following program.

- When practicable, all pumps and tubing will be removed from the well.
- All wells will be plugged from total depth to within three feet of the collar with a nonorganic well abandonment plugging fluid of neat cement or bentonite based grout mixed in the recommended proportion of 20 lbs per barrel of water, to yield an abandonment fluid with a 10 minute gel strength of at least 20 lbs/100 sq ft and a filtrate volume not to exceed 13.5 cc.
- The casing is cut off at least three feet below the ground surface. Abandonment fluid is topped off to the top of the cut-off casing. A steel plate is placed atop the sealing mixture showing the permit number, well identification, and date of plugging.
- A cement plug is placed at the top of the casing (if cement is not within three feet of the surface), and the area is backfilled, smoothed, and leveled to blend with the natural terrain.

As an alternative method of well plugging, a dual plug procedure may be used where a cement plug will be set using slurry of a weight of no less than 12 lbs/gallon into the bottom of the well. The plug will extend from the bottom of the well upwards across the first overlying aquitard. The remaining portion of the well will be plugged using a bentonite/water slurry with a mud weight of no less than 9.5 lbs/gallon. A 10-foot cement top plug will be set to seal the well at the surface.

5.1.2 Surface Disturbance

The primary surface disturbances associated with ISR mining are the sites containing the central processing and satellite plants, maintenance buildings and office areas. Surface disturbances also occur during the well drilling program, pipeline and well installations, and road construction. These more superficial disturbances involve relatively small areas or have very short-term impacts.

Disturbances associated with the Antelope central processing plant, the JAB satellite plant, office and maintenance buildings, and field header buildings, will be for the life of those activities and topsoil will be stripped from the areas prior to construction. Disturbance associated with drilling and pipeline installation is limited, and is reclaimed and reseeded as soon as weather conditions permit. Vegetation will normally be reestablished over these areas within two years. Surface disturbance associated with development of access roads will occur at the Antelope and JAB sites and topsoil will be stripped from the road areas prior to construction and stockpiled as described in Section 2.6.

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged to the extent possible.
- Removal of buried wellfield piping.
- The wellfield area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.
- Removal of gravel surface on access roads, recontour and replace topsoil from stockpiles.
- Final revegetation of the wellfield areas and roads will be conducted according to the revegetation plan.
- All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.

It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted area landfill. Other materials that are contaminated will be decontaminated until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a licensed byproduct material disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence. Once a production unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the wellfield will be scheduled for decommissioning and surface reclamation.

5.1.3 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil will be salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment will typically be used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations will be determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which will be determined during final wellfield construction activities.

As described in Section 3.3, topsoil thickness varies within the license area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 12 inches.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles will be generally located on the leeward side of hills to minimize wind erosion. Stockpiles will not be located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles will be seeded at the next available window of opportunity in the fall or spring seeding season with the permanent seed mix. In accordance with WDEQ-LQD requirements, all topsoil stockpiles will be identified with a highly visible sign with the designation "Topsoil."

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil is separated from subsoil with a backhoe. Drill hole site topsoil management procedures was discussed in Section 5.1.

5.1.4 Final Contouring

Recontouring of land where surface disturbance has taken place will restore it to a surface configuration that will blend in with the natural terrain and will be consistent with the post mining land use. Since no major changes in the topography will result from the proposed mining operation, a final contour map is not required.

5.1.5 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During mining operations the topsoil stockpiles, and as much as practical of the disturbed wellfield areas will be seeded to establish a vegetative cover to minimize wind and water erosion. After topsoiling prior to final reclamation, an area will normally be seeded with a permanent seed mix which will often contain a nurse crop (sterile wheat or oats) to establish a standing vegetative cover along with the permanent seed mix. This long term permanent seed mix typically consists of one or more of the native wheat grasses (i.e. Western

Wheatgrass, Thickspike Wheatgrass). Listed below is the proposed permanent seed mix to be used at the Antelope and JAB site.

Table 5.1-1 Proposed Seed Mix for Use at the Antelope and JAB Project

SPECIES	LBS/ACRE	SEEDS/LB	SEEDS/FT SQ	% SEEDS
Bluebunch Wheatgrass	6.00	191,000.00	17.54	23.14
Slender Wheatgrass	4.00	110,000.00	10.10	13.33
Streambank Wheatgrass	6.00	97,000.00	4.45	5.88
Bottlebrush Squirreltail	4.00	926,000.00	21.26	28.04
Indian Ricegrass	4.00	181,000.00	8.31	10.96
American Vetch	4.00	154,000.00	14.14	18.66
Showy Evening Primrose	0.20		**75.80**	**100.00**
TOTAL POUNDS PLS/ACRE	28.20			

Larger disturbance areas will typically utilize drill seeding methods done with typical farming equipment. All seed will be drilled to the appropriate depths. Smaller disturbance areas may utilize broadcast seeding and raking methods. All seeding will be completed as soon as practical during the next available seasonal seeding window. At the minimum, all sites will be seeded within one month with a cover or nurse crop species if not in the optimal seasonal seeding window. An example of this situation would be if a construction of a site was completed on July 1. In this example, the site would be seeded within 30 days with a cover or nurse crop and then seeded with the permanent seed mix at a more optimal fall seeding date.

The success of permanent revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986). This method compares, on a statistical basis, the reclaimed area with adjacent undisturbed areas of the same vegetation type.

The Extended Reference Area will be located adjacent to the reclaimed area being assessed for bond release and will be sized such that it is at least half as large as the area being assessed. In no case will the Extended Reference Area be less than 25 acres in size.

The WDEQ-LQD will be consulted prior to selection of Extended Reference Areas to ensure agreement that the undisturbed areas chosen adequately represent the reclaimed areas being assessed. The success of permanent revegetation and final bond release will be assessed by the WDEQ-LQD.

Reclaimed wellfield and process facility areas will remain fenced until successful reclamation is achieved to protect newly seeded areas from livestock grazing.

5.1.6 Road Removal and Reclamation

Those portions of roads constructed and utilized for access to the facilities and wellfields will be reclaimed unless the BLM request that the roads be left for future access and accept the responsibility for their long term maintenance and ultimate reclamation.

Prior to reclamation, any contamination which resulted from the ISR operation would be cleaned to appropriate NRC standards and the contaminated material disposed at a licensed byproduct disposal facility. Following clean up, the roads will be ripped and/or disked to relieve compaction. Excess imported gravel will be removed. Culverts will be removed and pre-mine drainages reestablished. All roads and ditches to be reclaimed will be graded and recontoured to blend with the surrounding terrain.

Topsoil will salvaged and stockpiled during construction of all newly constructed primary and secondary access roads. Available topsoil will be replaced in a uniform manner prior to revegetation.

5.1.7 Procedures for Removing and Disposing of Structures and Equipment

5.1.7.1 Preliminary Radiological Surveys and Contamination Control

Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys so that the data can be directly compared for identification of potentially contaminated areas. For example, a comprehensive gamma scan of the site will be performed, including conversion of raw scan data to 3-foot HPIC equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be kriged in GIS to develop continuous estimates across the site, making direct spatial comparisons with baseline survey maps possible for any given area at the site. Both qualitative assessments and quantitative statistical comparisons between kriged data sets can be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will also be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.

Final status surveys after any remediation has occurred will also be conducted such that results can be directly compared to pre-operational baseline survey data. As with pre-reclamation surveys, final status gamma scan data will be converted to 3-foot HPIC equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations, then kriged using GIS for comparative assessments against pre-operational baseline data. For aspects of the final status survey, pre-operational baseline data may be used instead of a physically separated reference area to provide information on background conditions for statistical comparative testing. Subsurface sampling will be conducted as part of the final status survey only if residual subsurface contamination is known to remain after any remediation has been completed. Other post-operational environmental monitoring data such as sediments, surface waters, groundwater, air particulates, radon, and vegetation may also be compared quantitatively and/or qualitatively against pre-operational baseline data.

5.1.7.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- •Removal to a new location for future use;
- •Removal to another licensed facility for either use or permanent disposal; or
- •Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

Uranium One believes that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a licensed byproduct material disposal facility if contaminated.

5.1.7.2.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Materials and equipment that become contaminated as a result of normal operations are decontaminated if possible and disposed of by conventional methods. Equipment and materials that cannot be decontaminated are treated in the same manner as other contaminated 11e.(2) byproduct material.

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with NRC guidance. Release limits for alpha radiation are as follows:

- Removable alpha contamination of 1,000 dpm/100cm^2
- Average total alpha contamination of 5,000 dpm/100 cm^2 over an area no greater than one square meter

- Maximum total alpha contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2.

Decontamination of surfaces will be guided by the ALARA principle to reduce surface contamination to levels as far below the limits as practical. Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an licensed byproduct material disposal facility. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427. Particular attention will be given to equipment and structures in which radiological materials could accumulate in inaccessible locations including piping, traps, junctions, and access points. Contamination of these materials will be determined by surveys at accessible locations. Items that cannot be adequately characterized or that are too large to be scanned will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

5.1.7.2.2 Preparation for Disposal at a Licensed Facility

If facilities or equipment are to be moved to a facility licensed for disposal of 11e.(2) byproduct material, the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce excessive interior contamination as necessary for safe handling by workers during dismantling.

- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be excessively contaminated, the equipment may be washed down as necessary and decontaminated to permit safe handling by workers during dismantling.

- The equipment will be disassembled only to the degree necessary for transportation or as required by the licensed disposal facility. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.

- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.

- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

5.1.7.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. Uranium One is investigating alternatives for disposal at existing sites licensed to receive 11e.(2) byproduct material including Pathfinder Mines, Kennecott Uranium Company, Denison Mines, and Waste Control Specialists (Texas). An agreement for disposal of 11e.(2) byproduct material will be in place before operation of the Antelope and JAB project commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

5.1.8 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

5.1.8.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA goals and the chemical toxicity of uranium.

On April 12, 1999, the NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6(6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This section documents the modeling and assumptions made by Uranium One to derive a standard for natural uranium in soil for the proposed Antelope and JAB Project.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance was published as Appendix E to NUREG-1569[1]. This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual[2], the Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil[3] and site-specific parameters were used in the modeling as discussed in the following sections.

5.1.8.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.3 computer code was used to model the Antelope-JAB Project site and calculate the annual dose from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose is attached:

- The RESRAD Data Input Basis (Appendix C-1) provides a summary of the modeling values used as input parameters. A sensitivity analysis was performed for parameters that are important to the major component dose pathways and for which no site-specific data were available.
- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix C-2).
- A full printout of the final model results for the resident farmer scenario with the chosen input values is attached (Appendix C-3 and C-4).
- Graphs in Appendix C-5 provide the modeling results for the estimated doses during the 1,000 year time span for both radium-226 (Ra-226) and natural uranium (U-nat). A series of graphs depicts the summed dose for all pathways and the component pathways that contribute to the total dose.

The maximum dose from Ra-226 contaminated soil for the residential farmer scenario was 41.1 millirem per year (mrem/yr). This dose was based upon the 5 picocuries per gram (pCi/g) above background surface (0 to 6-inch) Ra-226 standard and occurred at time, t = 0 years. The most significant dose pathways (representing 90 percent of the maximum dose) were external exposure and plant ingestion (water independent). A sensitivity analysis was performed for important parameters used in these two pathways for which no site-specific information was available. The 41.1 mrem/yr dose from Ra-226 is the "Benchmark dose" at which the U-nat radiological end point soil standard will be based. Methods used to determine the U-nat soil concentration that would result in the radium "Benchmark dose" are describe in Section 3.0.

5.1.8.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of U-nat in soil distinguishable from background that would result in a maximum dose of 41.1 mrem/yr. The method involved modeling the dose from a set concentration of U-nat in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable U-nat concentration in soil.

To facilitate calculations, a preset concentration of 100 pCi/g U-nat was used for modeling dose. The fractions used were 48.9 percent (or pCi/g) uranium-234, 48.9 percent (or pCi/g) uranium-238, and 2.2 percent (or pCi/g) uranium-235. The distribution coefficients used for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate the potential effects of not using site-specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling. RESRAD output showing the input parameters is provided in Appendix C-3.

A U-nat concentration in soil of 100 pCi/g, resulted in a maximum dose of 8.1 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix C-4.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{100 \text{ pCi/g natural uranium}}{8.1 \text{ mrem/yr. natural uranium dose}} \right) \text{x } 41.1 \text{ mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 507 \text{ pCi/g natural uranium}$$

The U-nat limit is applied to soil cleanup with the Ra-226 limit using the unity rule. The unity rule approach will be used to determine if site soil cleanup standard are met. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}} \right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}} \right) < 1$$

5.1.8.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure were evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the Benchmark Dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 75 percent of the meat and milk, and 25 percent of fruits and vegetables are grown at the site. Intake of contaminated food through the aquatic pathway was considered improbable. Also, the model showed that the contamination would not affect groundwater quality. The model endpoint is dose based on U-nat activity concentrations in various compartments. This activity concentration can easily be converted to mass concentrations to evaluate the chemical toxicity of U-nat. Therefore the same model was used in assessing the chemical toxicity. In addition, the intake from eating meat and drinking milk was shown to be negligible compared to the plant pathway and, therefore, is not shown here.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. The soil-plant conversion factor is based on a dry weight, so the annual consumption is multiplied by the dry-weight to wet-weight ratio to convert it to a dry-weight basis. Parameters for these calculations are given in Section 6.5.9 of NUREG/CR-5512 Vol. 1.

Table 5.1-1 provides the parameters used in these calculations and annual human intakes for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 and 97 kilograms per year (kg/year) were assumed for leafy vegetables and other vegetables and fruit, respectively. It was assumed that the concentration of U-nat in the garden or orchard soil was 507 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils determined for the Antelope-JAB project site. Multiplying the specific activity of U-nat, 677 pCi per milligram, by 507 pCi/g results in a soil concentration of 748

milligrams per kilogram (mg/kg). The intake shown in the first column of Table 5.1-2 is equal to the product of the parameters given in the subsequent columns. Table 5.1-2 shows that the total uranium intake from all food sources from the site is 49.3 mg/yr.

Table 5.1-2 Annual Intake of Uranium from Ingestion

Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil-to-Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio	Food Source
8.9	748	1.7E-2	3.5	0.2	Leafy Vegetables
34	748	1.4E-2	13	0.25	Other Vegetables
6.4	748	4.0E-3	12	0.18	Fruit
49.3	**Total**				

A two-compartment model of uranium toxicity in the kidney from oral ingestion was used to predict the burden of uranium in the kidney following chronic uranium ingestion (ICRP, 1995). This model tracks the distribution of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells (macrophages), and other soft tissues.

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows:

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P = uranium burden in the plasma, μg
IR = dietary consumption rate, mg uranium/d
f_1 = fractional transfer of uranium from GI tract to blood, unitless
f_{ps} = fractional transfer of uranium from plasma to skeleton, unitless
f_{pr} = fractional transfer of uranium from plasma to red blood cells, unitless
f_{pl} = fractional transfer of uranium from plasma to liver, unitless
f_{pt} = fractional transfer of uranium from plasma to soft tissue, unitless
f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unitless;
λ_p = biological retention constant in the plasma, d^{-1}.

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg;
λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}.

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, μg;
λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};
f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and values recommended by the ICRP as listed below (ICRP, 1995).

IR = 0.14 mg/day
f_1 = 0.02
f_{ps} = 0.105
f_{pr} = 0.007
f_{pl} = 0.0105
f_{pt} = 0.347
f_{pk1} = 0.00035
f_{pk2} = 0.084
λ_{k1} = ln(2)/5 yrs
λ_{k2} = ln(2)/7 days

From the last equation above, the calculated uranium in the kidneys is 0.0093 mg, or a uranium concentration of 0.03 μg/g. This is three percent of the 1.0 μg U/g value that has generally been understood as the threshold of the toxic effects of uranium to the kidney.

The US EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 μg/liter. Assuming a water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using data obtained from toxicity experiments with animals and a conservative factor of 100, the EPA arrived at a 30 μg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis in Table 5.1-2 indicates that a soil limit of 507 pCi/g of U-nat would result in an intake of approximately 0.14 mg/day (49.3 mg/yr divided by 365 days). Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil concentration of 217 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore, exposure to soils containing 217 pCi/g of natural uranium should not result in chemical toxicity effects.

5.1.8.2 Excavation Control Monitoring

Uranium One will use hand-held and GPS-based gamma surveys to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

5.1.8.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas. Areas will be divided into 100 m^2 grid blocks. Soil samples will be obtained from grid blocks with gamma count rates exceeding the gamma action level. The samples will be five-point composites and will be analyzed at an offsite laboratory for radium-226 and natural uranium.

Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys so that the data can be directly compared for identification of potentially contaminated areas. For example, a comprehensive gamma scan of the site will be performed, including conversion of raw scan data to 3-foot HPIC equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be kriged in GIS to develop continuous estimates across the site, making direct spatial comparisons with baseline survey maps possible for any given area at the site. Both qualitative assessments and quantitative statistical comparisons between kriged data sets can be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will also be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.

Final status surveys after any remediation has occurred will also be conducted such that results can be directly compared to pre-operational baseline survey data. As with pre-reclamation surveys, final status gamma scan data will be converted to 3-foot HPIC equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations, then kriged using GIS for comparative assessments against pre-operational baseline data. For aspects of the final status survey, pre-operational baseline data may be used instead of a physically separated reference area to provide information on background conditions for statistical comparative testing. Subsurface sampling will be conducted as part of the final status survey only if residual subsurface contamination is known to remain after any remediation has been completed. Other post-operational environmental monitoring data such as sediments, surface waters, groundwater, air particulates, radon, and vegetation may also be compared quantitatively and/or qualitatively against pre-operational baseline data.

5.1.8.4 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. Uranium One is investigating alternatives for disposal at existing sites licensed to receive 11e.(2) byproduct material including Pathfinder Mines, Kennecott Uranium Company, Denison Mines, and Waste Control Specialists (Texas). An agreement for disposal of 11e.(2) byproduct material will be in place before operation of the Antelope and JAB project commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

5.1.8.5 Quality Assurance

A quality assurance program will be implemented at the Antelope and JAB Uranium Projects for all relevant operational monitoring and analytical procedures. The objective of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid. The Uranium One Quality Assurance Plan for Wyoming ISR Operations is provided in Addendum 5-A of the Technical Report.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports will be provided.
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.
- Written procedures for QA activities. These procedures will include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.
- Quality control (QC) in the laboratory. Procedures will cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.

- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

QA procedures will include:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.

5.2 MITIGATION MEASURES FOR TRANSPORTATION IMPACTS

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve either vehicles delivering bulk chemical products, transporting resin to the Antelope Central Plant from the JAB satellite plant, transporting radioactive contaminated waste from the Antelope and JAB facilities to an approved disposal site, or from vehicles carrying yellowcake slurry or dried yellowcake product from the Antelope Central Plant.

All chemicals and products delivered to or transported from the site will be transported in accordance with DOT regulations. Emergency response procedures will be developed and implemented as part of Uranium One's Environmental Management Programs to insure a rapid response to the situation. All appropriate personnel will be trained to the level required in the emergency response procedures to facilitate proper response from Uranium One employees.

5.2.1 Access Road Construction Impacts

The impacts associated with upgrading and extending the existing gravel road to provide access to the central plant site are minor, consisting primarily of air quality impacts from equipment exhaust and dust. Mitigation measures for air quality impacts are discussed in detail in Section 5.6.

5.2.2 Transportation Accident Risk

Transportation of hazardous materials to and from the Antelope and JAB Projects can be classified as follows:

- Shipments of uranium-laden resin from the JAB Satellite to the Antelope Central Plant for processing and return shipments of barren, eluted resin. Resin will be transported in tank trucks to the Antelope Central Plant facility for elution, precipitation, and drying.
- Shipments of dried yellowcake. Yellowcake will be transported in 208-L (55-gal.) drums to a distant conversion facility for refining and conversion. Conversion facilities are currently located in Metropolis, Illinois and Port Hope, Ontario, Canada.
- Shipments of process chemicals or fuel from suppliers to the site.
- Shipment of radioactive waste from the site to a licensed disposal facility.

Accident risks involving potential transportation occurrences and mitigating measures are discussed in the following sections.

5.2.2.1 Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the Antelope and JAB Projects is the transfer of the ion exchange resin to and from the plant. Loaded ion exchange resin would be transported from the JAB Satellite in a 4,000 gallon capacity tanker trailer. It is currently anticipated that up to two loads of uranium-laden resin may be transported for elution at the Antelope Central Plant and up to two loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to a central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[4].

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.
- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.
- Properly licensed and trained drivers will transport the resin between the Antelope and JAB Projects.

Uranium One will develop an emergency response plan for yellowcake and other transportation accidents to or from the Antelope and JAB Projects. Uranium One personnel will receive training for responding to a transportation accident.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, Uranium One will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help.
- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.
- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin.
- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident.
- Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

5.2.2.2 Accidents Involving Yellowcake Shipments

NUREG-0706 concluded that the probability of a truck accident involving shipments of yellowcake in any year is 11 percent for each uranium extraction facility. This calculation used average accident probabilities (4.0 x 10^{-7}/km for rural interstate, 1.4 x 10^{-6}/km for rural two-lane road, and 1.4 x 10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative.

As with resin shipments, yellowcake shipments will be made in accordance with DOT and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material and will follow the same general shipping procedures as outlined for ion exchange resin shipments in Section 5.2.2.1.

The worst case accident scenario involving yellowcake transportation would be an accident involving the transport truck where the integrity of one or more drums containing yellowcake was breached, resulting in a release to the environment. Unlike ion exchange resin shipments, ISR operators do not typically transport their own yellowcake to conversion facilities but rather contract with transport companies that specialize in shipments of yellowcake. These companies have extensive emergency response programs including spill response equipment on board, drivers trained in radiological emergency response, constant monitoring of truck location and operating parameters, and standing contracts with environmental emergency response contractors for cleanup of spills. As with ion exchange resin, the primary environmental impact associated with an accident involving the spill of yellowcake would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure.

5.2.2.3 Accidents Involving Shipments of Process Chemicals

It is estimated that approximately 4 bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, salt, soda ash, hydrogen peroxide, ammonia, sulfuric acid, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

5.2.2.4 Accidents Involving Radioactive Wastes

Low level radioactive 11(e).2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

5.3 MITIGATION MEASURES FOR GEOLOGIC AND SOILS IMPACTS

5.3.1 Geologic Impacts

The potential exists for earthquakes to impact the Antelope and JAB Project. The International Building Code (IBC) is based upon probabilistic seismic analyses. Sweetwater County adopted the IBC in 2005. As the historic record is limited, it is nearly impossible to determine when a 2,500-year event last occurred in the county. Because of the uncertainty involved, and based upon the fact that the IBC utilizes 2,500-year events for building design, it is recommended that the 2,500-year probabilistic maps be used for Sweetwater County analyses. Uranium One will use this conservative approach is in the interest of public safety.

5.3.2 Soil Impacts

Soil Erosion Properties and Impacts

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the Antelope and Jab License Area varies from slight to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the sandy loam, loam, and gravelly texture of the surface horizons throughout the majority of the Antelope and Jab License Area, the soils are more susceptible to erosion from wind than water. See Tables 3.3-12 and 3.3-13 for a summary of wind and water erosion hazards within the Antelope and Jab License Area.

The Antelope and Jab License Area is underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. All topsoil will be stripped, stockpiled and maintained in accordance with WDEQ-LQD rules and regulations, the surface will be graded, and stormwater will be routed. These measures will help reduce the effect of construction on soil erosion.

The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment. All areas are reseeded as soon as possible to keep the duration of bare soil to a minimum. Reseeding will help mitigate the increased erosion potential from the construction disturbance.

Prime Farmland Assessment

No prime farmland was indicated within the Antelope and Jab License Area based on a reconnaissance survey by the NRCS in Riverton, Wyoming. Refer to Addendum 3.3-F, Prime Farmland Designation, for the NRCS letter of negative determination.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the Antelope and JAB Project include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means;
- Salvage and stockpiling of topsoil from the central plant and satellite facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion. This is accomplished by grading stockpiles to the appropriate slopes, avoiding excessive compaction, establishing a temporary vegetative cover, using appropriate fencing and signs, and installation of sedimentation catchments;
- Reestablishment of temporary or permanent native vegetation as soon as possible after disturbance; and
- Constructing roads to minimize erosion through practices such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation, and providing adequate road drainage with runoff control structures and revegetation.

Implementation of Best Management Practices (BMPs) will minimize the effects to soils associated with the construction and operation of the Antelope and JAB Project.

No drainages or bodies of water will be significantly modified or altered within the Antelope and JAB Project areas during project construction or operations. If significant changes or alterations were to occur, the impact to the second tributary to Simmons Draw wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed Permit area. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - WQD regulations. Best management practices will be implemented to reduce erosion impacts according to storm water management plans developed for those permits.

5.4 MITIGATION MEASURES FOR WATER RESOURCES IMPACTS

5.4.1 Surface Water Impacts

5.4.1.1 Surface Water Impacts from Sedimentation

In areas where surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations. Best management practices will be implemented to reduce erosion impacts according to storm water management plans developed for those permits.

5.4.2 Groundwater Impacts

Mitigation measures for potential environmental impacts to groundwater resources from mining and restoration are described in this section.

5.4.2.1 Groundwater Consumption

5.4.2.1.1 Monitoring

To assess the impacts from mining and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in the private domestic or livestock water wells surrounding the project area before mining and every three months during operations; and,
- Measure background water levels in regional monitoring wells installed by EMC before mining and every three months during operations

5.4.2.1.2 Mitigation

It is likely that the wells surrounding the Antelope and JAB License Area may provide stock water for private or public (BLM) leases. If significant impacts to those wells are observed (e.g., water levels drop to a point that impairs the usefulness of the wells), the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or,
- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

5.4.2.2 Impacts on Groundwater Quality

The State of Wyoming and the NRC require restoration of affected groundwater in the mining zone to the pre-mining class of use following production activities. Successful groundwater restoration has been demonstrated using the methods proposed by Uranium One as discussed in this section. Therefore, long term impacts on groundwater quality are expected to be minimal.

5.4.2.2.1 Groundwater Restoration Criteria

The purpose of groundwater restoration following mining operations is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Approval is based on existing water quality, the ability to commercially produce minerals, and the lack of use as an underground source of drinking water (USDW). Groundwater restoration prevents any mobilized constituents from affecting aquifers adjacent to the ore zone.

The goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the standard of pre-mining class of use or better using Best Practicable Technology (BPT) as defined in §35-11-103(f)(i) of the Wyoming Environmental Quality Act, 2006. The pre-mining class of use will be determined by the baseline water quality sampling program which is performed for each wellfield, as compared to the use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, shall be the mean of the pre-mining baseline data after outlier removals. Restoration shall be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division (LQD) Rules and Regulations.

The evaluation of the effectiveness of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Restoration success will be evaluated by comparing restoration results to the RTVs to determine if pre-mining class of use has been met. Table 5.4-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Baseline values will not be changed unless the operational monitoring program indicates that baseline water quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline water quality. Such a change would require resampling of monitor wells and review and approval by the WDEQ.

Table 5.4-1 Baseline Water Quality Parameters

Parameter (units)
Dissolved Aluminum (mg/l)
Ammonia Nitrogen as N (mg/l)
Dissolved Arsenic (mg/l)
Dissolved Barium (mg/l)
Boron (mg/l)
Dissolved Cadmium (mg/l)
Dissolved Chloride (mg/l)
Dissolved Chromium (mg/l)
Dissolved Copper (mg/l)
Fluoride (mg/l)
Gross Alpha (pCi/l)
Gross Beta (pCi/l)
Total and Dissolved Iron (mg/l)
Dissolved Mercury (mg/l)
Dissolved Magnesium (mg/l)

Table 5.4-1 Baseline Water Quality Parameters

Parameter (units)
Total Manganese (mg/l)
Dissolved Molybdenum (mg/l)
Dissolved Nickel (mg/l)
Nitrate + Nitrite as N (mg/l)
Dissolved Lead (mg/l)
Radium-226 (pCi/L)
Radium-228 (pCi/L)
Dissolved Selenium (mg/l)
Dissolved Sodium (mg/l)
Sulfate (mg/l)
Uranium (mg/l)
Vanadium (mg/l)
Dissolved Zinc (mg/l)
Dissolved Calcium (mg/l)
Bicarbonate (mg/l)
Carbonate (mg/l)
Dissolved Potassium (mg/l)
Total Dissolved Solids (TDS) @ 180°F (mg/l)

Source: WDEQ LQD Guideline 8, Hydrology, March 2005

5.4.2.2.2 Ground Water Restoration Method

The commercial groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage typically consists of three phases:

1) Groundwater transfer;
2) Groundwater sweep;
3) Groundwater treatment.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. EMC will monitor the quality of groundwater in selected wells as needed during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used in restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The sequence of the activities will be determined by EMC based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by EMC.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the mining zone. EMC may also employ bioremediation as a reduction process.

Reductants are beneficial because several of the metals, which are solubilized during the leaching process, are known to form stable insoluble compounds, primarily as sulfides. Dissolved metal compounds that are precipitated under reducing conditions include those of arsenic, molybdenum, selenium, uranium and vanadium.

Ground Water Transfer

During the ground water transfer phase, water may be transferred between a wellfield commencing restoration and a wellfield commencing mining operations. Also, a ground water transfer may occur within the same wellfield, if one area is in a more advanced state of restoration than another.

Baseline quality water from the wellfield commencing mining will be pumped and injected into the wellfield in restoration. The higher TDS water from the wellfield in restoration will be recovered and injected into the wellfield commencing mining. The direct transfer of water will act to lower the TDS in the wellfield being restored by displacing affected ground water with baseline quality water.

The goal of the ground water transfer phase is to blend the water in the two wellfields until they become similar in conductivity. The water recovered from the restoration wellfield may be passed through ion exchange (IX) columns and/or filtered during this phase if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the ground water transfer between wellfields to occur, a newly constructed wellfield must be ready to commence mining. Therefore this phase may be initiated at any time during the restoration process. If a wellfield is not available to accept transferred water, ground water sweep or some other activity will be utilized as the first phase of restoration.

The advantage of using the ground water transfer technique is that it reduces the amount of water that must ultimately be sent to the waste water disposal system during restoration activities.

Ground Water Sweep

Ground water sweep may be used as a stand-alone process where ground water is pumped from the wellfield without injection causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The plume of affected water near the perimeter of the wellfield is also drawn inside the boundaries of the wellfield. Ground water sweep may also be used in conjunction with the ground water treatment phase of restoration. The water produced during ground water sweep is disposed of in an approved manner.

The rate of ground water sweep will be dependent upon the capacity of the waste water disposal system and the ability of the wellfield to sustain the rate of withdrawal. Due to the limited success of groundwater sweep during restoration at other ISR facilities, Uranium One anticipates that groundwater sweep will have limited use at the Antelope and JAB projects.

Ground Water Treatment

Either following or in conjunction with the groundwater sweep phase water will be pumped from the mining zone to treatment equipment at the surface. Ion exchange (IX), reverse osmosis (RO) or Electro Dialysis Reversal (EDR) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will be passed through an IX system prior to RO/EDR treatment, as part of the waste disposal system or it will be re-injected into the wellfield. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Additionally, prior to or following IX treatment, the groundwater may be passed through a de-carbonation unit to remove residual carbon dioxide that remains in the groundwater after mining.

At any time during the process, a reductant (either biological or chemical), which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements.

All or some portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids in the affected groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration. The RO passes a high percentage of the water through the membranes, leaving 60 to 90 percent of the dissolved salts in the brine water or concentrate. The clean water, called permeate, will be re-injected or stored for use in the mining process. The permeate may also be de-carbonated prior to re-injection into the wellfield. The brine water that is rejected contains the majority of dissolved salts in the affected groundwater and is sent for disposal in the waste system. Make-up water, which may come from water produced from a wellfield that is in a more advanced state of restoration, water being exchanged with a new mining unit, water being pumped from a different aquifer, the purge of an operating wellfield or a combination of these sources, may be added prior to the RO or wellfield injection stream to control the amount of "bleed" in the restoration area.

The reductant (either biological or chemical) added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding the reductant, the Eh of the aquifer is lowered thereby decreasing the solubility of these elements. Regardless of the reductant used, a comprehensive safety plan regarding reductant use will be implemented.

If necessary, sodium hydroxide may be used during the groundwater treatment phase to return the groundwater to baseline pH levels. This will assist in immobilizing certain parameters such as trace metals.

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing Total Dissolved Solids (TDS) and the success of the reductant in lowering the uranium and trace element concentrations. Estimates of the number of pore volumes required for each restoration phase are discussed in Section 6 of the Technical Report.

5.4.2.2.3 Restoration Schedule

The proposed Antelope and JAB mine schedule is shown in Figure 5.4-1 and 5.4-2 respectively, showing the estimated schedule for restoration. The restoration schedule is preliminary based on Uranium One's current knowledge of the area, and are based on the completion of mining activities for the proposed wellfields. As the Antelope and JAB Project is developed, the restoration schedule will be defined further.

Figure 5.4-1 Proposed Antelope Project Operations and Restoration Schedule

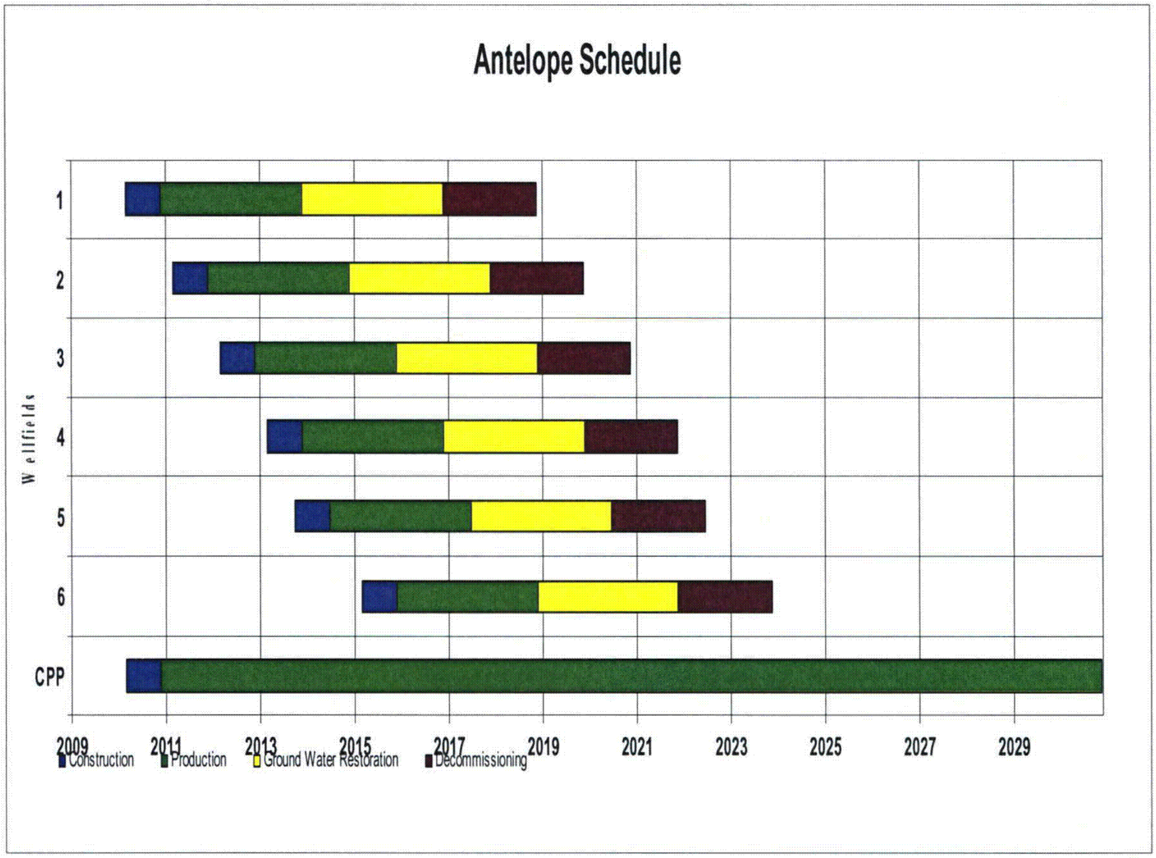
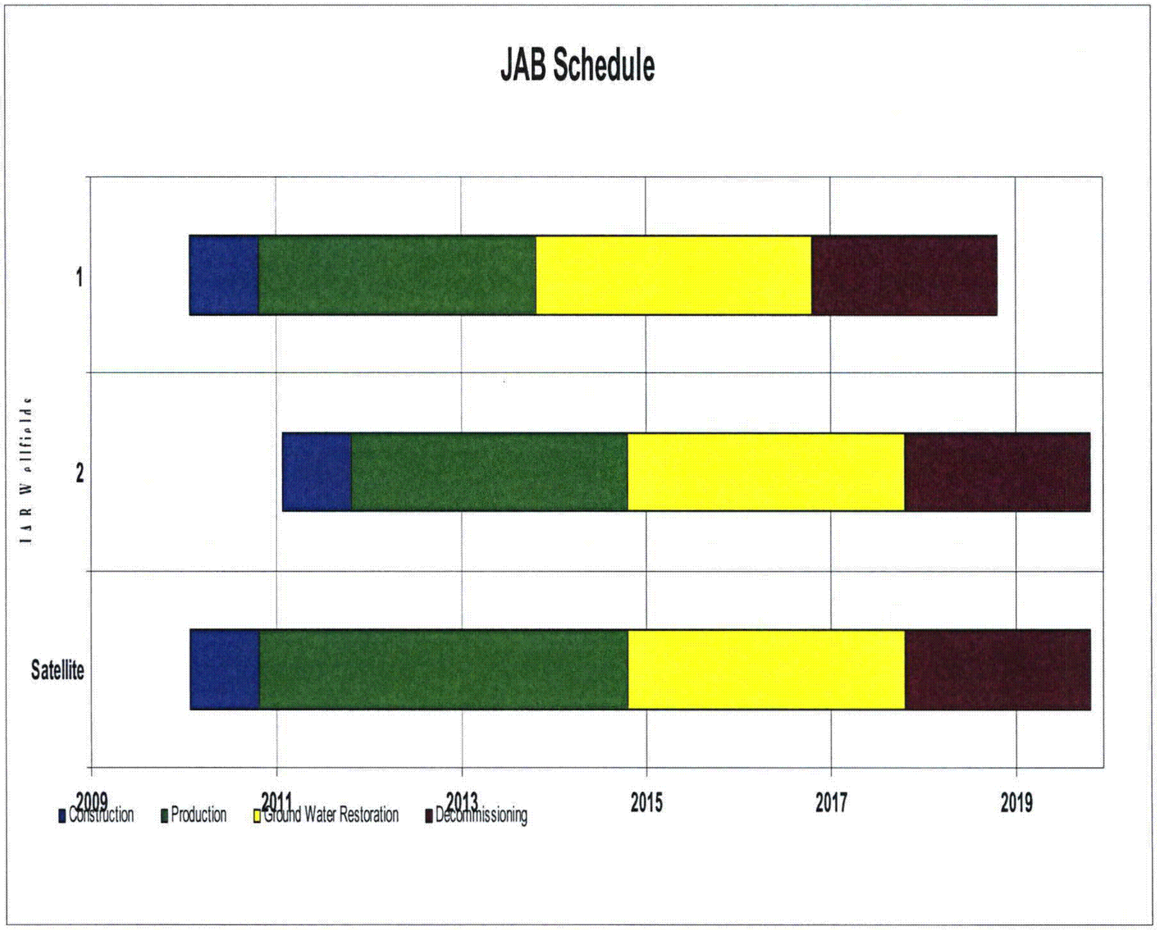


Figure 5.4-2 Proposed JAB Project Operations and Restoration Schedule



5.4.2.2.4 Effectiveness of Ground Water Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISR facilities in the Powder River Basin as well as in Nebraska and Texas. A number of uranium ISR mines in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The following two ISR facilities with restoration history and regulatory approvals are located in the Powder River Basin in central Wyoming.

- Smith Ranch/Highland Uranium Project

Groundwater restoration activities at the Smith Ranch-Highland Uranium Project currently operated by Power Resources, Inc. (PRI) have been approved by the NRC and the WDEQ for the R&D operations and for the A-Wellfield during commercial operations. In 1987, the NRC confirmed successful restoration of the Q-sand project. Although one well exhibited uranium and nitrate levels above the target restoration values, the wellfield averages on a whole were below the targets.

In 2004, the NRC concurred with the WDEQ's determination that the A-wellfield at Highland had been restored in accordance with the applicable regulatory requirements[5]. Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-mining class of use.

- Irigaray/Christensen Ranch Uranium Project

Groundwater restoration activities at the Irigaray/Christensen Ranch Uranium Project operated by COGEMA Mining, Inc. have been approved by the NRC and the WDEQ for Wellfields 1 through 9 following commercial operations and groundwater restoration. Post-mining water quality in the nine production units was described in Section 6.1.2 of the Technical Report. The WDEQ determined that twenty-seven of twenty-nine constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. WDEQ determined that these two constituents met the criteria of pre-mining class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-mining class of use and that the post restoration groundwater conditions did not significantly differ from the background water quality.

In 2006, the NRC concurred with the WDEQ's determination that wellfields 1 through 9 at Irigaray had been restored in accordance with the applicable regulatory requirements[6]. NRC determined that COGEMA used best practicable technology and agreed that the WDEQ class-of-use standards were met.

5.4.2.2.5 Groundwater Restoration Monitoring

Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the monitor ring wells (M-Wells), overlying aquifer wells (MO or MS-Wells), and underlying aquifer wells (MU or MD-Wells) are sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity. Water levels are also obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

Restoration Stability Monitoring

A minimum six month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program will be performed during the stability period:

- The monitor ring wells will be sampled once every two months and analyzed for the UCL parameters, chloride, total alkalinity (or bicarbonate) and conductivity; and
- At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 5.4-2.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells (if sampled under the same schedule as M-Wells) cannot be monitored within 65 days of the last sampling event.

5.4.2.2.6 Restoration Wastewater Disposal

Uranium One plans to install deep disposal wells (EPA UIC Class I or Class V non-hazardous wells) at the Antelope and JAB Project areas as the primary liquid waste disposal method. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I or Class V well permanently isolates the waste water from the public and the environment. Alternatives assessed by Uranium One for waste water disposal are discussed in Section 8 of the Technical Report.

Based on the expected post mining concentrations of groundwater quality constituents discussed in Section 5.4.2 and the proposed groundwater restoration techniques discussed in

Section 5.4.2, Uranium One projects that the restoration wastewater injection stream will exhibit the range of characteristics shown in Table 5.4-2.

Table 5.4-2 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
Calcium	mg/l	350	700
Magnesium	mg/l	50	150
Sodium	mg/l	400	950
Potassium	mg/l	40	90
Carbonate	mg/l	0	0.3
Bicarbonate	mg/l	200	1250
Sulfate	mg/l	900	2500
Chloride	mg/l	300	1000
Nitrate	mg/l	0.01	0.5
Fluoride	mg/l	0.01	2
Silica	mg/l	10	65
Total Dissolved Solids	mg/l	1000	6500
Conductivity	µmho/cm	1000	5500
Alkalinity	mg/l	165	1025
pH	Std. Units	6	12
Arsenic	mg/l	0.01	1
Cadmium	mg/l	0.0001	0.001
Iron	mg/l	0.5	15
Lead	mg/l	0.01	0.04
Manganese	mg/l	0.01	1.5
Mercury	mg/l	0.0001	0.001
Molybdenum	mg/l	0.1	1.5
Selenium	mg/l	0.01	0.5
Uranium	mg/l	0.05	15
Ammonia	mg/l	0.1	0.5

Table 5.4-2 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
Radium-226	pCi/l	500	5000

All compatible liquid wastes generated during groundwater restoration at the Antelope and JAB Project will be disposed in the planned deep wells. A feasibility study for both areas was initiated in the spring of 2007 and potential target sands have been identified. Data collection is continuing to further refine potential receivers and an application is under preparation for submittal to the WDEQ for a Class I (or Class V) UIC Permit for the Antelope and JAB Uranium Project. Uranium One plans to submit this application to the WDEQ in the third quarter of 2008.

5.4.2.3 Potential Groundwater Impacts from Accidents

5.4.2.3.1 Lixiviant Excursions

Uranium One will control the lateral movement of lixiviant by maintaining well field production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution will either be recycled in the plant or sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the Mine Unit, mining solutions are contained within the monitor well ring.

Uranium One will monitor for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. Monitor wells will be installed as discussed in Section 6. Monitor wells will be sampled biweekly for approved excursion indicators.

The historical experience at other ISR uranium operations indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Uranium One will prevent vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the WDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing will be conducted in accordance with WDEQ regulations and methods approved by NRC and WDEQ. Construction and integrity testing methods were discussed in detail in Section 1. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 5.1.1.

Uranium One will monitor for vertical excursions in the overlying aquifer using shallow monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled biweekly for approved excursion indicators.

5.4.2.3.2 Wellfield Spills

All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each Mine Unit will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the wellhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. EMC will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, EMC will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

5.5 MITIGATION MEASURES FOR ECOLOGICAL RESOURCES IMPACTS

As described above, only 10% of the Antelope and JAB License/Permit Area is expected to be impacted by the combined results of exploratory drilling and future construction of well fields, processing facilities, and associated infrastructure. That disturbance would occur in 14 non-contiguous mineral development areas spread across more than 14,500 acres.

Current residual (cumulative) short- and long-term disturbances to vertebrate species of concern within the survey area arise from multiple sources. Those include direct and indirect impacts of livestock grazing, hunting and recreational use, road development, conventional oil and gas development, and other forms of energy exploration and extraction operations. Those activities have occurred in the past and most are expected to continue at similar levels. Energy development is expected to occur at an increased rate in the future. Those activities require increased levels of traffic, noise, dust, and, ultimately, infrastructure (roads, fences, power lines) which can elevate the level of disturbance in the area.

Adverse effects to the evaluated species would consist primarily of potential harassment or displacement of foraging individuals due to human and equipment disturbance, and mortality or injury caused by vehicle collisions. The overall result of implementing the proposed action would be that individuals of some vertebrate species may be lost, but the cumulative impacts are not expected to significantly reduce the size or viability of their local populations. In addition, the proposed action would not conflict with the current multiple-use management objectives on lands managed by the BLM.

Given the limited number of vertebrate species of concern known or suspected to inhabit the area, the limited habitat disturbance associated with drilling and future ISR operations relative to the size of the license/permit area, and Uranium One's commitments to honor important timing and spatial limitations and continue long-term monitoring, any such residual effects from this project would likely only occur on an individual basis. Drilling and ISR operations have requirements for reclamation of disturbed areas as recovery of energy resources is completed. Those reclamation efforts can further mitigate impacts to wildlife species and habitats, though the standards are widely variable among industries.

5.5.1 Vegetation

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become and increasingly important result of previous and current disturbance in Wyoming. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with the surrounding undisturbed vegetation. Uranium One will conduct weed control as needed to limit the spread of undesirable and invasive, non-native species on disturbed areas.

No threatened or endangered vegetation species were observed within the Antelope and JAB Projects areas; therefore, no impacts are anticipated.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent seed mix typically contains native wheatgrasses, fescues, and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

5.5.2 Wildlife and Fisheries

The potential for impacts associated with drilling operations would be largely mitigated by the relatively small area of surface disturbance associated with exploration activities. Surface disturbance associated with each drill site consists of an area measuring approximately 15 feet by 25 feet, or 0.01 acre, with drill sites spaced at regular intervals within each claim. Consequently, the maximum potential disturbance associated with exploratory drilling in the Antelope and JAB License/Permit Area would likely be no more than 20 non-contiguous acres (less than 0.001 % of the total license/permit area acreage) along with some limited potential disturbance from drill site access. This type of disturbance will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. Additionally, all drill sites will be reclaimed following either the completion of drilling or uranium recovery operations, depending on the location of, and results from, each drill site. When the project expands to full development, impacts would also be partially mitigated by the low proportion (10%) of the total license/permit area expected to be impacted by future construction of well fields, processing facilities, and associated infrastructure. Once those structures are completed, regular disturbance would be reduced to only that needed to operate and maintain the operations. Traffic would persist during production, but should occur at a reduced and possibly more predictable level. Limited habitat disturbance also results in fewer displaced animals from existing territories into other, potentially occupied, areas, which reduces competition and stress on animals in both locations.

Given the factors outlined above, and the limited use of the Antelope and JAB Survey Area by most vertebrate species of concern, impacts to those species from exploratory drilling and future ISR operations are expected to be minimal. Nevertheless, regulatory guidelines and requirements designed to prevent or reduce impacts to wildlife would include one or more of the following, as directed by the various regulating and permitting agencies:

1. Fencing designed to permit big game passage to the extent possible;

2. Use of existing roads when possible, and location of newly constructed roads to access more than one drill site;

3. Enforced speed limits to minimize collisions with wildlife, especially during the breeding season;

4. Adherence to timing and spatial restrictions within specified distances, as determined by appropriate regulatory agencies, of active sage-grouse leks during the breeding season (March 1 – June 15);

5. If direct impacts to raptors or other migratory bird species of management concern could result from drilling exploration or future ISR development and operations, then a Monitoring and Mitigation Plan for those species must be prepared and approved by the USFWS, including one or more of the following provisions:

   i. Relocation of active and inactive raptor nests that would be impacted by drilling, construction, or operation activities in accordance with the approved raptor monitoring and mitigation plan;

   ii. Creation of raptor nests and nesting habitat through enhancement efforts such as nest platforms to mitigate other nest sites impacted by ISR operations;

   iii. Obtaining appropriate permits for all removal and mitigation activities;

   iv. Establishing buffer zones protecting raptor nests where necessary and restricting mine-related disturbances from encroaching within buffers around active raptor nests from egg-laying until fledging to prevent nest abandonment, or injury to eggs or young;

   v. Reestablishing the ground cover necessary to attract and sustain a suitable raptor prey base after drilling, construction, and future mining; and

   vi. Required use of raptor-safe construction for overhead power lines according to current guidelines and recommendations by the Avian Power Line Interaction Commission (APLIC) and/or USFWS;

6. Restoration of sagebrush and other shrubs on reclaimed lands and grading of reclamation to create swales and depressions for sage-obligates and their young;

7. Restoration of pre-drilling and pre-mining native habitats for species that nest and forage in those vegetative communities;

8. Restoration of diverse landforms, direct topsoil replacement, and the construction of brush piles, snags, and/or rock piles to enhance habitat for wildlife;

9. Restoration of habitat provided by jurisdictional wetlands; and

10. Reclamation of creek channels and restoration of surface water flow quantity and quality after mining to approximate pre-mining conditions.

Another effective way to minimize impacts related to exploratory drilling in the Antelope and JAB License/Permit Area would be to use a systematic drilling pattern that affects only one area at a time, working from one side the license/permit area to another. Reclamation would be completed in the same manner, with activity occurring in just one area at a time after drilling is complete. Agency standards for reclamation would be followed. This systematic approach would allow more mobile wildlife species to relocate into adjoining, undisturbed habitat and then return following completion of drilling in a particular area. These efforts, in conjunction with the mitigation measures outlined above, would decrease direct and indirect impacts for all wildlife species.

Given the seasonal use of the area by those vertebrate species of concern that were documented in the survey area, the impacts described above could be fully mitigated with the delay of all road construction and drilling activity within established buffer zones during the recognized breeding and nesting season (February 1 through July 31, annually) for those species. Exploration would be conducted between August and the end of January. Given the timing of the current application process, this timing is likely to occur for much of the proposed drilling project. The fact that crews work only during daylight hours would further reduce impacts to year-round residents, particularly more nocturnal species such as some reptiles; that timing also reduces potential impacts to these less mobile species due to moving equipment and vehicles.

5.6 MITIGATION MEASURES FOR AIR QUALITY IMPACTS

Air quality impacts are primarily related to fugitive dust from construction activities and vehicular traffic. As discussed in Section 4.6, these impacts are negligible. Enforcement of site speed limits and the application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition.

5.7 MITIGATION MEASURES FOR NOISE IMPACTS

As a result of the remote location of the project and the low population density of the surrounding area, impact to noise or congestion within the project area or in the surrounding 2.0-mile area are not anticipated. Noise impacts will be mitigated through enforcement of site speed limits.

5.8 MITIGATION MEASURES FOR HISTORIC AND CULTURAL RESOURCES IMPACTS

As discussed in Section 3.8, the Class III Inventory investigations on the Antelope Project found 10 sites and 81 isolates. Three of the sites are considered significant under Criteria D, and are therefore potentially eligible for listing on the National Registry of Historic Places (NRHP). The other sites are not considered significant because they are small in areal extent, lack features, and exhibit poor integrity. The three sites considered significant will be avoided for development and therefore no impacts to these sites are anticipated.

Class III Inventory investigations on the JAB Project found a total of 25 sites and 29 isolates. Of the 25 sites, one is currently listed on the NRHP. No development is currently planned near the location of this listed site. Therefore no impacts to this site from operations at JAB is expected.

5.8.1 Antelope Site

A file search (#19374) was conducted with the Wyoming State Historic Preservation Office (SHPO) for the 20 sections in T26N R92W. Results from that search revealed 13 unique inventories covering 40 acres in the sections of interest. The previous inventories were associated with well pads (five), power lines (three), seismic lines (two), and one each with a pipeline, a road, and a range improvement project. A second file search (#19840) conducted for the eight sections of interest in T26N R93W revealed 10 uniqueinventories. Four of these were related to a single power line, two were for road projects, two were associated with the development of a uranium mine, one was for a pipeline, and another was for a seismic line.

No archaeological sites are reported from the sections in T26N R92W. A single isolated find, a Late Archaic dart point was reported. Based on the results of previous studies, the potential for cultural resources in this area is considered low. However, it should be noted than less than two-tenths of 1% of this area had been inventoried prior to this study.

Three sites are considered significant under Criteria D, and are therefore potentially eligible for listing on the National Register of Historic Places (NRHP). The other sites are not considered significant because they are small in areal extent, lack features, and exhibit poor integrity.

The Class III Cultural Resource Inventory for the Antelope site in Appendix A contains information that falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)). The report, including Wyoming Cultural Resource Forms, has also been submitted to WSHPO for concurrence and the WDEQ-LQD under a separate cover from ARCADIS U.S. The Wyoming Cultural Resource Forms are not included in Appendix A since these forms were not provided to the client due to disclosure restrictions in the NHPA Section 304. Accordingly, disclosure is specifically exempted by statute as specified in 10 CFR §2.390(a)(3). Therefore, Uranium One requests that all applicable portions of Appendix A remain "CONFIDENTIAL" for the purpose of Public Disclosure of this application. Each page of the protected cultural resource information has been marked as follows:

Confidential Information Submitted under 10 CFR 2.390

The cover page for Appendix A has been marked with a more detailed statement, as follows:

Confidential Information Submitted under 10 CFR 2.390
Disclosure is Limited Under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)).

5.8.2 JAB Site

Approximately 2,080 acres of the site were previously surveyed in 1982. Portions of the previously surveyed areas within the site were re-inventoried at the request of the BLM, Lander Field Office, because the LFO BLM wanted to sample areas of high site probability within the previously surveyed area. ARCADIS' Buffalo office conducted the field work between August 13 to August 24, 2007, covering a total of 285 previously surveyed acres and 1,960 new surveyed acres. Previous archaeological surveys cover the remaining portions of the site, and those investigations are discussed further in the Background Research section of this report. Project results document 25 archaeological sites and 29 isolated resources. On November 29, 2007, BLM Lander Field Office archaeologist Craig Bromley requested that seven sites identified during the August 2007 inventory work undergo limited testing to determine potential for subsurface cultural resources. Seven previously recorded sites were shovel tested between June 16 and June 17, 2008, to determine potential for subsurface cultural resources. Five of the seven previously recorded sites did not contain subsurface cultural resources and are recommended not eligible for the NRHP. Two previously recorded sites contained subsurface cultural resources and are recommended eligible for the NRHP. An addendum to the August 2007 Class III inventory for this work is presented in Appendix A.

5.9 MITIGATION MEASURES FOR VISUAL/SCENIC RESOURCES IMPACTS

Scenic Resources

Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. The measures should be applied to all facilities, even those that meet VRM objectives. Mitigation would enable proposed project facilities to harmonize with the surrounding landscape to the extent feasible.

In addition to selecting paint colors that harmonize with the surrounding landscape, several other measures would minimize adverse effects of project facilities in the landscape.

- Using existing vegetation and topographic features to screen wells, facilities, and roads;
- Painting facilities with non-reflective paint that harmonizes with the surrounding landscape;
- Avoiding straight line-of-sight road construction;
- Aligning roads with the contours of the topography rather than cutting straight across contours to well houses, although this method of aligning the roads may result in a greater area of disturbance;
- Constructing clearings to appear as natural clearings by rounding corners and feathering the vegetation interface between the clearing and the surrounding grasses and shrubs (In those areas where the existing vegetation is dense, clearings should be irregular in shape); and
- Removing construction debris immediately because it creates undesirable textural contrasts with the landscape.

In general, resource protection measures proposed for erosion control, road construction, rehabilitation and re-vegetation, and wildlife protection would mitigate effects to visual quality.

5.10 MITIGATION MEASURES FOR SOCIOECONOMIC IMPACTS

As discussed in Section 4.10, it is anticipated that the overall effect of the proposed Antelope and JAB Project on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. Assuming that the entire projected work force of 40 to 60 workers relocated to the area, this increase would account for 0.1 percent of the population of Sweetwater and Carbon Counties, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in those counties. Families moving into the Sweetwater and Carbon County school districts would not stress the current school system because it is presently under capacity.

No mitigative measures are identified.

5.11 MITIGATION MEASURES FOR ENVIRONMENTAL JUSTICE

As described in Section 4.11, no concentrations of minority populations were identified as residing near the License Area, as residents nearest are rural populations. There would be no disproportionate impact to minority population from the construction and implementation of the Antelope and JAB Projects.

Also, the populations within the Tracts exhibit lower rates of people living below the poverty level than the state. Both Tracts contain rural populations; therefore, there is no concentration of people living below the poverty level in these Tracts. No disproportionate adverse environmental impacts would occur in populations living below the poverty level within the Census Tracts from proposed Project activities.

Since no adverse environmental impacts are expected to occur to minority populations or populations living below the poverty level, no mitigative measures are identified.

5.12 MITIGATION MEASURES FOR PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

5.12.1 Nonradiological Impacts

Uranium One will develop emergency management procedures to implement the nonradiological risk control recommendations contained in NUREG/CR-6733 analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs were discussed in detail in Section 5 of the Technical Report for this License Application

5.12.2 Radiological Impacts

5.12.2.1 Radiological Impacts from Routine Operations

As discussed in Section 4.12.2, the maximum Total Effective Dose Equivalent (TEDE) estimated by MILDOS-AREA is 0.53 mrem/yr. to a receptor located at the northwest property boundary. This dose is 0.53 percent of the public annual dose limit from licensed operations of 100 mrem.

The dose estimates developed by MILDOS-AREA are based on the central plant system design, which includes pressurized downflow ion exchange columns to reduce the release of radon-222 to a minimum and the use of vacuum dryers, which have no airborne radioactive emissions. The Uranium One design applies state-of-the-art ISR technology to reduce radiological doses to the public and employees to a minimum.

A separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the process tanks. Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. The design of the fans will be such that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Regulatory Guide 8.31. Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the plant. Tank ventilation systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for minimizing employee exposure.

The work area ventilation system will be designed to force air to circulate within the plant process areas. The ventilation system will exhaust outside the building, drawing fresh air in. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. The design of the ventilation system will be adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20.

Yellowcake processing and drying will be carried out using a vacuum dryer with a wet condenser system, thus there are no airborne effluents from this system. The vacuum drying system is proven technology that is being used successfully in several ISR sites where uranium oxide is being produced. Air particulate controls of the vacuum drying system include a bag house, condenser, vacuum pump, and packaging hood.

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation of water vapor during the drying cycle. It is kept under negative pressure by the vacuum system.

The condenser unit is located downstream of the bag house and is water cooled. It is used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Any particulates that pass through the bag filters are wetted and entrained in the condensing moisture within this unit.

The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture is provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the powder is being transferred.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded as part of routine operations, if currently loaded, or reloaded, if currently empty, until the emission control system is returned to service within specified operational conditions.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

No other mitigation measures to control radiological impacts from routine operations have been identified.

5.12.2.2 Radiological Impacts from Accidents

The Antelop Central Plant and JAB Satellite Plant will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. The central plant and satellite plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central plant building.

As discussed in Section 2, area ventilation will be provided to control concentrations of airborne radioactive material in the central plant.

All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each wellfield will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld). Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.

Uranium One will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods.

5.13 MITIGATION MEASURES FOR WASTE MANAGEMENT IMPACTS

This section describes mitigation measures for the waste management impacts from the Antelope and JAB Project. The estimated waste stream and management programs are described in Section 4.13.

5.13.1 Gaseous and Airborne Particulates

The radiological effluents of concern at ISR operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake.

Section 5.12.2 discussed the mitigation measures included in the Uranium One design to control gaseous and airborne impacts.

5.13.2 Liquid Waste

Wastewater disposal for the Antelope and JAB Project will be done through deep well injection. Deep injection has been utilized by ISR operations as the primary tool for waste disposal and has been utilized by ISR facilities throughout the Powder River Basin. The deep injection well(s) will be permitted in accordance the WDEQ-WQD Class I UIC rules and regulations.

5.13.3 Solid Waste

5.13.3.1 Uncontaminated Solid Waste

Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 4,000 cubic yards (yd^3) of uncontaminated solid waste combined per year. Uncontaminated solid waste will be collected on the sites on a regular basis and disposed of in the nearest sanitary landfill. Uranium One will employ waste minimization and recycling to reduce the quantity of solid waste generated to a minimum.

5.13.3.2 Byproduct Material

Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 500 yd^3 of 11e.(2) byproduct material combined per year. These materials will be stored on site inside the restricted area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

To the extent feasible, Urnaium One will strive to reduce the quantity of 11e.(2) material produced on site. One waste minimization method that will be employed is decontamination. Decontaminated materials must have activity levels lower than those specified in NRC guidance. Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 5 of the Technical Report.

All contaminated items that cannot be decontaminated to meet release criteria will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers.

5.13.3.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the WDEQ for Class V UIC wells. Disposal of solid materials collected in septic systems must be performed in accordance with WDEQ Solid Waste Management rules and regulations.

5.13.3.4 Hazardous Waste

Based on preliminary waste determinations conducted by Uranium One in consideration of the processes and materials that will be used on the projects, Uranium One will likely be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. Uranium One expects that only used waste oil and universal hazardous wastes such as spent batteries will be generated at the Antelope and JAB Uranium Project. Uranium One will develop management programs to meet the WDEQ regulatory requirements for a CESQG.

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[1] U.S. Nuclear Regulatory Commission, NUREG-1569, *Standard Review Plan for In situ Leach Uranium Extraction License Applications."* 2003.

[2] Argonne National Laboratory, C. Yu, A. J. Zielen, J.-J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H. Peterson. *User's Manual for RESRAD Version 6*. 2001.

[3] Argonne National Laboratory, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*, 1993.

[4] U.S. Nuclear Regulatory Commission, NUREG-1508, *Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico*. 1997.

[5] U.S. Nuclear Regulatory Commission, *Review of Power Resources, Inc.'s A-Wellfield Ground Water Restoration Report for the Smith Ranch-Highland Uranium Project*, June 29, 2004.

[6] U.S. Nuclear Regulatory Commission, *Technical Evaluation Report, Review of Cogema Mining, Inc.'s Irigaray Mine Restoration Report, Production Units 1 through 9, Source Materials License SUA-1341*, September 2006.

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6 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 RADIOLOGICAL MONITORING

6.1.1 Introduction

The Antelope and JAB Uranium Project areas comprise approximately 14,574 acres of Bureau of Land Management (BLM) land about 10-20 miles west of Bairoil, WY. These two sites are approximately 5 miles apart, involving about 10,531 acres for the Antelope project area and 4,043 acres for the JAB project area (Figures 6.1-1 and 6.1-2).

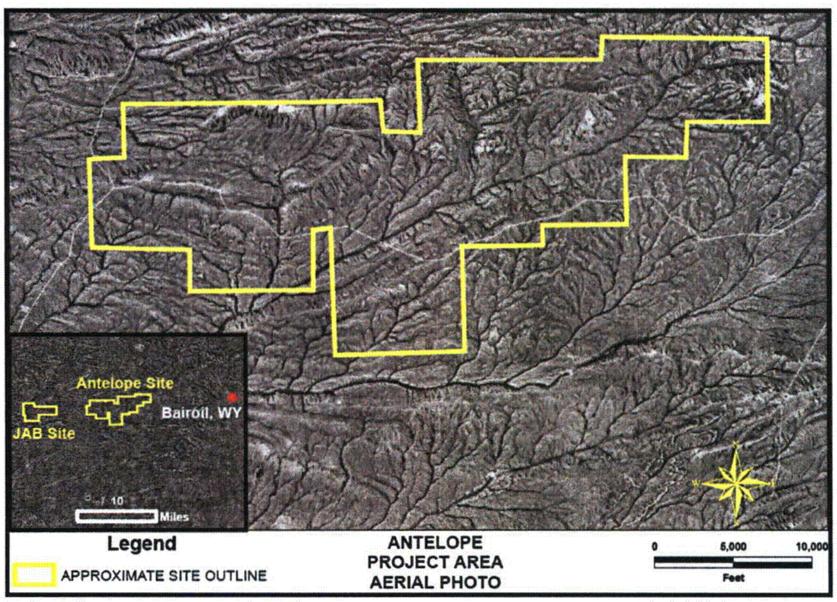


Figure 6.1-1: Aerial Photo of the Antelope Uranium Project area.

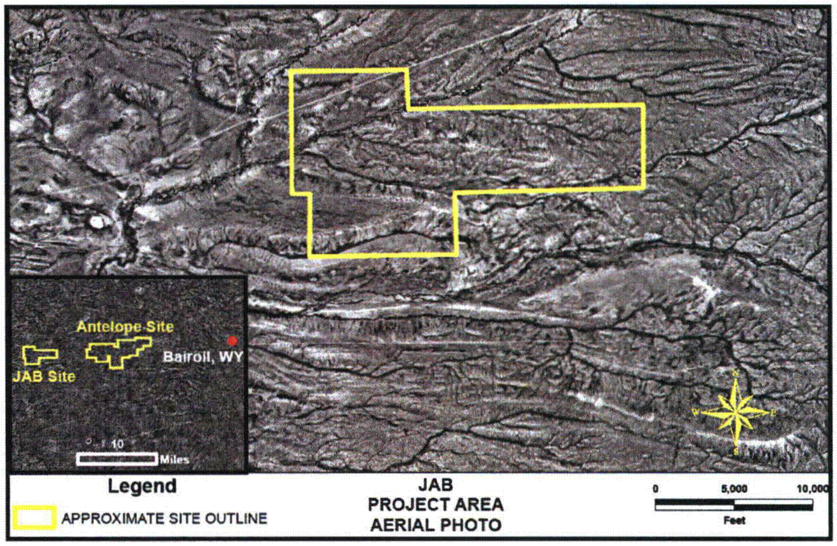


Figure 6.1-2: Aerial Photo of the JAB Uranium Project area.

Topography at both sites is comprised primarily of low rolling hills, relatively flat areas, and small ephemeral drainages (Figure 6.1-3). Sagebrush vegetation dominates these sites, with interspersed short grass prairie varieties. The sites are managed by the BLM with livestock grazing and wildlife habitat representing the predominant land use. There are no residents currently within the project areas.

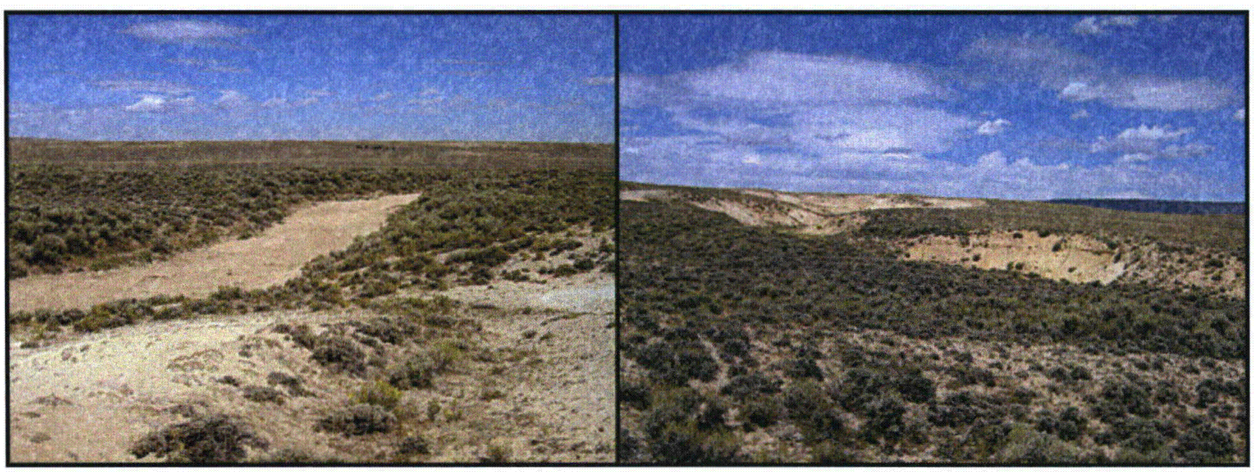


Figure 6.1-3: Photos of portions of the JAB (left) and Antelope (right) Uranium Project areas.

On behalf of Uranium One, Tetra Tech (Fort Collins, CO) conducted various radiological baseline survey measurements in 2007 and 2008 at the Antelope and JAB Uranium Project sites for proposed ISR operations. Radiological survey planning for this project was developed under the assumption that all phases of the uranium extraction and processing cycle could potentially be performed within either permit area.

Basic guidance for radiological baseline surveys at uranium recovery sites can be found in Regulatory Guide 4.14 (NRC, 1980). Although Regulatory Guide 4.14 does not address special considerations associated with ISR uranium recovery sites, the U.S. Nuclear Regulatory Commission (NRC) and the Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD) both currently recommend following Regulatory Guide 4.14 for conducting radiological baseline surveys of ISR sites (NRC, 1982; WDEQ/LQD, 2007).

Baseline surveys of these sites have been conducted based on Regulatory Guide 4.14 protocols. Some aspects of radiological survey activities have been further developed according to more recent NRC regulatory guidance documents as referenced in applicable sections of this report. Data from both study sites are presented in this report for consideration by the NRC and WDEQ/LQD with respect to licensing/permitting applications. The following sections describe methods, activities, and results to date of radiological baseline surveys for the Antelope and JAB Uranium Project areas.

6.1.2 Gamma Survey

Regulatory Guide 4.14 calls for a pre-operational gamma survey covering a maximum area of 1750 acres with up to 80 individual gamma exposure rate measurements (NRC, 1980). The suggested sampling design includes higher density of measurements clustered near the mill location, with more dispersed measurements in a radial pattern at greater distances from the mill. Regulatory Guide 4.14 does not address differences or special considerations associated with ISR uranium mining and recovery operations.

Consistent with ISR permit application guidelines described in Regulatory Guide 3.46 (NRC, 1982) and NUREG-1569 (NRC, 2003), as well as radiological survey guidelines outlined in MARSSIM, the Multi-Agency Radiation Survey and Site Investigation Manual (NRC, 2000), Tetra Tech used GPS-based scanning technologies for this project. Versus Regulatory Guide 4.14 grid-based measurements, these scanning systems are capable of providing much higher density and more uniform gamma measurements across very large areas. The basic scanning system developed by Tetra Tech can be mounted in various configurations including backpacks, off-highway vehicles (OHVs), or trucks, and have been used for remedial support at a number of uranium mill site decommissioning projects as well as other radiological site characterization applications in the U.S. and abroad.

Tetra Tech has used OHV-mounted versions of this scanning system for previous ISR baseline surveys at several similar sites with results presented in licensing/permitting applications to the NRC and the WDEQ/LQD (EMC, 2007; Lost Creek ISR, LLC, 2007).

The method should meet or exceed minimum guidelines outlined in Regulatory Guide 4.14 and other applicable regulatory guidance documents. This system is among current state-of-the-art technologies for conducting radiological site characterizations and can provide far more detailed information on baseline radiological conditions at ISR sites relative to past approaches such as grid-based measurements.

6.1.2.1 Methods

6.1.2.1.1 Baseline Gamma Survey

For the Antelope and JAB surveys, the most recently developed Yamaha Rhino-mounted scanning system configuration was used (Figure 6.1-4). Given the large size of these sites, along with occasional rugged terrain and sagebrush vegetation, these two-seater Rhino OHVs with roll-bar cages and conventional driver control systems (i.e. steering wheel, foot-controlled gas and break pedals) were well suited for the project. Equipped with special extra-wide tires, these vehicles are well suited to safely negotiating sites like Antelope and JAB while minimizing environmental impact.

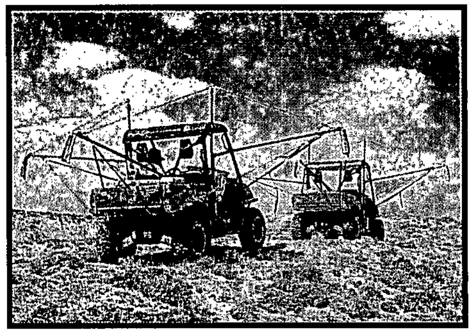


Figure 6.1-4: 3-detector GPS-based scanning systems mounted on Rhino OHVs.

In addition to addressing safety considerations, roll-bar cages on Rhino OHVs provides a support system for adjustable outriggers designed to mount three Ludlum 44-10 NaI gamma detectors and paired GPS receivers. The detectors are coupled to Ludlum 2350 rate meters housed in a cooler carried in the OHV cargo bed. Simultaneous GPS and gamma exposure rate data are recorded every 1-2 seconds using an onboard PC with data acquisition software developed by Tetra Tech.

System configuration involves about 8-foot spacing between detectors (measured perpendicular to direction of travel), with each detector positioned at 4.5 feet above the ground surface. A 3-foot detector height is generally accepted, but not mandated, by the NRC. This height was impractical at the site given the relatively frequent tall brush, ravines, or fence gate crossings. A detector height of 4.5 feet was the lowest practical height for the system under site conditions. Experimental measurements were later performed to determine statistically equivalent readings as measured by a high-pressure ionization chamber (HPIC) at 3 feet above the ground surface (discussed later).

Based on previous observations and experience in the field under similar scanning geometries, lateral NaI detector response to significantly elevated planar (non-point) gamma sources at the ground surface is estimated to be about 5 feet, giving each detector an estimated "field of view" of about 10 feet in diameter at the ground surface. This does not imply a system detector can pick up readings from a small point source 5 feet away, but does suggest that scattered photons from larger elevated source areas (e.g. 100 m^2) are likely to be detected at that distance. Within this conceptual framework, the scanning track width for each vehicle's scanning system is estimated to be about 25 feet across, perpendicular to the direction of travel. Vehicle scanning speeds ranged between 2 and 10 mph depending on the roughness of the terrain, with an estimated average speed of 4-6 mph.

Data were downloaded daily into a project database and mapped using Gamma Viewer software developed by Tetra Tech (Tetra Tech Inc., 2006). In addition to daily quality control (QC) measurements used to evaluate instrument performance and insure data quality (discussed later), daily scan results were evaluated in terms of general agreement between onboard detectors to help identify any problems that may have occurred during data acquisition throughout the day. Gamma Viewer field maps also helped to assess adequacy of scan coverage on a daily basis.

Initial results indicated that the range of gamma exposure rate readings across these sites was relatively broad (e.g. ranging from about 10 to 80 μR/hr), prompting use of fairly wide data mapping increments to best illustrate distributional patterns or trends. In areas near estimated subsurface ore bodies or areas of higher readings, attempts were made to achieve scanning coverages approaching 100%. Based on experience gained from scanning other sites, a distance of 15-30 feet between the adjacent detectors in both vehicles was deemed practical and sufficient to resolve smaller-scale variability in areas targeted for higher density scanning coverage. This vehicle spacing is estimated to provide effective ground scanning coverage of 75-90%.

In other portions of the claim area, 5-10% was the target scan coverage though practical considerations such as safety, terrain, and natural obstructions often dictated actual distances maintained between vehicles. For most areas of the site, a target distance of 300 feet between vehicles was a conservative goal employed during scanning as this is estimated to provide ground area coverages of about 15%. In terrain deemed unsafe for OHV scanning, efforts were made to scan as closely as possible along the perimeters of such terrain.

6.1.2.1.2 Cross-calibration of NaI Detectors against a High-Pressure Ionization Chamber

Gamma exposure rates measured by NaI detectors are only relative measurements as response characteristics of NaI detectors are energy dependent. True gamma exposure rates are best measured with a less energy dependent system such as a high-pressure ionization chamber (HPIC). Depending on the radiological characteristics of a given site, NaI detectors can have measurement values significantly different from corresponding HPIC measurement values.

NaI systems are useful for ISR mining sites because they can quickly and effectively demonstrate relative differences between pre- and post-operational gamma exposure rate conditions. Unless the same equipment and scanning geometry is used for both surveys, however, it is necessary to normalize the data to a common basis of comparison. This is the purpose of performing NaI/HPIC cross-calibration measurements. Cross-calibration insures that the results of future gamma scans, which are likely to use different detectors (and perhaps different detector heights, detector models, or measurement technologies) can be meaningfully compared against the results of pre-ISR gamma surveys.

To perform NaI/HPIC cross-calibrations, static measurements were taken at various discrete locations covering a range of exposure rates representative of the claim area. These locations were identical to those used for gamma/Ra-226 correlation plot measurements (discussed in the next section). At each cross-calibration measurement location, 10 individual HPIC readings were recorded and averaged. The center of the sensitive volume for the HPIC is about 3 feet above the ground surface. A pin flag was pushed into the ground directly below the HPIC to mark the exact measurement location for subsequent NaI measurements. The OHVs were then systematically positioned such that each NaI detector was located directly above the pin flag when taking measurements. For each NaI detector, 20 individual NaI readings at a 4.5-foot detector height were collected and averaged. Mean values were recorded. Pictures of this process are shown in Figure 6.1-5.

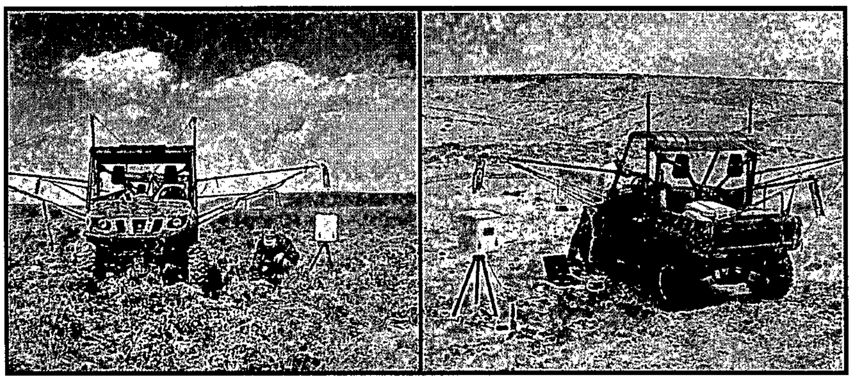


Figure 6.1-5: Static measurements at JAB (left) and Antelope (right) for cross-calibration of NaI detectors against the HPIC at a 4.5-foot NaI detector height.

6.1.2.1.3 Gamma / Ra-226 Correlation Grids

Regulatory Guide 4.14 indicates that 40 baseline surface soil samples should be collected at 5-cm depths within 1.5 kilometers from the center of the milling area, with additional samples collected at air monitoring stations. NUREG-1569 suggests that 15-cm depths should also be sampled for consistency with decommissioning criteria. This guidance, combined with the large size of the Antelope and JAB Uranium Project areas, prompted a number of gamma/Ra-226 correlation plots to be sampled. Depending on the statistical strength of the relationship between gamma readings and Ra-226 concentrations in surface soils, such correlations can be used to estimate approximate Ra-226 soil concentrations (to a 15-cm depth) across the entire site based on gamma survey results.

Correlation soil sampling was conducted as composite sampling over 10×10 meter plots. Within each plot, 10 soil sub-samples were collected to a depth of 15 cm then composited into a single sample. GPS coordinates were taken at the center of each sampling plot and recorded. Samples were sent to Energy Laboratories Incorporated (ELI) in Casper, WY for analysis of Ra-226 concentrations. Samples were dried, crushed, and thoroughly homogenized prior to analysis to insure a representative average radionuclide concentration over each 100 m^2 plot. Samples were then canned, sealed, and held 21 days prior to counting to allow sufficient ingrowth of radon and short-lived progeny before Ra-226 analyses were performed using high-purity germanium (HPGe) gamma spectroscopy (method E901.1).

Following methods described in Johnson et al. (2006), each 100 m^2 soil sampling plot was also scanned using the same OHV systems used to scan the entire site. The average NaI gamma reading over each plot was calculated and recorded to pair with the corresponding average Ra-226 concentration. A diagram depicting the sampling design for correlation plot measurements is shown in Figure 6.1-6.

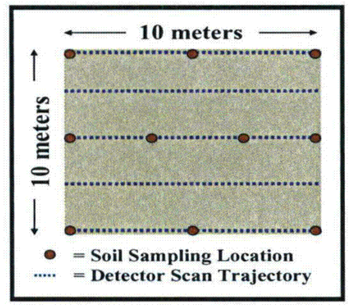


Figure 6.1-6: Diagram of correlation plot soil sampling and gamma measurement design.

6.1.2.1.4 Data Quality Assurance / Quality Control

Data quality assurance and quality control issues for gamma surveys of the Antelope and JAB Uranium Project areas are addressed in various ways. In general, quality assurance (QA) includes qualitative factors that provide confidence in the results, while quality control (QC) includes quantitative evidence that supports the validity of results (e.g. data accuracy and precision).

<u>Quality control documentation for this project includes the following</u>:

- Daily QC measurements were performed for each NaI detector used in gamma scanning activities and results were plotted on instrument control charts. Background as well as Cs-137 check-source QC measurements were taken each day indoors under a controlled geometry. For normally distributed count data, over 99% of measurements from a given detector are expected to fall within ± 3 standard deviations from the mean. Also, background gamma exposure rates at a given location can vary over successive days due to fluctuations in natural shielding factors for cosmic and/or terrestrial sources (NRC, 1994). Furthermore, in this application data from multiple detectors are used to measure overall site conditions. Response characteristics between individual detectors can vary even after proper calibration by the manufacturer.

To help account for all potential sources of measurement variability for this application, any instrument with measurements falling outside ± 3 standard deviations from the mean of all QC measurements for all instruments on both background and check source charts indicates unacceptable instrument performance. Detectors performed within acceptable QC limits throughout the project. While meeting specified QC limits, one detector showed indications of a systematic low bias relative to other detectors (about 1 μR/hr at indoor background). This was further investigated and addressed as described in the following bullet point.

- Each day, the actual performance of each scanning system was tested in the field by scanning along a designated strip near the vehicle staging area. These "field strip" scans were conducted before and after each day's scanning. Under actual field conditions, scanning systems performed within acceptable QC limits throughout the project. While meeting specified QC limits, two of the scan system/detector combinations each showed indications of a systematic low bias relative to the other systems (one affected system involved the detector mentioned in the preceding bullet point).

  Based on careful assessment of all QC data and a statistical analysis of correlation plot data across a range of gamma exposure rates found at the sites, readings from the two low-biased system/detector combinations were determined to average about 86% of readings from the other systems. Using regression analysis techniques, the affected correlation plot data were normalized accordingly, resulting in excellent agreement between all detector readings at each correlation plot location. All site survey data collected from the two low-biased system/detector combinations were also normalized accordingly to create a final NaI-based gamma survey data set.

- Re-scanning is an important tool for verification and demonstrating reproducibility of measurements in the field. Part of re-scan verification involved comparing data from various discrete, stationary measurements across the site (collected as part of HPIC cross-calibration and gamma/Ra-226 correlation activities) with original scan data. In general, these stationary measurement data showed good agreement with original continuous scan data.

- With respect to soil sampling results from Energy Laboratories, final official reports indicated that all QC indicators (e.g. duplicate sample analyses, blanks, laboratory control samples, sample matrix spikes) "met EPA or laboratory specifications" for quality control. No flags or analytical problems were noted in the reports. Copies of these reports are available upon request.

Data quality assurance factors for this project include the following:

- All detectors used for gamma scanning at the claim area, along with the HPIC, were calibrated by the manufacturer within one year prior to the date of use on this project.
- A detailed field log book of daily activities was maintained.
- Chain-of-custody protocols were followed for soil sampling and contract laboratory analyses.
- Tetra Tech's Radiological Health Group staff has extensive qualifications and over 100 years worth of combined experience for performing radiological measurements and related site assessments (CV's provided on request).
- Scanning system methodologies and technology are published in peer-reviewed radiation protection and measurement research publications (Johnson et al., 2006; Meyer et al. 2005a; Meyer et al. 2005b; Whicker et al., 2008; Whicker et al., 2006).
- Daily scan results for each vehicle were reviewed for consistency along track paths for all onboard detectors. Obvious inconsistencies prompted further investigation and in cases where technical problems were discovered or where the data were otherwise clearly incorrect, the affected data were omitted from the project database.

6.1.2.2 Gamma Survey Results

6.1.2.2.1 Baseline Gamma Survey Results

NaI-based gamma survey results for each site are shown in Figures 6.1-7 and 6.1-8. In most areas of these sites, readings are below 30 μR/hr and gamma exposure rates are relatively homogeneous. There are several areas at each site with significantly higher readings indicative of elevated naturally occurring terrestrial radionuclides at or near the soil surface. The areas of higher density scanning shown in Figures 6.1-7 and 6.1-8 cover areas of interest with respect to estimated subsurface deposits or areas found to have higher exposure rate readings during initial scanning.

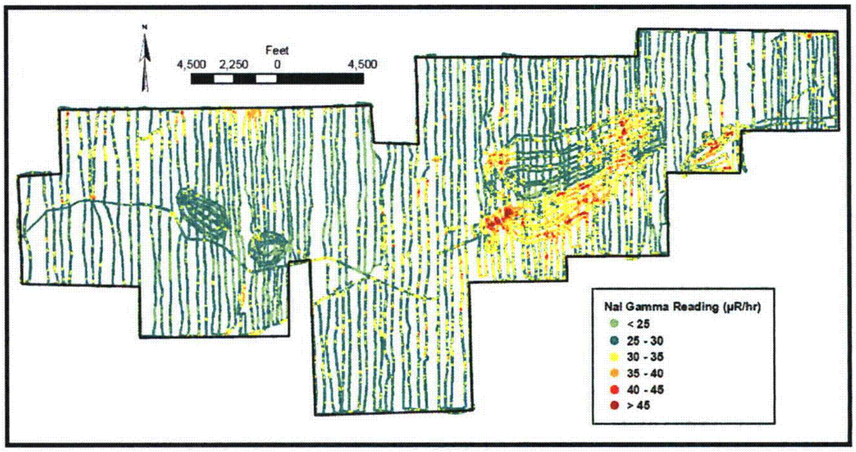


Figure 6.1-7: Raw, NaI-based gamma survey results for the Antelope Uranium Project area.

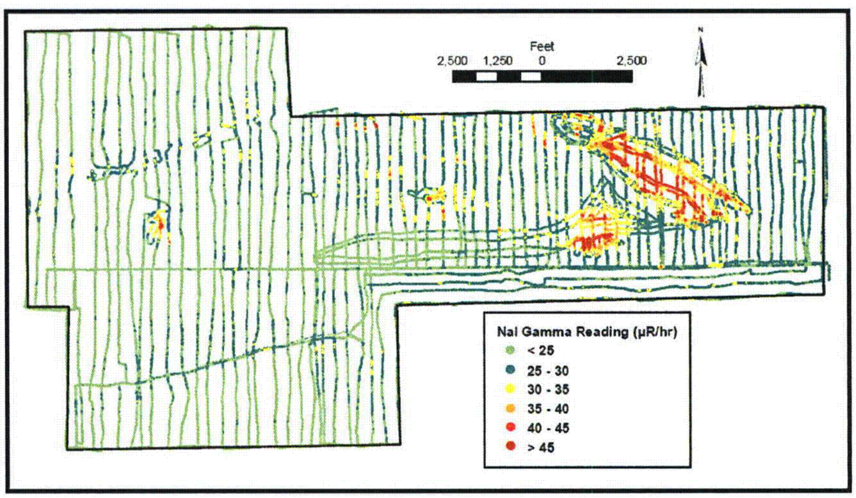


Figure 6.1-8: Raw, NaI-based gamma survey results for the JAB Uranium Project area.

Discrete, stationary measurements taken at correlation plot survey locations showed good agreement with the results of the continuous OHV survey data in corresponding locations. In some cases, areas at these sites with the higher readings have certain geomorphologic features that appear to be associated with higher gamma exposure rates (e.g. hill tops, eroded areas, outcrops of exposed rocks or unusually colored soils).

Examples of such areas are shown in Figure 6.1-9. In many cases, transitions between areas of consistently higher and lower readings are relatively abrupt. Such transitions sometimes have visible features that appear to delineate distinct boundaries between areas of higher and lower readings (Figure 6.1-10). In other cases, there are no obvious features associated with areas of higher readings or with transition zones.

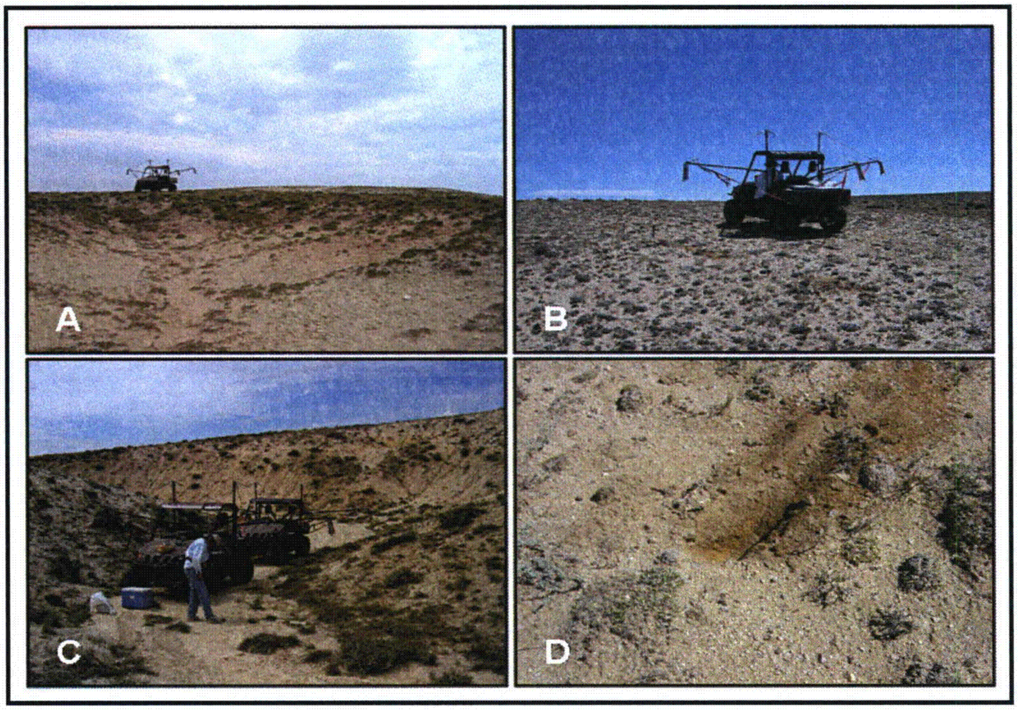


Figure 6.1-9: Photos of areas with higher readings: A) erosional depression at Antelope with exposed unusual soil layers (readings 30-35 μR/hr); B) knoll top correlation plot location at Antelope (readings 55-60 μR/hr); C) deep ravine at Antelope (readings 30-40 μR/hr); D) correlation plot soil sampling location at JAB with a yellowish-tinted soil layer just below the soil surface (readings 45-50 μR/hr).

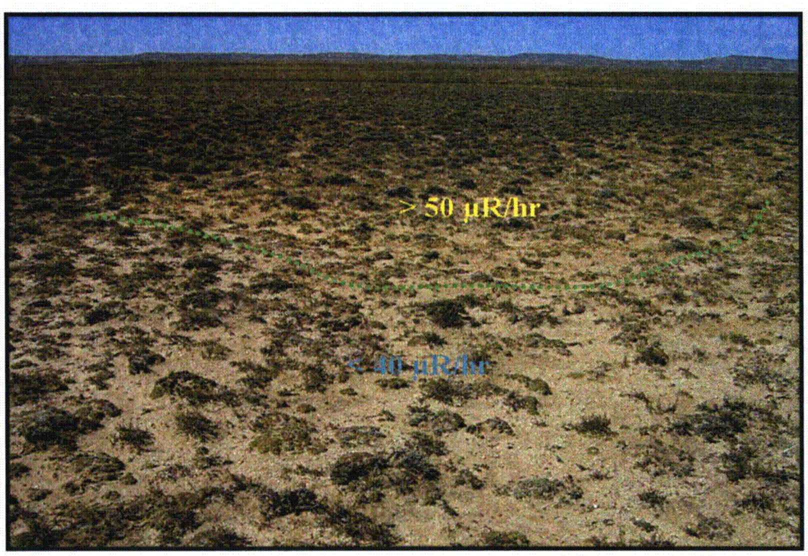


Figure 6.1-10: Area at JAB with an abrupt transition in gamma readings that appeared to coincide with a subtle, yet visible change in surface soil color.

6.1.2.2.2 HPIC / NaI Cross-calibration Results

Results of the cross-calibration between HPIC and NaI detectors positioned at 4.5-foot detector heights are shown in Figures 6.1-11 and 6.1-12. Regression coefficients are consistent with those measured by Tetra Tech at other uranium recovery sites, including nearby sites in this region of Wyoming. The ratio of HPIC to NaI readings was inversely proportional to the magnitude of exposure rates being measured. HPIC/NaI ratios across the two sites ranged from 0.65 to 0.98, roughly corresponding to locations with the highest and lowest respective measurement readings. Locations having NaI readings lower than about 18 µR/hr demonstrated little difference between HPIC and NaI measurements.

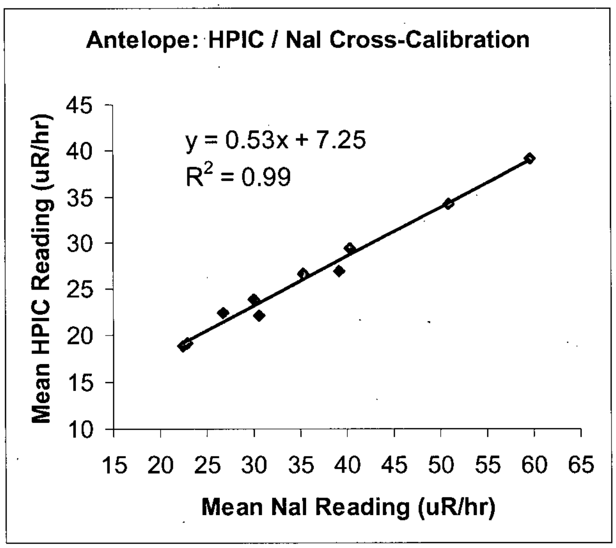


Figure 6.1-11: Antelope: cross-calibration curve for the HPIC versus NaI detectors positioned at a 4.5-foot detector height.

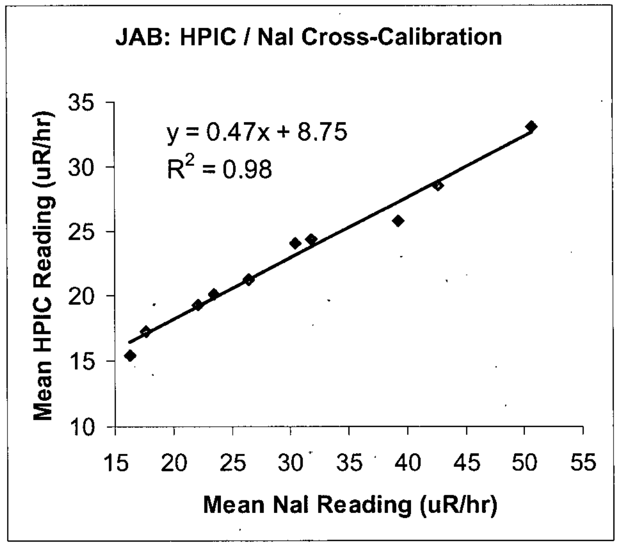


Figure 6.1-12: JAB: cross-calibration curve for the HPIC versus NaI detectors positioned at a 4.5-foot detector height.

6.1.2.2.3 NaI/Ra-226 Correlation Grid Results

Overlays of correlation plot sampling locations, color-coded and annotated to show soil Ra-226 results on raw NaI gamma scan maps, are shown in Figures 6.1-13 and 6.1-14. Soil sampling results represent average 15-cm depth Ra-226 concentrations over 100 m^2 sampling plots.

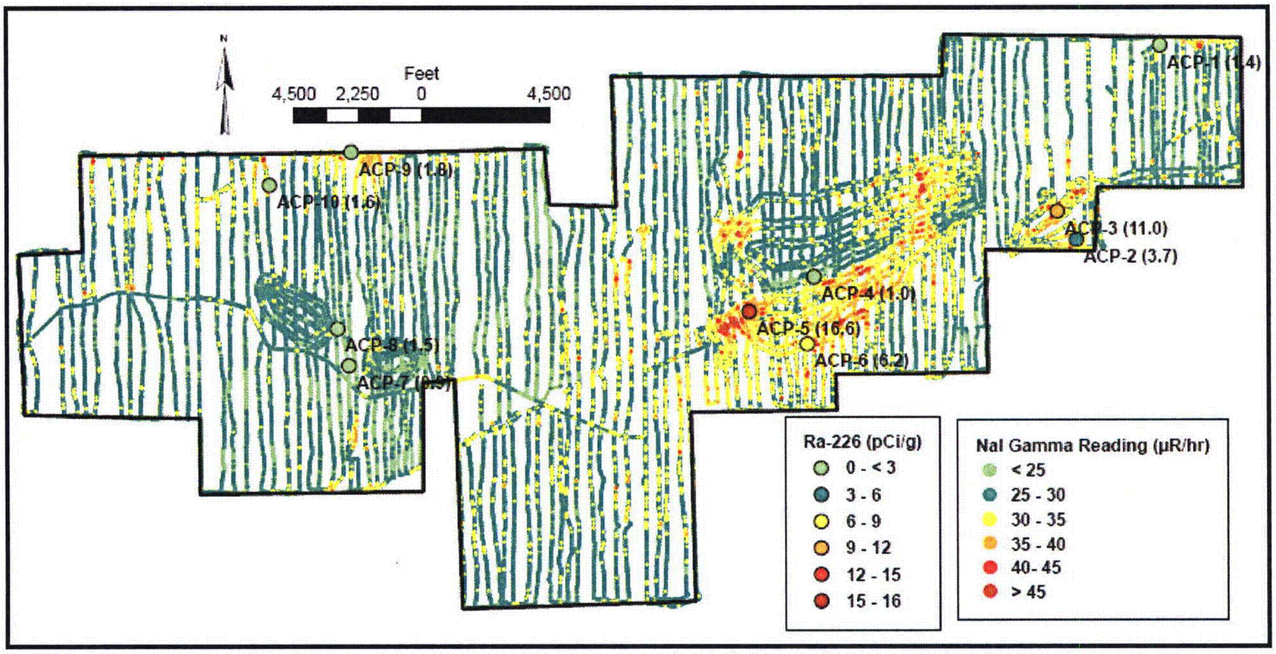


Figure 6.1-13: Antelope: correlation plot measurement locations and annotated soil Ra-226 concentration results (pCi/g, in parentheses) overlain on the NaI scan track map.

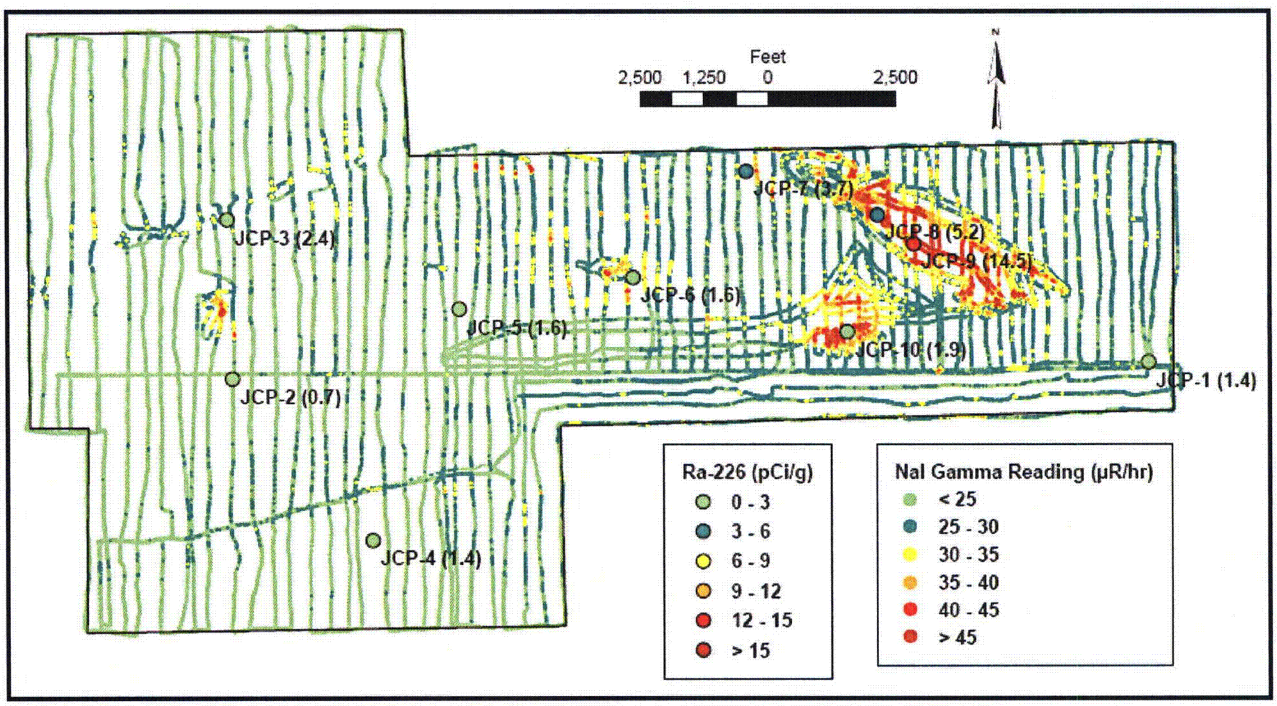


Figure 6.1-14: JAB: correlation plot measurement locations and annotated soil Ra-226 concentration results (pCi/g, in parentheses) overlain on the NaI scan track map.

Correlation plot data contained one location at each site having unusually low soil Ra-226 concentrations relative to gamma readings, possibly due to scattered photons from areas adjacent to these plots and/or from subsurface layers of elevated Ra-226 concentrations. Excluding these two locations, correlation plots at each site demonstrated a significant linear relationship between mean Ra-226 soil concentration and mean NaI gamma reading (Figures 6.1-15 and 6.1-16).

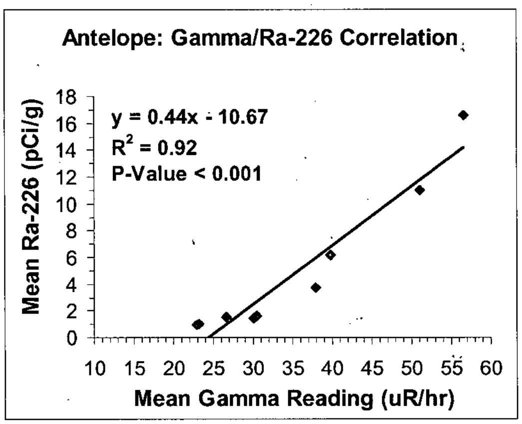


Figure 6.1-15: Antelope: linear correlation between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

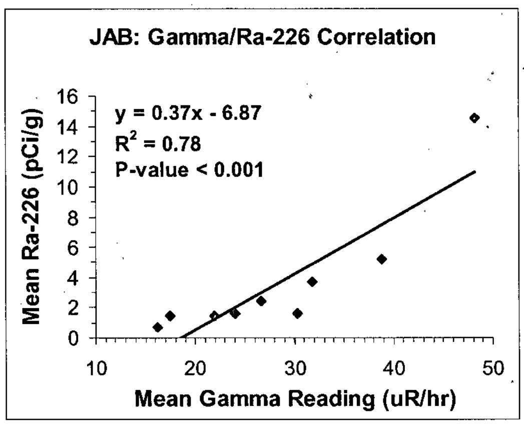


Figure 6.1-16: JAB: linear correlation between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

Although linear regressions for correlation plot data from each site were statistically significant, the data from both sites appear somewhat nonlinear. Nonlinear models were fitted to each set of correlation data (Figures 6.1-17 and 6.1-18), significantly improving respective R-squared values and suggesting the potential for reduced error in predicting Ra-226 concentrations based on NaI gamma readings.

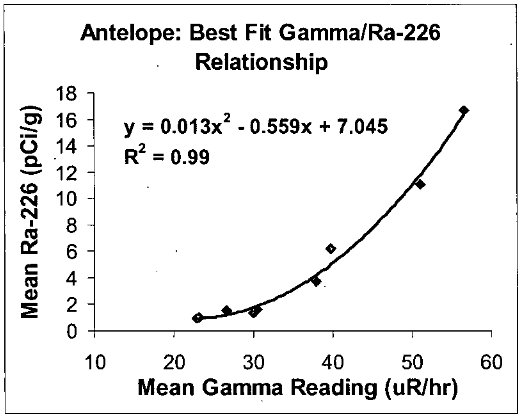


Figure 6.1-17: Antelope: nonlinear "best fit" relationship between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

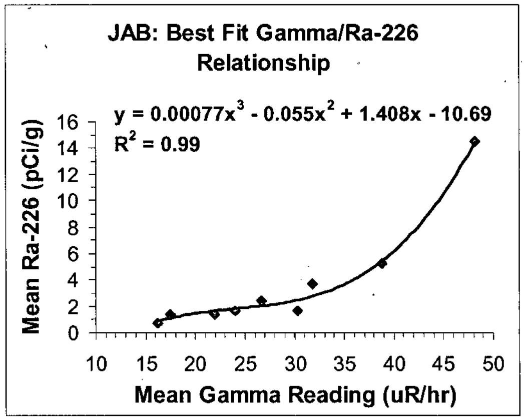


Figure 6.1-18: JAB: nonlinear "best fit" relationship between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

6.1.2.2.4 Final Gamma Exposure Rate Mapping

Using regression equations shown in Figures 6.1-11 and 6.1-12, baseline gamma survey data collected with NaI detectors at the Antelope and JAB Uranium Project sites were normalized to 3-foot HPIC equivalent gamma exposure rates to create final respective data sets. Using a kriging program in ArcGIS, these final data sets were used to develop continuous estimates of 3-foot HPIC equivalent gamma exposure rates across each site.

Kriging is a geostatistical interpolation procedure that fits a mathematical function to a specified number of nearest points within a defined radius to determine an output value for each location. A given "location" is represented by a cell of specified areal dimensions that may or may not include any measured data points. Values closer to the cell are given more weight than values further away and distances, directions, and overall variability in the data set are all considered in the predictive semivariogram model. Approximate input parameters used for this application were as follows:

Cell size:	10 feet × 10 feet
Max search radius:	500 feet
Semivariogram model:	Exponential
Number of nearest data points:	10

Maps of estimated 3-foot HPIC equivalent gamma exposure rates across each site are shown in Figures 6.1-19 and 6.1-20.

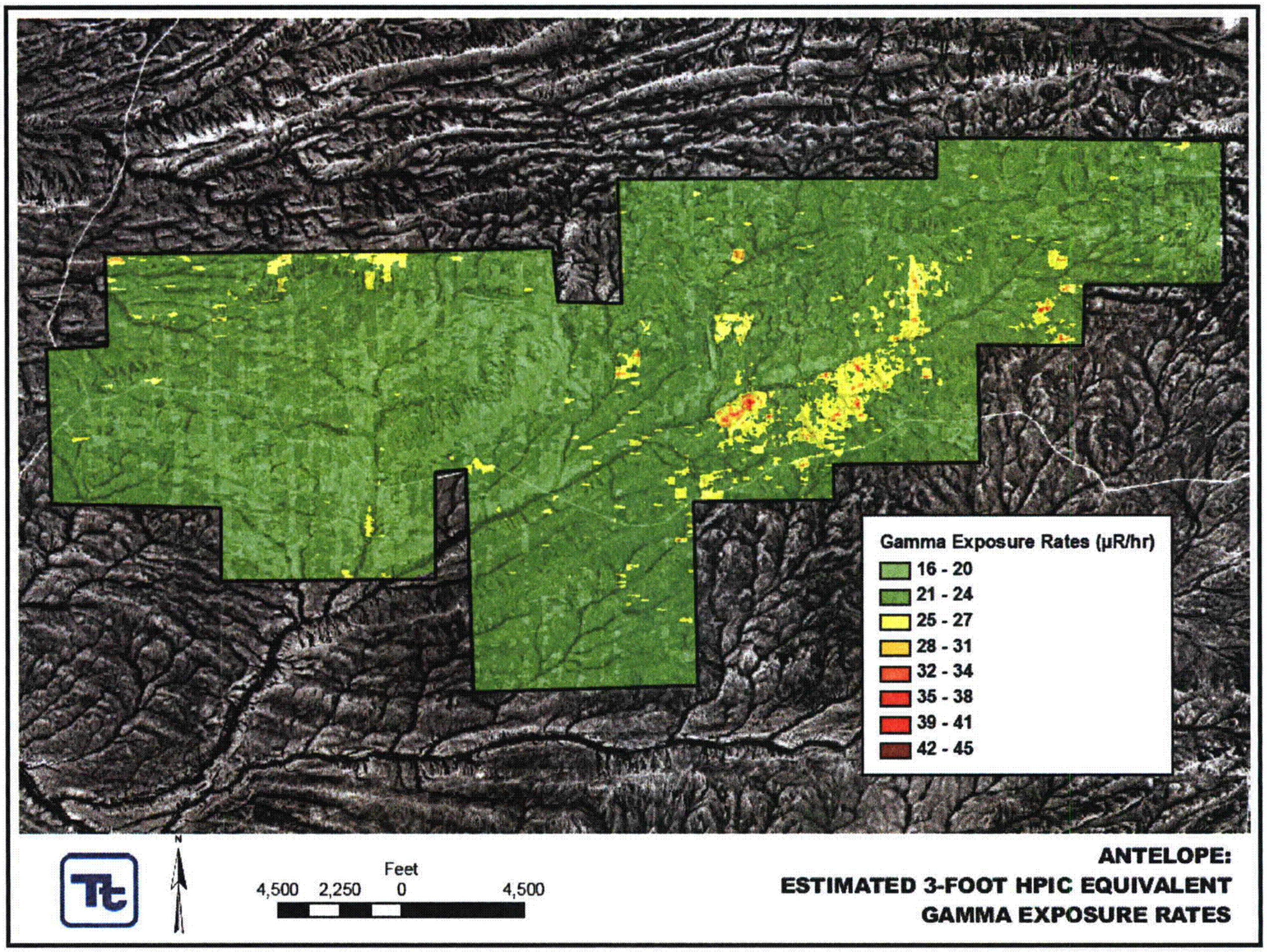


Figure 6.1-19: Continuous, kriged estimates of 3-foot HPIC equivalent gamma exposure rates at the Antelope Uranium Project site.

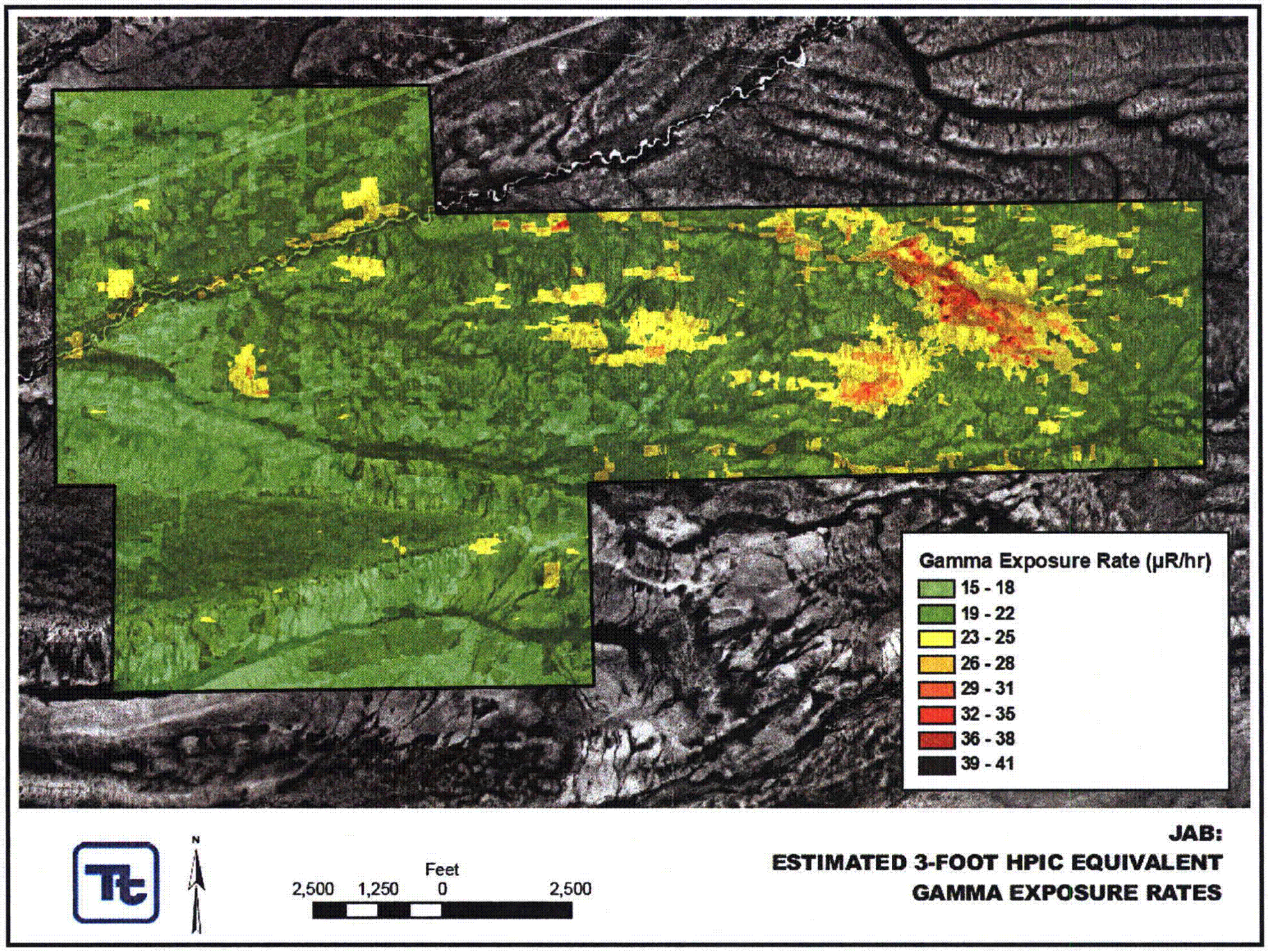


Figure 6.1-20: Continuous, kriged estimates of 3-foot HPIC equivalent gamma exposure rates at the JAB Uranium Project site.

Note that gamma scale legend increments differ between the raw, NaI-based gamma scan track maps shown in Figures 6.1-7 and 6.1-8 of this report and final official maps of gamma survey results provided as Figures 6.1-19 and 6.1-20. This is because the data in final maps of official gamma survey results have been converted to 3-foot HPIC equivalent values and more respective mapping increments have been added to final maps to better resolve small changes in gamma exposure rate distributions.

6.1.2.2.5 Soil Ra-226 Concentration Mapping

The nonlinear gamma/Ra-226 equations shown in Figures 6.1-17 and 6.1-18 were used to convert raw NaI gamma readings from each site into estimates of Ra-226 concentrations in surface soils. These converted data sets were then kriged to provide continuous estimates of Ra-226 in surface soils across each site (Figures 6.1-21 and 6.1-22). The kriged maps of estimated soil Ra-226 concentrations will be evaluated for predictive accuracy against actual soil sample results (see Section 6.1.3).

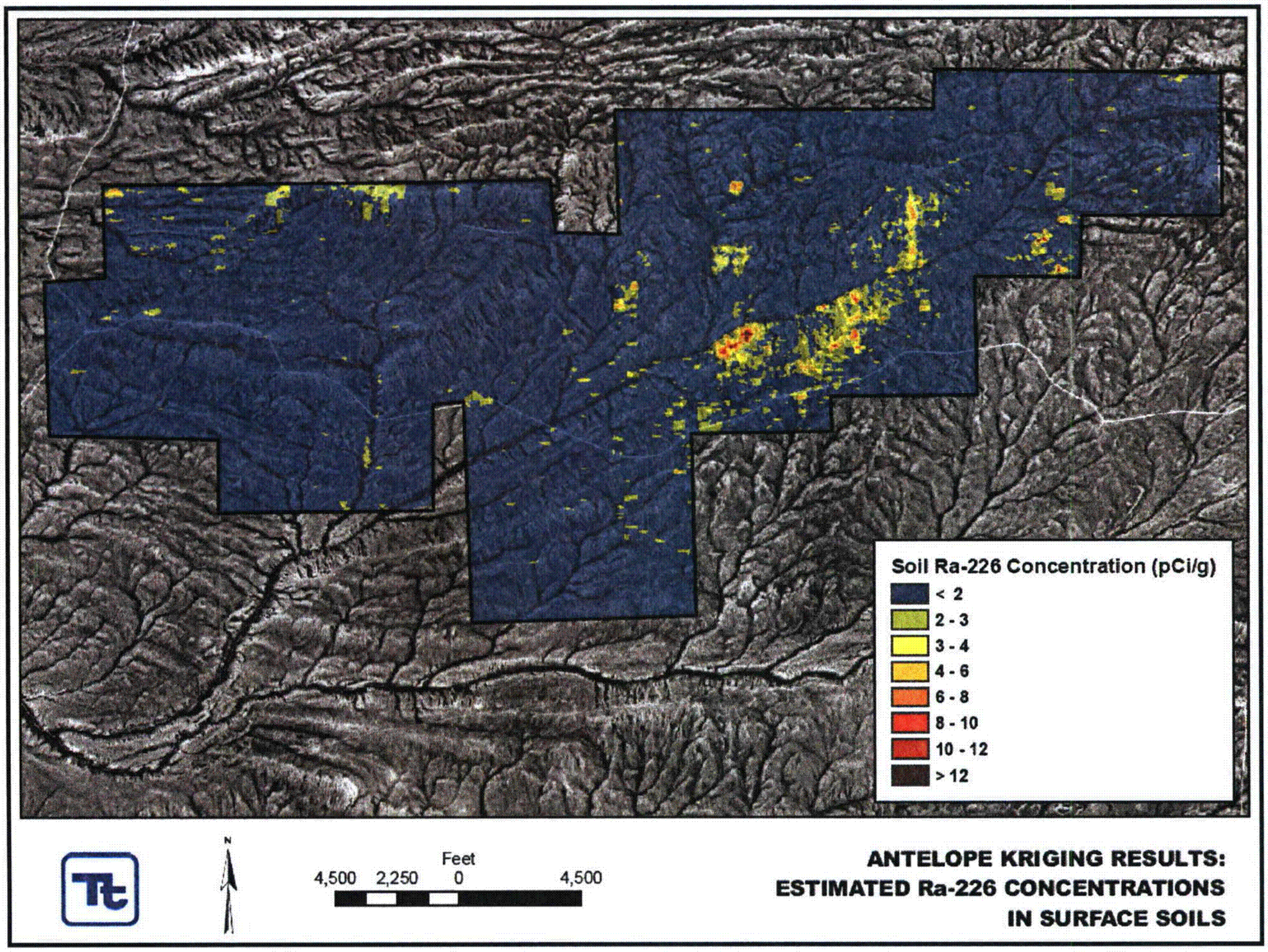


Figure 6.1-21: Antelope: continuous, kriged estimates of Ra-226 concentrations in surface soils based on gamma survey results.

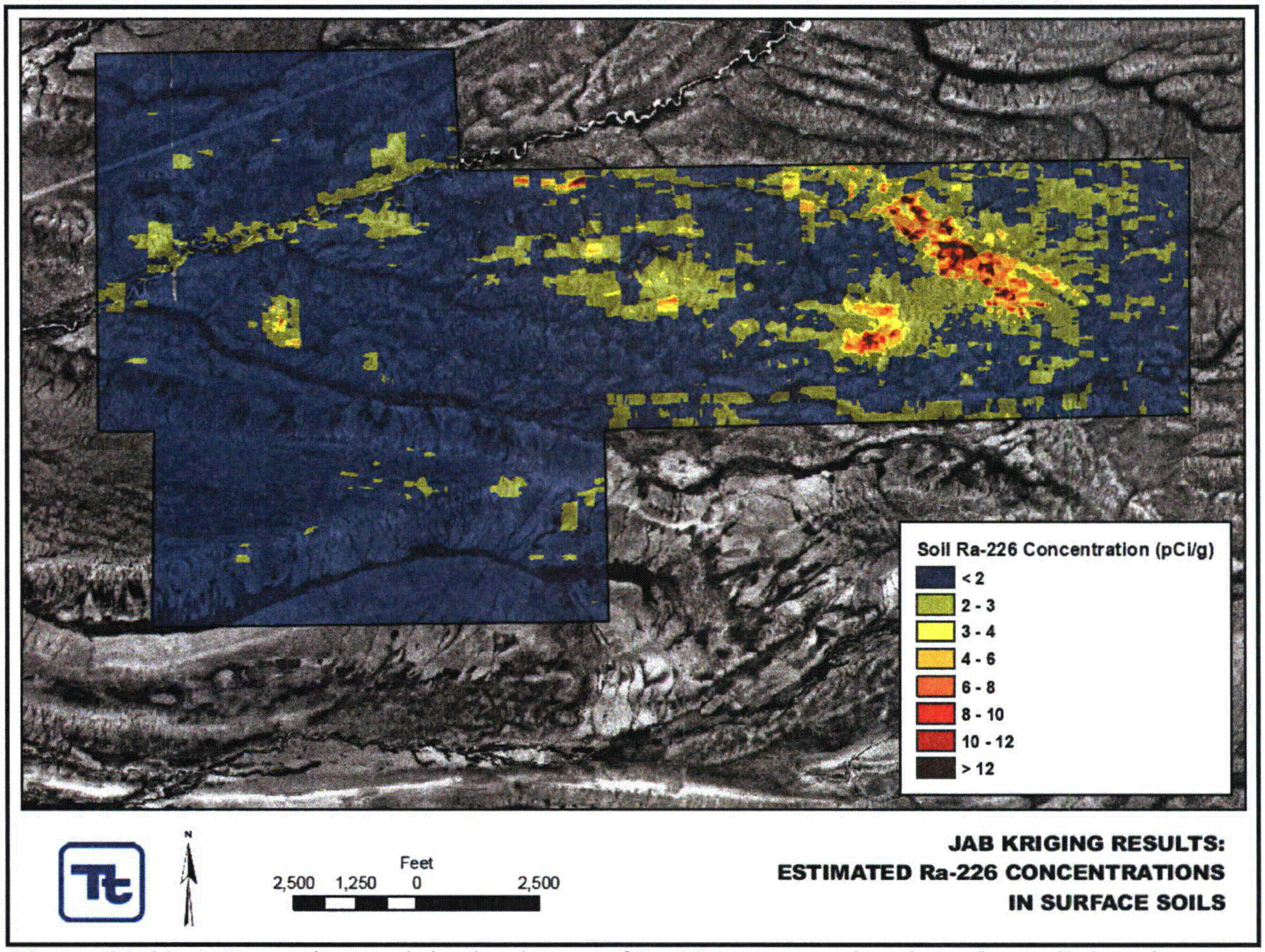


Figure 6.1-22: JAB: continuous, kriged estimates of Ra-226 concentrations in surface soils based on gamma survey results.

6.1.2.2.6 Data Uncertainty

For comparison of pre- and post-operational measurements, converting raw gamma survey data to a 3-foot HPIC equivalent is only one important consideration. It is also necessary to take into account the degree of uncertainty in measurements. Sources of measurement uncertainty include instrument variability, spatial variability in gamma exposure rates (differences in readings due to small differences in measurement geometry or location), and temporal variability in gamma exposure rates (e.g. differences over time due to changes in natural shielding factors for terrestrial or cosmic sources such as soil moisture or barometric pressure).

In general, QC measurements along field strips at each site provide an indication of total measurement uncertainty including spatial, temporal and instrument sources of variability in background gamma exposure rate readings. Based on control charts maintained over the course of the project, the total amount of potential uncertainty in NaI scanning measurements at field strip locations ranged up to about ± 2 μR/hr. Approximately the same amount of uncertainty should be applicable to 3-foot HPIC equivalent data at these locations. The field strips were located in areas having average background gamma readings in the range of 22 – 24 μR/hr (at the lower end of the ranges of values found at the sites). In areas of higher gamma exposure rates, the degree of uncertainty in measurements may be higher.

Finally, the kriging process for continuous estimation of overall baseline conditions is believed to smooth out some variability associated with certain sources of data uncertainty (e.g. variability in response characteristics of different detectors). In areas scanned at lower ground coverage densities, only larger-scale distributional characteristics are inferred as smaller-scale spatial variability in exposure rates between scan tracks from each survey vehicle is not captured.

6.1.2.3 Conclusions

The 2007 baseline gamma surveys of the Antelope and JAB Uranium Project areas in Sweetwater County, WY provide detailed characterizations of natural background gamma exposure rates and associated Ra-226 soil concentrations that exist at these sites. The data collected are of high quality and should meet or exceed regulatory guidelines for baseline surveys. These data will help insure that any potential radiological contamination that could result from ISR mining activities at each site can be effectively identified for remedial action. Extensive gamma survey data sets, HPIC cross-calibrations, gamma/Ra-226 correlations, comprehensive quality control measurements, and advanced spatial analysis techniques provide the most thorough and accurate documentation possible of these baseline radiological parameters. This is important for helping to insure that the land will be returned to its pre-operational state during site decommissioning. The technology and methods used, while relatively new to the ISR licensing/permitting process, are likely to benefit all stakeholders.

6.1.3 SOIL SAMPLING

Due to early onset of snow storms and prolonged snow cover conditions at these sites in the fall of 2007 through the spring of 2008, soil sampling according to Regulatory Guide 4.14 protocols was delayed at these sites until late May of 2008. As a result, respective results are not yet available. Estimates of Ra-226 concentrations in surface soils (to a depth of 15 cm) across each entire site, based on gamma scanning and gamma correlations with soil Ra-226 concentrations, are provided in Section 6.1.2.2.5. Full results of the Regulatory Guide 4.14 soil sampling and analyses, along with corresponding revisions to this section and assessments of implications for estimates of soil Ra-226 across these sites as presented in Section 6.1.2.2.5, will be provided to the NRC and the WDEQ/LQD as soon as they are available (expected in August of 2008).

Comprehensive baseline soil sampling and analyses were conducted in May of 2008 in accordance with Regulatory Guide 4.14 protocols. Data from these sampling efforts represent discrete, systematic locations involving 5-cm sampling depths for surface soils and incremental profile sampling to a depth of 1 meter for subsurface soils (NRC, 1980). With gamma/Ra-226 correlation grid and subsurface soil samplings, 15-cm surface soil depths will also be represented in the final survey data sets. Surface soil radionuclide concentration data from both 5-cm and 15-cm soil depths will be presented in revisions to this section in accordance with Regulatory Guide 4.14 protocols and NUREG-1569 application review recommendations (NRC, 2003).

6.1.3.1 Methods

6.1.3.1.1 Surface Soil Sampling

Soil sampling activities at the Antelope and JAB Uranium Project sites were conducted in August, 2007 (correlation sampling, discussed earlier), and May, 2008 (Regulatory Guide 4.14 soil sampling). The Regulatory Guide 4.14 surface soil sampling design involves a radial grid pattern with the approximate location of proposed ISR processing plant facilities at the center of the grid. Discrete soil samples were collected along transects radiating in 8 compass directions from the plant at 300 meter intervals (Figures 6.1-23 and 6.1-24). Each transect was about 1,500 meters long, resulting in the collection of 5 samples per transect for a total of 41 "grid samples" that were sent to ELI (Casper, WY) for analysis of all analytes specified in Regulatory Guide 4.14 for soil samples.

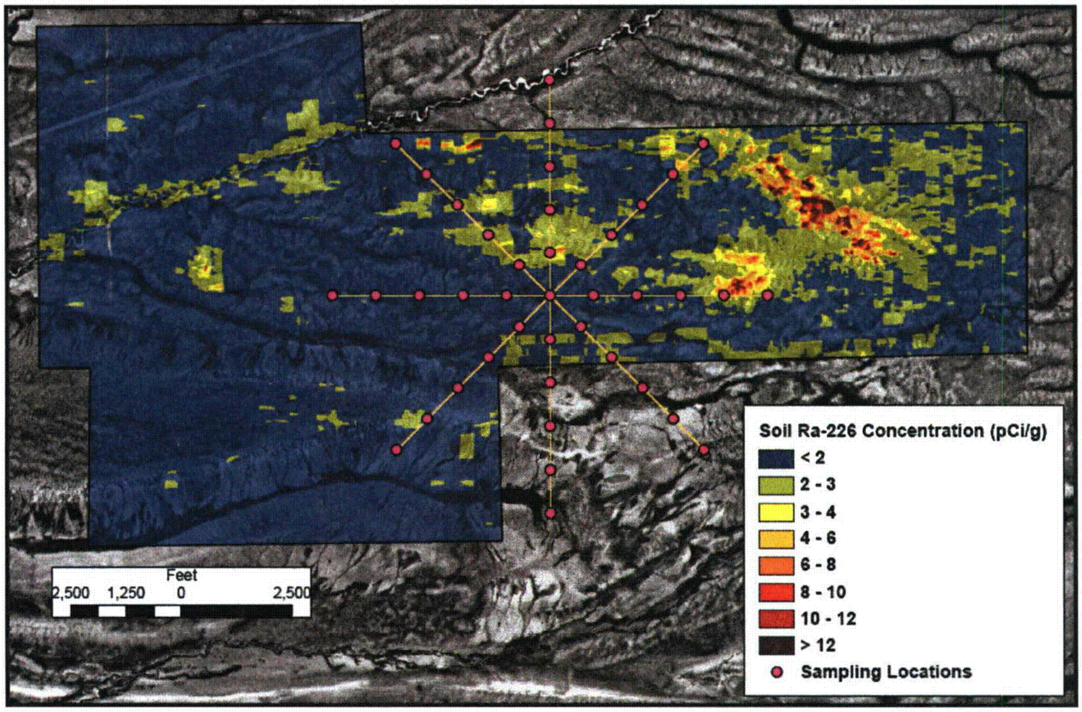


Figure 6.1-23: Regulatory Guide 4.14 radial grid surface soil sampling locations for Antelope (pink dots), overlain on the gamma survey-based map of estimated soil Ra-226 concentrations across the site.

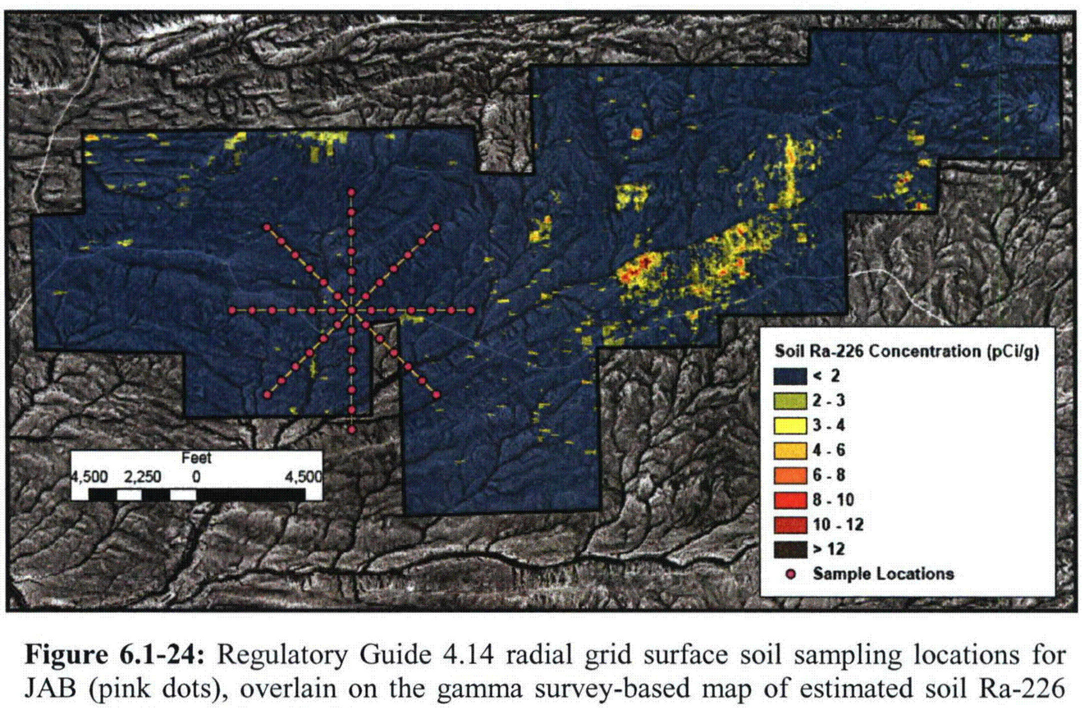


Figure 6.1-24: Regulatory Guide 4.14 radial grid surface soil sampling locations for JAB (pink dots), overlain on the gamma survey-based map of estimated soil Ra-226 concentrations across the site.

Soil sampling analytes include Ra-226, with 10 percent of samples were further analyzed for natural uranium (U-nat), Th-230, and Pb-210. Additional surface soil samples were collected and analyzed from each air particulate monitoring station per Regulatory Guide 4.14 specifications.

All radial grid and air station surface soil samples were collected with a hand trowel to a depth of 5 cm, double bagged, and labeled. Location ID numbers, date, and GPS coordinates for each sampling location were recorded in the field log book. Samples were sent to ELI in Casper, WY along with chain of custody / analysis request forms. After receipt by ELI, samples were dried, crushed, ground, and thoroughly homogenized prior to analysis. For samples analyzed by HPGe gamma spectroscopy, aliquots were weighed and placed into counting tins, then sealed for about 21 days prior to counting to allow ingrowth of short-lived Ra-226 progeny and approximate equilibrium conditions to become established. Separate aliquots were used for analyses requiring wet radiochemical methods.

6.1.3.1.2 Depth Profile Soil Sampling

Five depth profile sampling locations were selected also based on Regulatory Guide 4.14 recommendations. One location was in the approximate center of planned ISR processing plant facilities, with the other four locations located along radial transects used for surface soil sampling, but at 750 meters from the plant and in four primary compass directions.

Subsurface soil samples were collected with a hand-coring soil sample collector in 15-cm increments to a depth of 105 cm or until rock prevented further coring device penetration. Sample collection, lab delivery, chain of custody, sample preparation, and analysis protocols were the same as those described in above in Section 6.1.3.1.1 for surface soil samples. All soil depth profile samples were analyzed by HPGe gamma spectroscopy for Ra-226 and ELI's suite of naturally occurring radionuclides. The top-most and bottom-most layers of each depth sampling location were further analyzed for natural U-nat, Th-230, and Pb-210 by wet radiochemical methods.

6.1.3.2 Soil Sampling Results

6.1.3.2.1 Surface Soil Sample Results

Estimates of Ra-226 concentrations in surface soils (to a depth of 15 cm) across each entire site, based on gamma scanning and gamma correlations with soil Ra-226, are provided in Section 6.1.2.2.5. Individual soil sample results for Ra-226 from the correlation plots are provided in Section 6.1.2.4. A complete tabulation of all soil analysis results, including Regulatory Guide 4.14 sampling, will be provided to the NRC and the WDEQ/LQD in a supplement to this report as soon as remaining analytical results are available (expected in

June, 2008). Summary statistics, graphical presentations, color-coded mapping, and comparative analyses of results will also be provided in the supplementary report.

6.1.3.3 Conclusions

Baseline soil radionuclide data from the Antelope and JAB site surveys were collected and analyzed according to Regulatory Guide 4.14 protocols. These data sets, combined with the correlation soil sampling data and continuous kriged estimates of Ra-226 concentrations across these sites based on comprehensive gamma scanning as presented in Sections 6.1.2.1.3 and 6.1.2.2.3, provide a thoroughly detailed and reliable characterization of existing soil radionuclide concentrations across the site. This information should meet respective baseline characterization requirements as indicated by the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality / Land Quality Division for ISR licensing/permitting applications.

6.1.4 Sediment Sampling

In August of 2007 and May of 2008, baseline sediment sampling was conducted at the Antelope and JAB Uranium Project areas in accordance with Regulatory Guide 4.14 protocols (NRC, 1980). Only ephemeral stream drainage channels (Figure 6.1-25) were sampled as no significant surface water impoundments were identified. At each site, sediments were collected at 4-5 locations along stream drainage channels, including (where possible) locations roughly upstream and downstream from proposed processing plant facility locations.

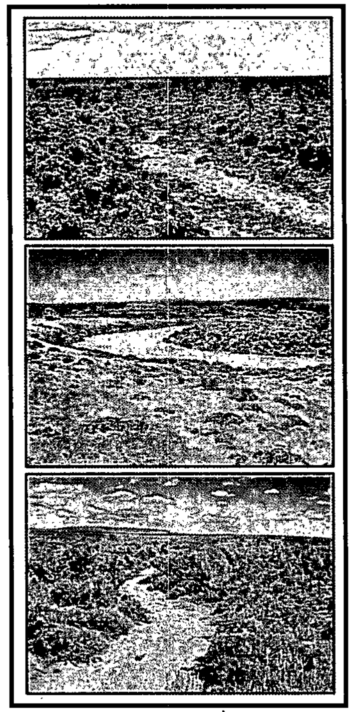


Figure 6.1-25: Sediment sampling: examples of ephemeral stream drainage channels at the Antelope and JAB sites.

These two sampling events are intended to characterize radionuclide content in stream sediments during seasonal runoff (spring) and low-flow (fall) conditions (NRC, 1980). Analytical results for the 2007 sampling event are presented in this section. Data from the 2008 sampling event are still pending. A complete tabulation of all sediment sampling results will be provided to the NRC and the WDEQ/LQD in a supplement to this report as soon as all analytical results are available (expected in June, 2008). Based on results of sediment sampling at other ISR sites in Wyoming, major differences in analytical results between the 2007 and 2008 sampling events at these sites are not anticipated.

6.1.4.1 Methods

6.1.4.1.1 Stream Sediment Sampling

Stream sediment sampling locations were selected to be generally representative of primary drainages found at these sites. At each location, four sediment sub-samples were collected with a hand trowel to a depth of 5 cm each, along a transect spanning the width of the lowest portion of the ephemeral stream channel. The four sub-samples were composited to represent the average radionuclide concentration across the drainage channel. Composite sediment samples were subsequently double bagged, and labeled. Location ID numbers, date, and GPS coordinates for each sampling location were recorded in the field log book.

Samples were sent to Energy Laboratories, Inc. in Casper, WY along with chain of custody / analysis request forms. Samples were dried, crushed, ground, and thoroughly homogenized prior to analysis. All samples were analyzed for Ra-226, along with other select analytes that are automatically included with ELI's gamma spectroscopy analysis package for analysis of naturally occurring radionuclides. In addition, sediment samples were further analyzed for U-nat, Th-230, and Pb-210. For samples analyzed by HPGe gamma spectroscopy, aliquots were weighed and placed into counting tins, then sealed for about 21 days prior to counting to allow ingrowth of short-lived Ra-226 progeny and approximate equilibrium conditions to become established. Separate aliquots were used for analyses requiring wet radiochemical methods.

6.1.4.1.2 Surface Water Impoundment Sediment Sampling

Although significant anthropogenic surface water impoundments were not observed at either of these sites, surface waters from areas of natural ephemeral ponding were sampled (primarily at JAB) during the short snowmelt/runoff period in the spring of 2007. Data for radiological parameters are presented in this section. Data for all surface water quality parameters are provided in the section of ISR licensing applications related specifically to surface water (Section 3.4). Approximate surface water sampling locations are shown in Figure 6.1-26.

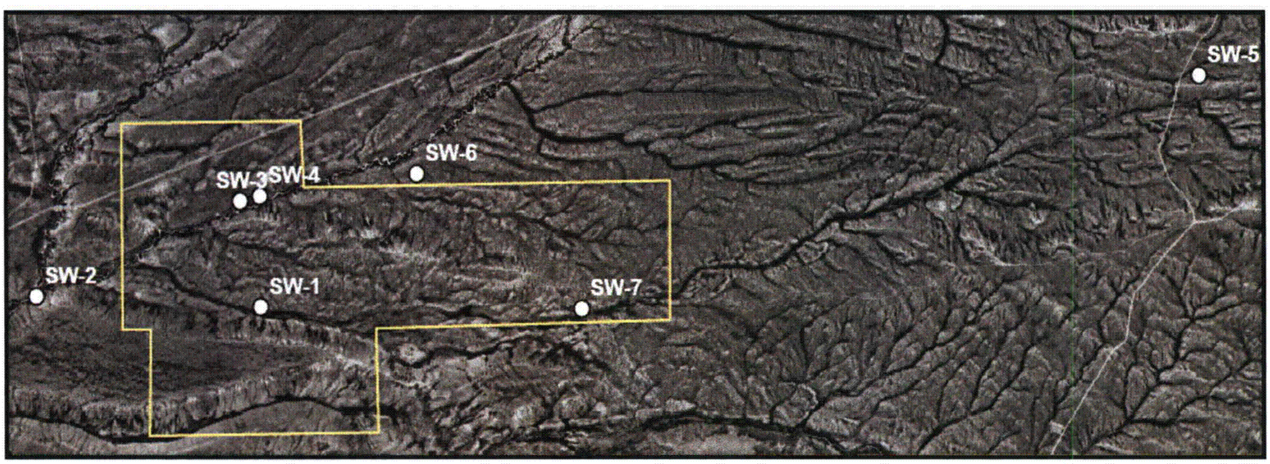


Figure 6.1-26: Surface water sampling locations.

Surface water samples were collected in the appropriate containers provided by the contract laboratory. Field meters were used to measure pH, specific conductance, and temperature of water samples and calibrated before each day's use as directed in the Owner's Manual. Sample containers are flushed with the sample water in order to remove potential contaminants from the container. The bottle is then filled directly from the stream or pond with the with the sample bottle in a manner to prevent collecting debris or filled by using an alternate clean container. All samples analyzed by a contract laboratory are accompanied by a chain of custody to ensure proper analysis is performed and the sample is tracked.

6.1.4.2 Sediment Sampling Results

6.1.4.2.1 Stream Sediment Sample Results

Descriptive summary statistics of stream sediment data for the August 2007 sampling event are provided in Tables 6.1-1 and 6.1-2. Individual stream drainage channel sampling locations and respective Ra-226 results for the August 2007 sampling event are shown in Figures 6.4-27 and 6.1-28. In general, stream sediment baseline results to date for Ra-226 at each site are similar to those for surface soils across most areas of these sites as estimated in Section 6.1.2.2.5.

Table 6.1-1: Antelope: Stream Sediment Sample Statistics (August, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.4	0.17	1.4	1.6	1.2	4
Pb-210	3.1	0.73	3.3	3.7	2.1	4
Th-230	3.1	0.73	3.3	3.7	2.1	4
U-nat	2.1	0.24	2.0	2.4	1.8	4

Table 6.1-2: JAB: Stream Sediment Sample Statistics (August, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.5	0.72	1.3	2.6	0.9	5
Pb-210	0.7	1.52	0.0	3.4	0.0	5
Th-230	0.8	0.80	0.4	2.2	0.3	5
U-nat	1.3	0.74	0.9	2.4	0.7	5

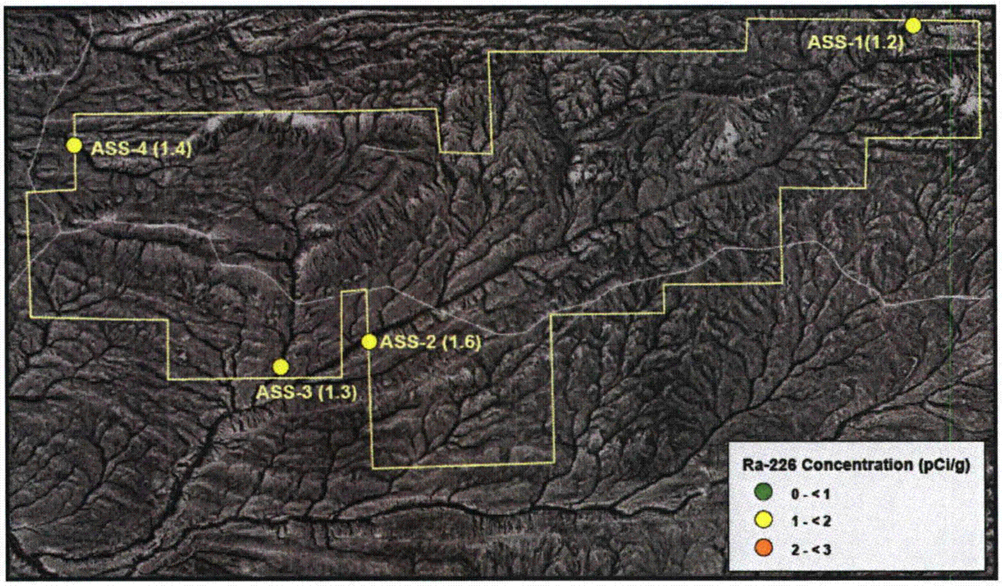


Figure 6.1-27: Antelope: sediment sampling locations and August 2007 Ra-226 concentration results for ephemeral stream drainage channels.

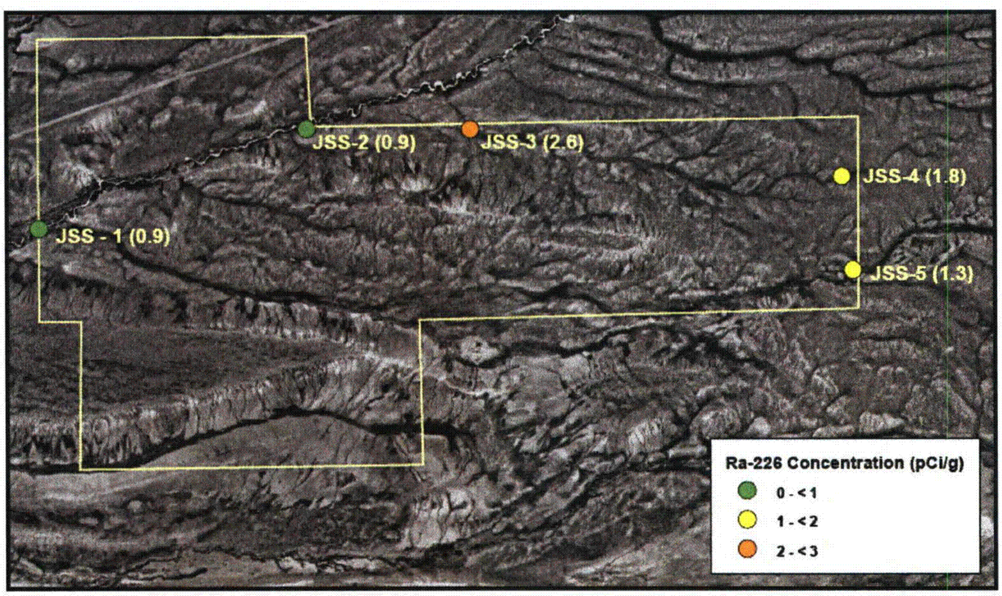


Figure 6.1-28: JAB: sediment sampling locations and respective Ra-226 concentration results for ephemeral stream drainage channels.

6.1.4.2.2 Pond Sediment Sample Results

Results for dissolved radiological water quality parameters are shown in Table 6.1-3. Most sample results for uranium are at or below analytical reporting limits, and all are well below the U.S. Environmental Protection Agency's (EPA's) 30 µg/L drinking water standard for uranium (EPA, 2000). Based on the conversion factor indicated in Table 6.1-3, an equivalent EPA uranium drinking water standard in units of specific activity is 20 pCi/L. Though well below this standard, the highest levels of radiological water quality parameters were found along the Arapahoe Creek drainage that runs through the JAB site (locations SW-2 and SW-4). One surface water sample was obtained from a location near the Antelope site (location SW-5). Respective results were consistent with those from the JAB vicinity samples. Given similarities in radiological surface soil and sediment concentrations between the Antelope and JAB sites (see Sections 6.1.2.2.4, 6.1.2.2.5, and 6.1.4.2), occasionally ponded surface runoff water at either site is likely to have generally similar radiological characteristics to those measured during the 2007 spring runoff event.

Table 6.1-3: Analytical results for baseline radiological parameters in surface water samples collected in spring, 2007. Values with less-than qualifiers were below analytical reporting limits.

Surface Water Sampling ID	Sampling Date	Uranium* (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)
SW-1	5/9/2007	<0.2	5.8	5.8	<0.2	1.5
SW-2	5/9/2007	3.0	19.5	14.4	5.2	<1.0
SW-3	5/9/2007	<0.2	5.6	5.7	<0.2	<1.0
SW-4	5/9/2007	2.8	16.8	11	2.2	<1.0
SW-5	5/9/2007	<0.2	1.6	2.1	<0.2	<1.0
SW-6	5/14/2007	0.2	3.8	4.2	<0.2	<1.0
SW-7	5/14/2007	<0.2	1.2	2.3	<0.2	<1.0

***Converted from units of mg/L to activity units of pCi/L using a conversion factor of 677 pCi/mg**

6.1.4.3 Conclusions

Baseline sediment radionuclide data for the Antelope and JAB Uranium Project sites were collected and analyzed according to Regulatory Guide 4.14 protocols. Once analytical results from the May 2008 round of stream sediment sampling are available (expected in July, 2008), this section will be updated accordingly in a supplemental report to the NRC and WDEQ/LQD. This information should be sufficient to meet the minimum respective baseline survey requirements as indicated by the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality / Land Quality Division with respect to ISR licensing/permitting applications.

Radiological surface water data collected as part of baseline characterizations for these sites were limited due to the relatively infrequent occurrence of ponded surface water existing at these sites. The data obtained should nevertheless provide adequate characterization of baseline radionuclide concentrations in surface waters for review by the NRC and WDEQ/LQD with respect to licensing/permitting applications.

6.1.5 Ambient Gamma and Radon Monitoring

Continuous passive monitoring of ambient gamma dose rates and radon concentrations within the Antelope and JAB Uranium Project areas was initiated in March 2007. Regulatory Guide 4.14 calls for 12 consecutive months of respective monitoring data as part of the overall radiological characterization of the site (NRC, 1980). These data were collected and reported on a quarterly basis.

Passive devices for monitoring ambient gamma dose rates and radon levels are each housed at the same station. Station locations were selected based on Regulatory Guide 4.14 guidance, including consideration for the locations of plant facilities, prevailing wind directions, air monitoring stations, and practical access. In all, 10 of these passive stations were installed at each site, including one or more stations located near each air particulate monitoring station. Locations of passive monitoring stations, as well as air particulate sampling stations, are shown in Figures 6.1-29 and 6.1-30.

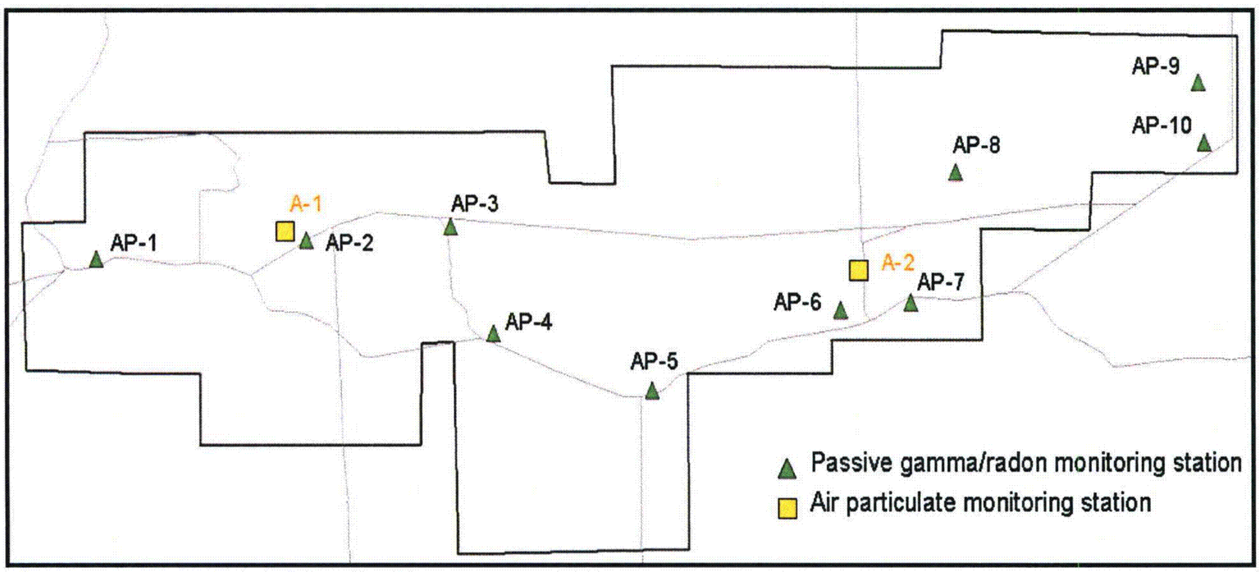


Figure 6.1-29: Antelope: approximate passive gamma/radon and air particulate monitoring station locations.

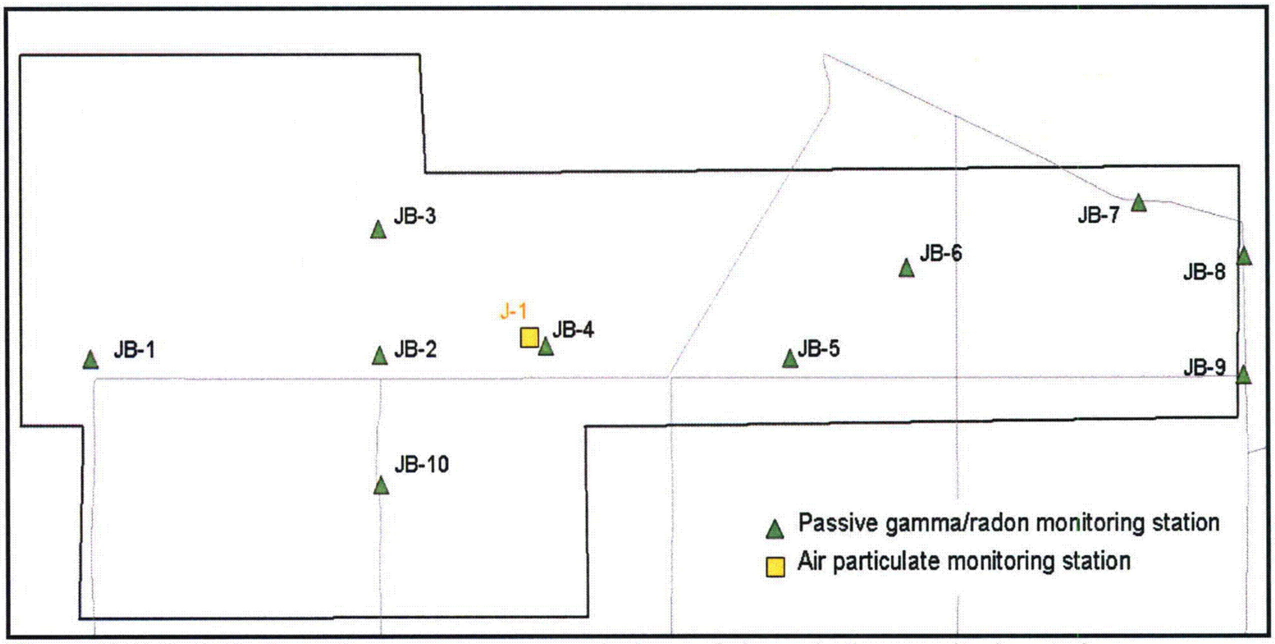


Figure 6.1-30: JAB: approximate passive gamma/radon and air particulate monitoring station locations.

6.1.5.1 Methods

6.1.5.1.1 Ambient Gamma Dose Rate Monitoring

Passive monitoring of gamma dose rates at the site is being conducted with thermo-luminescent dosimeters (TLDs) supplied by Landauer, Incorporated. The TLDs are housed in insulated plastic spigot covers, attached to fence posts (Figure 6.1-31). Radon monitoring devices are also housed in these spigot covers.

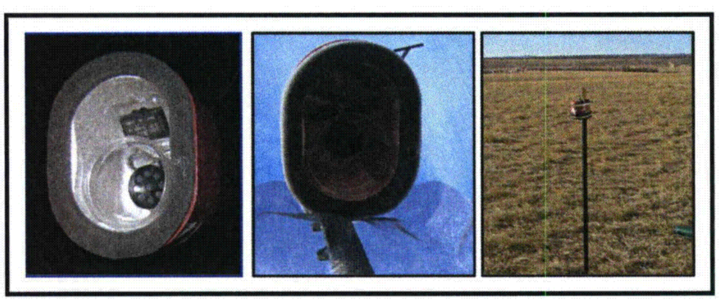


Figure 6.1-31: Photos of passive gamma/radon monitoring station equipment.

Each batch of TLDs contains a "transit" and "deploy" control TLD badge to account for background doses received by field badges when not actually deployed at the site. The transit control is stored at the Tetra Tech office in Fort Collins (away from any radioactive sources) at all times except while in transit to and from Landauer. The deploy control badge accompanies the transit control badge at all

times except for the short period of time it must travel to or from the site along with field badges during their respective deployment or removal from the site.
Landauer reports a "net" dose result, calculated by subtracting the gross deploy control badge result from each field badge result. This gives the net above background dose, which is useful for occupational dose assessments relative to regulatory dose limits, but is not applicable for environmental monitoring where the total dose received at the site during the monitoring period is of interest. For this, a different calculation is required, one that subtracts only the fraction of control badge dose representing the amount of time the field badges are not actually deployed at the site. For this project, the calculations used to obtain this gamma dose value are outlined as follows:

1. Determine the average daily dose rate for the transit control badge:
    - Assuming the control badge receives background doses at a relatively constant rate, this is calculated as the gross reported dose (mrem), divided by the total number of days from TLD issuance to TLD analysis by the dosimetry vendor.
2. Determine the total dose to the field dosimeter whenever accompanied by the transit control badge:
    - Assume the field badge receives the same average daily dose rate as the transit control badge for all periods while stored or transported together with the transit control badge.
    - Calculate the total dose to the field dosimeter whenever accompanied by the transit control badge as: (Result from step 1 above) × (number of days from TLD issuance to TLD analysis, minus the number of days the field badge was actually deployed at the site)
3. Determine any additional background dose received by the field badge during deployment to and from the site:
    - Calculate the difference between the deploy control badge and the transit control badge, assuming this value represents the additional total dose received by the field badge during transport to and from the site.
4. Calculate total dose received by the field TLD while not deployed at the site:
    - Add the total doses calculated in steps 2 and 3 above.
5. Calculate the total dose received by the field TLD while deployed at the site:
    - Subtract the result in step 4 above from the gross result for the field TLD as reported by the vendor.

Due to scheduling issues involving initial TLD issuance from Landauer versus initial deployment of badges to the sites to begin the gamma monitoring program, begin/end dates for the first two quarters of TLD data for these sites were out of sync with Landauer's normal quarterly schedule. The third quarterly change out was delayed one month to synchronize the TLD monitoring schedule with Landauer's quarterly schedule based on a calendar year. This does not affect the results, but did simplify calculations and records keeping.

6.1.5.1.2 Ambient Radon-222 Monitoring

Passive monitoring of Rn-222 air concentrations at these sites is being conducted with Radtrak® alpha-track radon gas detectors supplied by Landauer. These radon detectors are housed along with the environmental TLDs as shown in Figure 6.1-31. The radon detectors are supplied by the vendor in special sealed packages designed to prevent the detectors from radon exposure prior to the beginning of the monitoring period. Upon completion of the site monitoring period, special sealing stickers supplied by the vendor are applied to detector openings to prevent further radon exposure until the device is analyzed by the vendor for average Rn-222 concentration (in pCi/L).

Prior to initial deployment of radon detectors to the sites, it was necessary to open the first quarter's batch of detectors prior to traveling to the sites in order construct the housing assemblies. This operation was performed as quickly as possible to minimize any potential radon exposures not due to site conditions. Within a few hours, housing assemblies were completed and this first batch of radon detectors was double-sealed in plastic bags and placed inside the company truck (parked outside in Fort Collins) until deployment to the site two days later.

6.1.5.2 Ambient Gamma and Radon Results

6.1.5.2.1 Ambient Gamma Dose Rate Monitoring

Passive gamma dose monitoring results are presented graphically in Figure 6.1-32 and in tabular format in Tables 6.1-4 and 6.1-5. In general, measured dose rates at each site typically ranged between 0.015 and 0.025 mrem/hr. Assuming a conventional radiation weighting factor of 1, these dose rates are consistent with the gamma survey results at these sites, which mostly ranged between 15 and 25 μR/hr (see Figures 6.1-19 and 6.1-20).

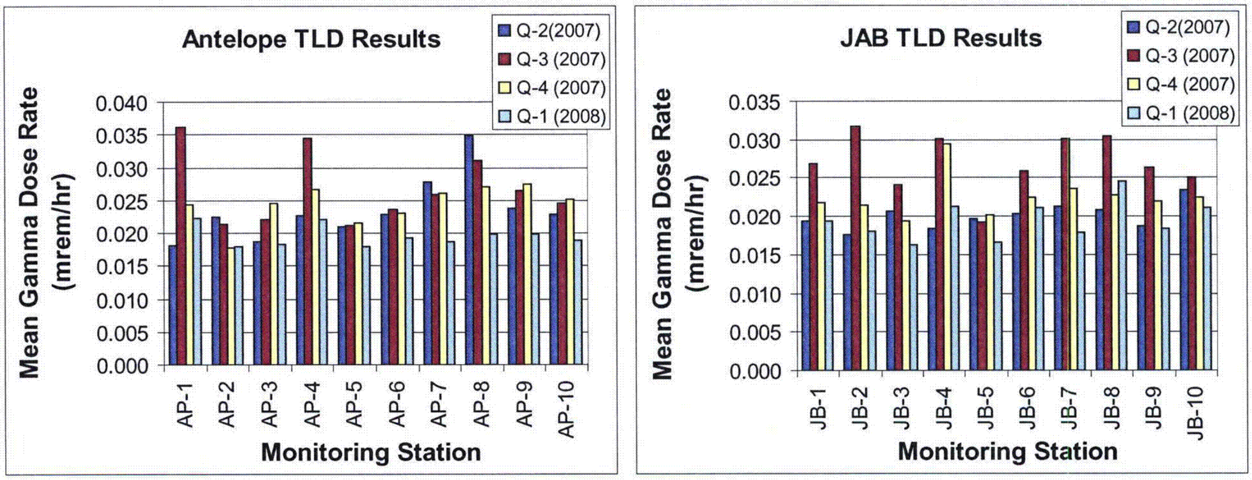


Figure 6.1-32: Gamma dose rate results for quarters 1 and 2 at Antelope (left) and JAB (right).

Table 6.1-4: Antelope: environmental gamma dose rate monitoring data for four consecutive quarters.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date	Landauer GROSS Result (mrems)	Estimated Quarterly Field Dose (mrem)	Estimated Daily Field Dose (mrem)	Estimated Field Dose Rate (mrem/hr)
QUARTER 2 (2007)							
AP-1	1/1/2007	3/6/2007	6/5/2007	62.8	39.3	0.432	0.018
AP-2	1/1/2007	3/6/2007	6/5/2007	72.7	49.2	0.541	0.023
AP-3	1/1/2007	3/6/2007	6/5/2007	64.2	40.7	0.447	0.019
AP-4	1/1/2007	3/6/2007	6/5/2007	73.0	49.5	0.544	0.023
AP-5	1/1/2007	3/7/2007	6/5/2007	69.1	45.6	0.501	0.021
AP-6	1/1/2007	3/7/2007	6/5/2007	73.3	49.8	0.547	0.023
AP-7	1/1/2007	3/7/2007	6/5/2007	84.3	60.8	0.668	0.028
AP-8	1/1/2007	3/7/2007	6/5/2007	99.8	76.3	0.839	0.035
AP-9	1/1/2007	3/7/2007	6/5/2007	75.6	52.1	0.573	0.024
AP-10	1/1/2007	3/7/2007	6/5/2007	73.3	49.8	0.547	0.023
Transit control	1/1/2007	-	6/5/2007	54.0	-	-	-
Deploy control	1/1/2007	-	6/5/2007	54.2	-	-	-
QUARTER 3 (2007)							
AP-1	4/1/2007	6/5/2007	10/8/2007	104.7	79.0	0.868	0.036
AP-2	4/1/2007	6/5/2007	10/8/2007	72.5	46.8	0.514	0.021
AP-3	4/1/2007	6/5/2007	10/8/2007	73.8	48.1	0.528	0.022
AP-4	4/1/2007	6/5/2007	10/8/2007	101.1	75.4	0.828	0.035
AP-5	4/1/2007	6/5/2007	10/8/2007	71.7	46.0	0.505	0.021
AP-6	4/1/2007	6/5/2007	10/8/2007	77.1	51.4	0.565	0.024
AP-7	4/1/2007	6/5/2007	10/8/2007	82.4	56.7	0.623	0.026
AP-8	4/1/2007	6/5/2007	10/8/2007	93.6	67.9	0.746	0.031
AP-9	4/1/2007	6/5/2007	10/8/2007	83.5	57.8	0.635	0.026
AP-10	4/1/2007	6/5/2007	10/8/2007	79.3	53.6	0.589	0.025
Transit control	4/1/2007	-	10/8/2007	67.2	-	-	-
Deploy control	4/1/2007	-	10/8/2007	68.8	-	-	-
QUARTER 4 (2007)							
AP-1	10/1/2007	10/8/2007	1/2/2008	57.8	50.5	0.587	0.024
AP-2	10/1/2007	10/8/2007	1/2/2008	43.8	36.5	0.424	0.018
AP-3	10/1/2007	10/8/2007	1/2/2008	57.9	50.6	0.588	0.025
AP-4	10/1/2007	10/8/2007	1/2/2008	62.2	54.9	0.638	0.027
AP-5	10/1/2007	10/8/2007	1/2/2008	51.8	44.5	0.517	0.022
AP-6	10/1/2007	10/8/2007	1/2/2008	54.8	47.5	0.552	0.023
AP-7	10/1/2007	10/8/2007	1/2/2008	61.0	53.7	0.624	0.026
AP-8	10/1/2007	10/8/2007	1/2/2008	63.1	55.8	0.649	0.027
AP-9	10/1/2007	10/8/2007	1/2/2008	63.9	56.6	0.658	0.027
AP-10	10/1/2007	10/8/2007	1/2/2008	59.1	51.8	0.602	0.025
Transit control	10/1/2007	-	1/2/2008	52.4	-	-	-
Deploy control	10/1/2007	-	1/2/2008	53.3	-	-	-
QUARTER 1 (2008)							
AP-1	1/1/2008	1/2/2008	4/22/2008	62.5	59.2	0.533	0.022
AP-2	1/1/2008	1/2/2008	4/22/2008	50.8	47.5	0.428	0.018
AP-3	1/1/2008	1/2/2008	4/22/2008	51.9	48.6	0.438	0.018
AP-4	1/1/2008	1/2/2008	4/22/2008	62.4	59.1	0.533	0.022
AP-5	1/1/2008	1/2/2008	4/22/2008	50.9	47.6	0.429	0.018
AP-6	1/1/2008	1/2/2008	4/22/2008	54.6	51.3	0.462	0.019
AP-7	1/1/2008	1/2/2008	4/22/2008	53.2	49.9	0.450	0.019
AP-8	1/1/2008	1/2/2008	4/22/2008	56.1	52.8	0.476	0.020
AP-9	1/1/2008	1/2/2008	4/22/2008	56.0	52.7	0.475	0.020
AP-10	1/1/2008	1/2/2008	4/22/2008	53.6	50.3	0.453	0.019
Transit control	1/1/2008	-	4/22/2008	46.5	-	-	-
Deploy control	1/1/2008	-	4/22/2008	47.4	-	-	-

Table 6.1-5: JAB: environmental gamma dose rate monitoring data for four consecutive quarters.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date	Landauer GROSS Result (mrems)	Estimated Quarterly Field Dose (mrem)	Estimated Daily Field Dose (mrem)	Estimated Field Dose Rate (mrem/hr)
QUARTER 2 (2007)							
JB-1	1/1/2007	3/6/2007	6/5/2007	65.8	42.3	0.465	0.019
JB-2	1/1/2007	3/6/2007	6/5/2007	61.8	38.3	0.421	0.018
JB-3	1/1/2007	3/6/2007	6/5/2007	68.5	45.0	0.495	0.021
JB-4	1/1/2007	3/6/2007	6/5/2007	63.7	40.2	0.442	0.018
JB-5	1/1/2007	3/7/2007	6/5/2007	66.6	43.1	0.474	0.020
JB-6	1/1/2007	3/7/2007	6/5/2007	67.9	44.4	0.488	0.020
JB-7	1/1/2007	3/7/2007	6/5/2007	69.9	46.4	0.510	0.021
JB-8	1/1/2007	3/7/2007	6/5/2007	68.9	45.4	0.499	0.021
JB-9	1/1/2007	3/7/2007	6/5/2007	64.3	40.8	0.448	0.019
JB-10	1/1/2007	3/7/2007	6/5/2007	74.6	51.1	0.562	0.023
Transit control	1/1/2007	-	6/5/2007	54.0	-	-	-
Deploy control	1/1/2007	-	6/5/2007	54.2	-	-	-
QUARTER 3 (2007)							
JB-1	4/1/2007	6/5/2007	10/8/2007	84.5	58.8	0.646	0.027
JB-2	4/1/2007	6/5/2007	10/8/2007	95.2	69.5	0.763	0.032
JB-3	4/1/2007	6/5/2007	10/8/2007	78.3	52.6	0.578	0.024
JB-4	4/1/2007	6/5/2007	10/8/2007	91.5	65.8	0.723	0.030
JB-5	4/1/2007	6/5/2007	10/8/2007	67.5	41.8	0.459	0.019
JB-6	4/1/2007	6/5/2007	10/8/2007	82.4	56.7	0.623	0.026
JB-7	4/1/2007	6/5/2007	10/8/2007	91.4	65.7	0.722	0.030
JB-8	4/1/2007	6/5/2007	10/8/2007	92.2	66.5	0.731	0.030
JB-9	4/1/2007	6/5/2007	10/8/2007	83.3	57.6	0.633	0.026
JB-10	4/1/2007	6/5/2007	10/8/2007	80.5	54.8	0.602	0.025
Transit control	4/1/2007	-	10/8/2007	67.2	-	-	-
Deploy control	4/1/2007	-	10/8/2007	68.8	-	-	-
QUARTER 4 (2007)							
JB-1	10/1/2007	10/8/2007	1/2/2008	52.5	45.2	0.525	0.022
JB-2	10/1/2007	10/8/2007	1/2/2008	51.8	44.5	0.517	0.022
JB-3	10/1/2007	10/8/2007	1/2/2008	47.4	40.1	0.466	0.019
JB-4	10/1/2007	10/8/2007	1/2/2008	68.1	60.8	0.707	0.029
JB-5	10/1/2007	10/8/2007	1/2/2008	48.9	41.6	0.484	0.020
JB-6	10/1/2007	10/8/2007	1/2/2008	53.6	46.3	0.538	0.022
JB-7	10/1/2007	10/8/2007	1/2/2008	56.0	48.7	0.566	0.024
JB-8	10/1/2007	10/8/2007	1/2/2008	54.2	46.9	0.545	0.023
JB-9	10/1/2007	10/8/2007	1/2/2008	52.6	45.3	0.527	0.022
JB-10	10/1/2007	10/8/2007	1/2/2008	53.7	46.4	0.539	0.022
Transit control	10/1/2007	-	1/2/2008	52.4	-	-	-
Deploy control	10/1/2007	-	1/2/2008	53.3	-	-	-
QUARTER 1 (2008)							
JB-1	1/1/2008	1/2/2008	4/22/2008	55.1	51.8	0.467	0.019
JB-2	1/1/2008	1/2/2008	4/22/2008	51.4	48.1	0.433	0.018
JB-3	1/1/2008	1/2/2008	4/22/2008	46.5	43.2	0.389	0.016
JB-4	1/1/2008	1/2/2008	4/22/2008	60.3	57.0	0.514	0.021
JB-5	1/1/2008	1/2/2008	4/22/2008	47.5	44.2	0.398	0.017
JB-6	1/1/2008	1/2/2008	4/22/2008	59.8	56.5	0.509	0.021
JB-7	1/1/2008	1/2/2008	4/22/2008	50.9	47.6	0.429	0.018
JB-8	1/1/2008	1/2/2008	4/22/2008	68.7	65.4	0.589	0.025
JB-9	1/1/2008	1/2/2008	4/22/2008	52.4	49.1	0.442	0.018
JB-10	1/1/2008	1/2/2008	4/22/2008	59.6	56.3	0.507	0.021
Transit control	1/1/2008	-	4/22/2008	46.5	-	-	-
Deploy control	1/1/2008	-	4/22/2008	47.4	-	-	-

The TLD data for both sites suggest that quarterly differences in average gamma dose rates at a given location can vary significantly, exceeding ± 0.01 mrem/hr in some cases. However, a number of passive station housings were found lying on the ground after being rubbed off the fence posts by pronghorns or cattle. This circumstance was particularly prevalent during the third quarter of 2007, with 13 of the 20 housings at the two sites found on the ground. In most cases affected housings were found relatively close to the posts, but in some cases housings were found at distances on the order of 50 meters or more away. Whether or not this might have influenced TLD results is unknown – assessment of the data in this regard was inconclusive. In addition to actual temporal variability in background sources of gamma radiation, spatial variation and/or measurement error may also have contributed to cases of significant variation.

6.1.5.2.2 Ambient Rn-222 Monitoring

A comparative summary of average Rn-222 results by quarter for the two sites is shown in Figure 6.1-33. Tabular data for individual stations are presented in Tables 6.1-6 and 6.1-7. The problem of animals rubbing passive station housings off of fence posts caused significant data loss in the third quarter 2007 monitoring period, with many detectors being damaged by water infiltration and rendered unreadable. Despite this problem, the available data provide a good indication of the magnitude of ambient Rn-222 air concentrations that exist at these sites. Measured ambient radon concentrations were generally slightly higher than the national average value of approximately 0.4 pCi/L (Foster, 1993). The highest quarterly values at both sites were observed in the third quarter of 2007. Slightly higher radon readings during summer months are consistent with findings at another ISR site in Wyoming (Moore Ranch; EMC, 2007). For each quarter, mean values at the JAB site were slightly higher than values measured at the Antelope site. The annual average Rn-222 concentrations measured at Antelope and JAB were 0.87 and 0.52 pCi/L respectively.

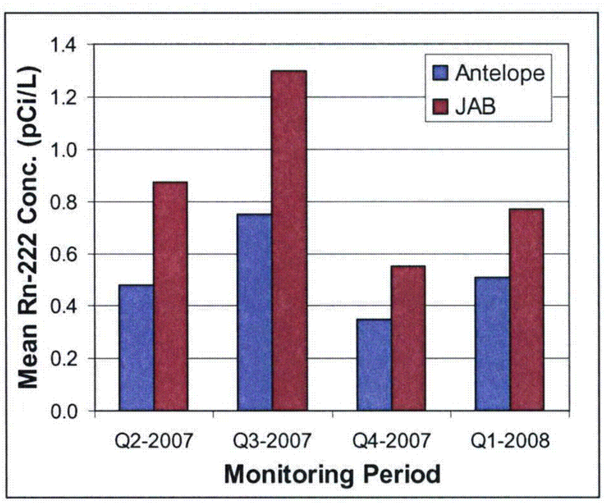


Figure 6.1-33: Average ambient Rn-222 results by quarter at Antelope and JAB.

Table 6.1-6: Antelope: ambient radon-222 monitoring data for four consecutive quarters.

Passive Monitoring Station ID	Radon Detector ID	Package Open Date	Field Installation Date	Quarter End (seal) Date	Quarterly Result (pCi-days/L)	Quarterly Result (pCi/L)
QUARTER 2 (2007)						
AP-1	4680343	3/4/2007	3/6/2007	6/5/2007	39.1	0.4
AP-2	4680344	3/4/2007	3/6/2007	6/5/2007	47.1	0.5
AP-3	4680353	3/4/2007	3/6/2007	6/5/2007	23.2	0.2
AP-4	4680354	3/4/2007	3/6/2007	6/5/2007	102.9	1.1
AP-5	4680355	3/4/2007	3/6/2007	6/5/2007	21.3	0.2
AP-6	4680356	3/4/2007	3/6/2007	6/5/2007	55.7	0.6
AP-7	4680345	3/4/2007	3/6/2007	6/5/2007	35.8	0.4
AP-8	4680346	3/4/2007	3/6/2007	6/5/2007	44.4	0.5
AP-9	4680347	3/4/2007	3/6/2007	6/5/2007	33.2	0.4
AP-10	4680347	3/4/2007	3/6/2007	6/5/2007	50.4	0.5
QUARTER 3 (2007)						
AP-1	4680419	6/5/2007	6/5/2007	10/8/2007	92.2	0.7
AP-2	4680420	6/5/2007	6/5/2007	10/8/2007	-	-
AP-3	4680421	6/5/2007	6/5/2007	10/8/2007	-	-
AP-4	4680422	6/5/2007	6/5/2007	10/8/2007	-	-
AP-5	4680437	6/5/2007	6/5/2007	10/8/2007	-	-
AP-6	4680438	6/5/2007	6/5/2007	10/8/2007	-	-
AP-7	4680430	6/5/2007	6/5/2007	10/8/2007	-	-
AP-8	4680471	6/5/2007	6/5/2007	10/8/2007	94.9	0.8
AP-9	4680469	6/5/2007	6/5/2007	10/8/2007	-	-
AP-10	4680470	6/5/2007	6/5/2007	10/8/2007	-	-
QUARTER 4 (2007)						
AP-1	4680389	10/8/2007	10/8/2007	1/2/2008	6.0	0.1
AP-2	4680390	10/8/2007	10/8/2007	1/2/2008	51.4	0.6
AP-3	4680391	10/8/2007	10/8/2007	1/2/2008	6.0	0.1
AP-4	4680398	10/8/2007	10/8/2007	1/2/2008	78.6	0.9
AP-5	4680397	10/8/2007	10/8/2007	1/2/2008	26.2	0.3
AP-6	4680393	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
AP-7	4680400	10/8/2007	10/8/2007	1/2/2008	40.8	0.5
AP-8	4680392	10/8/2007	10/8/2007	1/2/2008	38.2	0.4
AP-9	4680396	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
AP-10	4680395	10/8/2007	10/8/2007	1/2/2008	24.2	0.3
QUARTER 1 (2008)						
AP-1	4680362	1/2/2008	1/2/2008	4/22/2008	6.0	0.1
AP-2	4680363	1/2/2008	1/2/2008	4/22/2008	104	0.9
AP-3	4680364	1/2/2008	1/2/2008	4/22/2008	58.1	0.5
AP-4	4680365	1/2/2008	1/2/2008	4/22/2008	103.3	0.9
AP-5	4680411	1/2/2008	1/2/2008	4/22/2008	46.9	0.4
AP-6	4680412	1/2/2008	1/2/2008	4/22/2008	73.4	0.7
AP-7	4680414	1/2/2008	1/2/2008	4/22/2008	52.8	0.5
AP-8	4680413	1/2/2008	1/2/2008	4/22/2008	40.9	0.4
AP-9	4680410	1/2/2008	1/2/2008	4/22/2008	43.6	0.4
AP-10	4680408	1/2/2008	1/2/2008	4/22/2008	33	0.3

Red font = result below analytical reporting limits

Table 6.1-7: JAB: ambient radon-222 monitoring data for four consecutive quarters.

Passive Monitoring Station ID	Radon Detector ID	Package Open Date	Field Installation Date	Quarter End (seal) Date	Quarterly Result (pCi-days/L)	Quarterly Result (pCi/L)
QUARTER 2 (2007)						
JB-1	4680384	3/4/2007	3/6/2007	6/5/2007	82.9	0.9
JB-2	4680385	3/4/2007	3/6/2007	6/5/2007	91.6	1.0
JB-3	4680386	3/4/2007	3/6/2007	6/5/2007	-	-
JB-4	4680388	3/4/2007	3/6/2007	6/5/2007	-	-
JB-5	4680357	3/4/2007	3/6/2007	6/5/2007	106.8	1.1
JB-6	4680358	3/4/2007	3/6/2007	6/5/2007	144.1	1.5
JB-7	4680359	3/4/2007	3/6/2007	6/5/2007	48.4	0.5
JB-8	4680361	3/4/2007	3/6/2007	6/5/2007	36.5	0.4
JB-9	4680340	3/4/2007	3/6/2007	6/5/2007	94.9	1.0
JB-10	4680341	3/4/2007	3/6/2007	6/5/2007	59.0	0.6
QUARTER 3 (2007)						
JB-1	4680372	6/5/2007	6/5/2007	10/8/2007	223	1.8
JB-2	4680373	6/5/2007	6/5/2007	10/8/2007	158	1.3
JB-3	4680374	6/5/2007	6/5/2007	10/8/2007	-	-
JB-4	4680383	6/5/2007	6/5/2007	10/8/2007	-	-
JB-5	4680382	6/5/2007	6/5/2007	10/8/2007	-	-
JB-6	4680381	6/5/2007	6/5/2007	10/8/2007	-	-
JB-7	4680380	6/5/2007	6/5/2007	10/8/2007	114	0.9
JB-8	4680402	6/5/2007	6/5/2007	10/8/2007	156	1.2
JB-9	4680403	6/5/2007	6/5/2007	10/8/2007	-	-
JB-10	4680371	6/5/2007	6/5/2007	10/8/2007	-	-
QUARTER 4 (2007)						
JB-1	4680399	10/8/2007	10/8/2007	1/2/2008	70.0	0.8
JB-2	4680367	10/8/2007	10/8/2007	1/2/2008	48.1	0.6
JB-3	4680366	10/8/2007	10/8/2007	1/2/2008	48.1	0.6
JB-4	4680370	10/8/2007	10/8/2007	1/2/2008	44.1	0.5
JB-5	4680369	10/8/2007	10/8/2007	1/2/2008	57.4	0.7
JB-6	4680418	10/8/2007	10/8/2007	1/2/2008	79.9	0.9
JB-7	4680394	10/8/2007	10/8/2007	1/2/2008	34.8	0.4
JB-8	4680416	10/8/2007	10/8/2007	1/2/2008	20.9	0.2
JB-9	4680417	10/8/2007	10/8/2007	1/2/2008	57.4	0.7
JB-10	4680415	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
QUARTER 1 (2008)						
JB-1	4680474	1/2/2008	1/2/2008	4/22/2008	83.4	0.8
JB-2	4680472	1/2/2008	1/2/2008	4/22/2008	86.7	0.8
JB-3	4680331	1/2/2008	1/2/2008	4/22/2008	132.6	1.2
JB-4	4680332	1/2/2008	1/2/2008	4/22/2008	-	-
JB-5	4680334	1/2/2008	1/2/2008	4/22/2008	75.4	0.7
JB-6	4680333	1/2/2008	1/2/2008	4/22/2008	97.3	0.9
JB-7	4680330	1/2/2008	1/2/2008	4/22/2008	61.5	0.6
JB-8	4680406	1/2/2008	1/2/2008	4/22/2008	100.6	0.9
JB-9	4680409	1/2/2008	1/2/2008	4/22/2008	87.3	0.8
JB-10	4680473	1/2/2008	1/2/2008	4/22/2008	44.9	0.4

Red font = result below analytical reporting limits

6.1.5.3 Conclusions

Baseline ambient gamma dose rate and radon-222 air concentration data for the Antelope and JAB Uranium Projects were collected and analyzed according to Regulatory Guide 4.14 protocols. Gamma dose rate results are generally consistent with gamma exposure rate survey data. In general, ambient radon concentration results were slightly higher than the reported national average. Measured values at JAB were slightly higher than values measured at the Antelope site.

6.1.6 Air Particulate Monitoring

Continuous monitoring of baseline air particulate radionuclide concentrations was initiated in late May 2007 at the Antelope site and early June at the JAB site. Regulatory Guide 4.14 calls for 12 consecutive months of respective monitoring data as part of the overall radiological characterization of the site (NRC, 1980). These data are being collected and reported on a quarterly basis. An off-site location is also part of the air particulate monitoring program.

Low-volume air particulate sampling station locations were selected based on Regulatory Guide 4.14 guidance, including consideration for the locations of plant facilities, prevailing wind directions, and practical access. Given the remote nature of the sites and lack of existing power supply, these stations were set up using solar/wind generation equipment to supply electrical power to the air samplers. Locations of air particulate monitoring stations at each site are shown in Figures 2.9-28 and 2.9-29 of the previous section of this report.

Given the prevailing wind directions in the region (WSW), the JAB station serves as a location upwind of proposed plant operations the JAB site. Antelope 1 serves as a location generally downwind of proposed plant operations at JAB, and an upwind location for Antelope. Antelope 2 serves as a location generally downwind of proposed plant operations at Antelope. Located about 10-20 miles east of these sites, the town of Bairoil, WY is the nearest location with known residences and an air monitoring station has been set up at the western edge of this community.

6.1.6.1 Methods

The air particulate monitoring program is being conducted with Model DF-40L-8 electric powered air samplers from F&J Specialty Products, Inc. (Figure 6.1-34). These samplers are calibrated by the manufacturer and programmed to draw about 30 liters of air intake per minute through a 47 mm glass fiber air sampling filter. The air samplers are housed in protective coolers mounted on elevated steel platforms such that the intake and sample filter holder assembly is positioned at about 5 feet above the ground surface (Figure 6.1-35). This is intended to approximate an average breathing zone height.

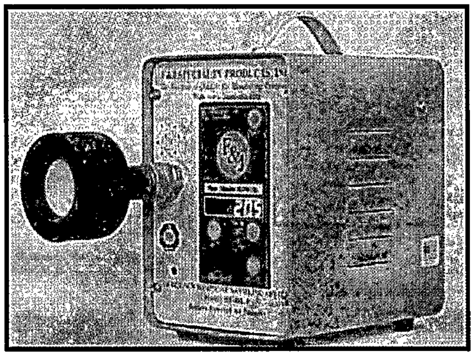


Figure 6.1-34: F&J air particulate sampler.

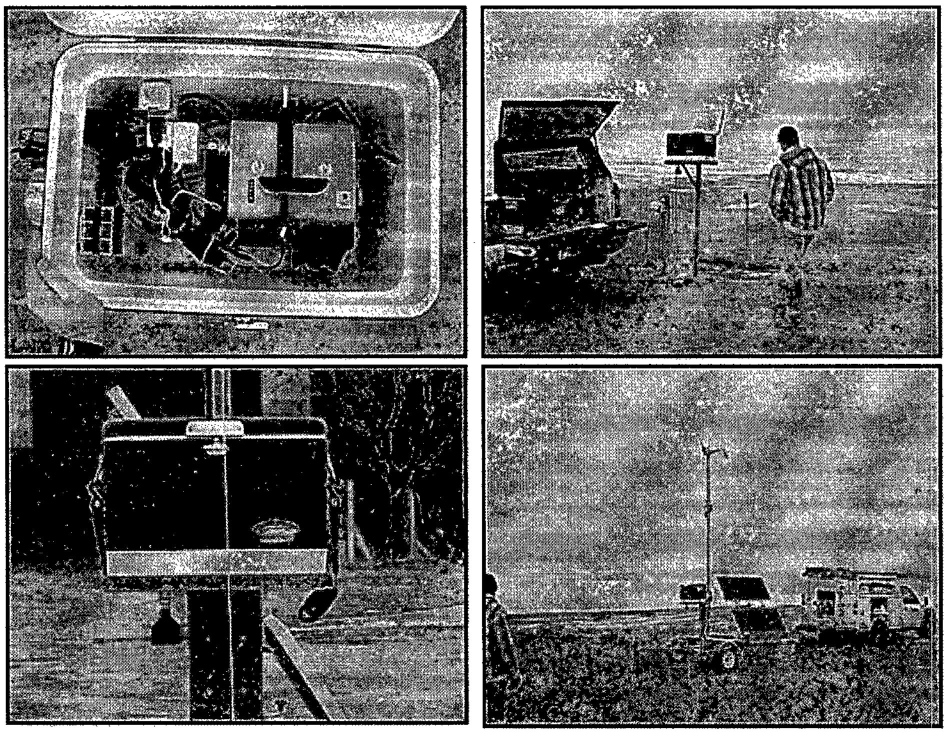


Figure 6.1-35: Air sampling station equipment and solar/wind powered system setup.

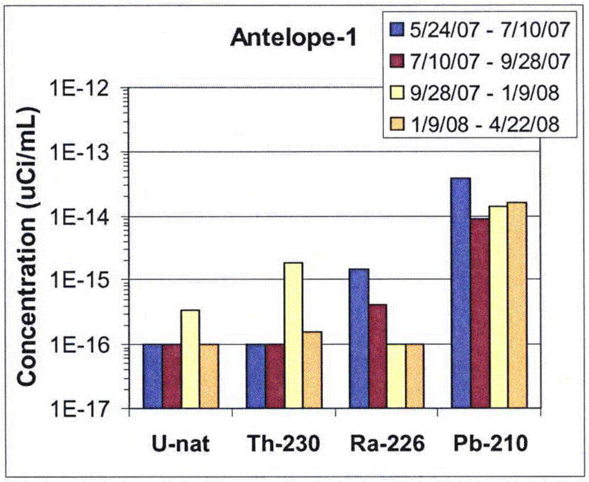
Filters are collected weekly to help prevent dust loading and are composited on an approximate quarterly basis to provide respective estimates of average radionuclide concentrations as specified in Regulatory Guide 4.14. Each quarterly batch of air filters from the four monitoring stations is submitted to ELI in Casper, WY for analysis of Ra-226, U-nat, Th-230, and Pb-210.

6.1.6.2 Air Particulate Sampling Results

Baseline air particulate sampling results are presented in Table 6.1-8 and graphically illustrated in Figures 6.1-36 and 6.1-37. In most cases, analytical results are above the lower limits of detection (LLD). The LLD values listed in Table 6.1-8 are those specified in Regulatory Guide 4.14. The effluent concentration values are provided by ELI as a relevant part of reporting for these data because they represent regulatory limits for each listed radionuclide in terms of doses to the public. This gives an indication of baseline conditions in this context and will help with evaluations of above background internal dose assessments via inhalation and ingestion pathways for data collected during ISR recovery operations.

Table 6.1-8: Air particulate radionuclide data to date for the Antelope and JAB Uranium Project sites, along with data collected at Bairoil, WY.

Air Station ID	Monitoring Period	Air Volume Sampled (mL)	Radionuclide	Concentration (uCi/mL)	Error Estimate (uCi/mL)	LLD (uCi/mL)	Effluent Conc.* (uCi/mL)	% Effluent Concentration
Antelope-1	5/24/07 - 7/10/07	1.08E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	1.48E-15	8.33E-16	1.00E-16	9.00E-13	1.65E-01
			Pb-210	3.76E-14	4.35E-15	2.00E-15	6.00E-13	6.27E+00
	7/10/07 - 9/28/07	2.23E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	4.04E-16	3.14E-16	1.00E-16	9.00E-13	4.48E-02
			Pb-210	9.10E-15	1.48E-15	2.00E-15	6.00E-13	1.52E+00
	9/28/07 - 1/9/08	2.90E+09	U-nat	3.45E-16	N/A	1.00E-16	9.00E-14	3.83E-01
			Th-230	1.86E-15	5.86E-16	1.00E-16	3.00E-14	6.21E-02
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.44E-14	1.69E-15	2.00E-15	6.00E-13	2.40E+00
	1/9/08 - 4/22/08	2.51E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	1.59E-16	1.99E-16	1.00E-16	3.00E-14	5.31E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.64E-14	2.91E-15	2.00E-15	6.00E-13	2.73E+00
Antelope-2	5/24/07 - 7/10/07	1.29E+09	U-nat	2.33E-16	N/A	1.00E-16	9.00E-14	2.58E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	2.09E-15	9.30E-16	1.00E-16	9.00E-13	2.33E-01
			Pb-210	2.27E-14	3.10E-15	2.00E-15	6.00E-13	3.79E+00
	7/10/07 - 9/28/07	2.39E+09	U-nat	2.09E-15	N/A	1.00E-16	9.00E-14	2.32E+00
			Th-230	1.09E-15	5.02E-16	1.00E-16	3.00E-14	3.63E+00
			Ra-226	5.02E-16	3.35E-16	1.00E-16	9.00E-13	5.58E-02
			Pb-210	1.20E-14	1.63E-15	2.00E-15	6.00E-13	1.99E+00
	9/28/07 - 1/8/08	1.68E+09	U-nat	1.19E-16	N/A	1.00E-16	9.00E-14	1.32E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.57E-14	2.37E-15	2.00E-15	6.00E-13	2.61E+00
	1/8/08 - 4/22/08	2.01E+09	U-nat	7.91E-15	N/A	1.00E-16	9.00E-14	8.79E+00
			Th-230	2.81E-14	2.59E-15	1.00E-16	3.00E-14	9.35+01
			Ra-226	2.99E-16	4.48E-16	1.00E-16	9.00E-13	3.32E-02
			Pb-210	1.12E-14	2.69E-15	2.00E-15	6.00E-13	1.87E+00
JAB	6/11/07 - 7/10/07	2.58E+08	U-nat	7.75E-15	N/A	1.00E-16	9.00E-14	8.61E+00
			Th-230	1.90E-14	5.43E-15	1.00E-16	3.00E-14	6.33E+01
			Ra-226	3.10E-15	2.71E-15	1.00E-16	9.00E-13	3.45E-01
			Pb-210	1.09E-13	1.51E-14	2.00E-15	6.00E-13	1.82E+01
	7/10/07 - 9/28/07	2.56E+09	U-nat	9.77E-16	N/A	1.00E-16	9.00E-14	1.09E+00
			Th-230	2.58E-15	7.42E-16	1.00E-16	3.00E-14	8.59E+00
			Ra-226	1.17E-15	5.08E-16	1.00E-16	9.00E-13	1.30E-01
			Pb-210	1.71E-14	1.88E-15	2.00E-15	6.00E-13	2.86E+00
	9/28/07 - 1/24/08	3.29E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	1.25E-15	5.47E-16	1.00E-16	9.00E-13	1.38E-01
			Pb-210	1.59E-14	1.67E-15	2.00E-15	6.00E-13	2.66E+00
	1/24/08 - 4/22/08	2.31E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	3.38E-14	4.37E-15	2.00E-15	6.00E-13	5.63E+00
Bairoil	7/20/07 - 9/28/07	4.20E+09	U-nat	1.78E-14	N/A	1.00E-16	9.00E-14	1.98E+01
			Th-230	6.02E-15	8.81E-16	1.00E-16	3.00E-14	2.01E+01
			Ra-226	4.50E-15	7.86E-16	1.00E-16	9.00E-13	5.00E-01
			Pb-210	6.12E-15	8.81E-16	2.00E-15	6.00E-13	1.02E+00
	9/28/07 - 1/8/08	3.33E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	1.32E-14	1.50E-15	2.00E-15	6.00E-13	2.19E+00
	1/8/08 - 4/22/08	3.48E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	9.91E-15	1.93E-15	2.00E-15	6.00E-13	1.65E+00



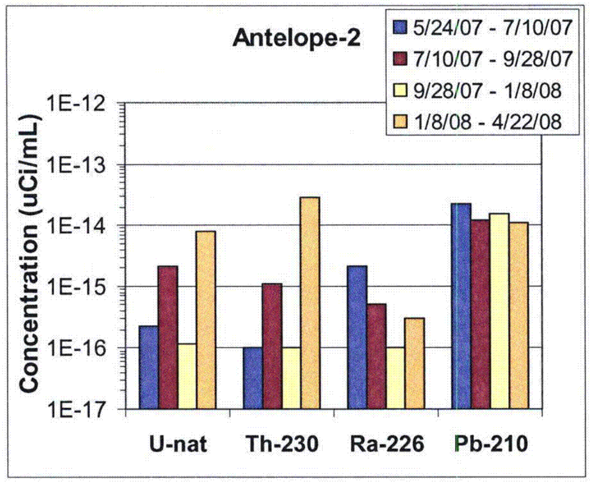
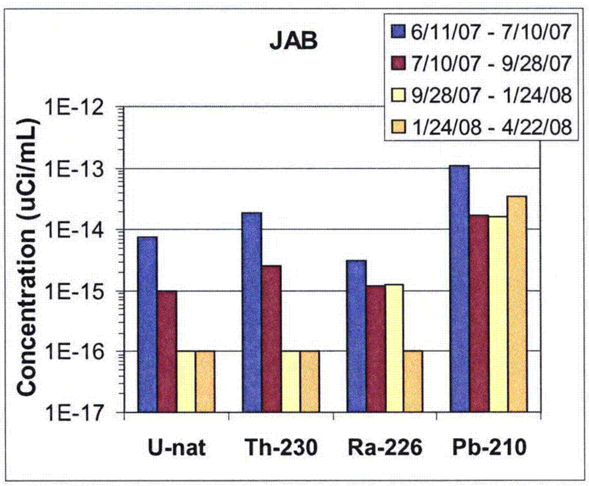


Figure 6.1-36: Antelope: monitoring station results for radionuclides in air particulate samples.



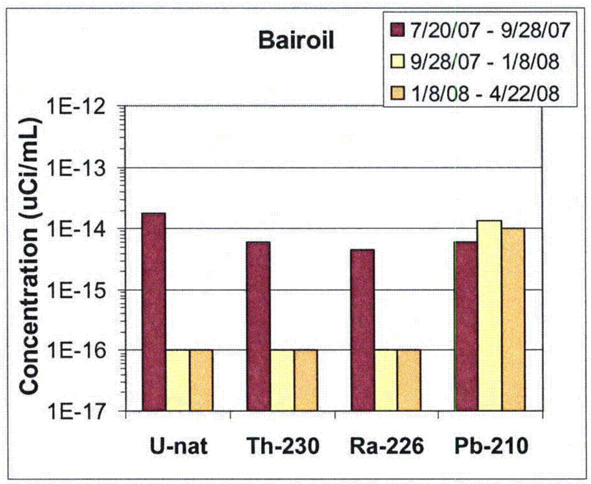


Figure 6.1-37: JAB and Bairoil: monitoring station results for radionuclides in air particulate samples.

6.1.6.3 Conclusions

Baseline air particulate concentration data for the Antelope and JAB Uranium Project areas were collected and analyzed according to Regulatory Guide 4.14 protocols. Four quarters of data are presented in this section of the overall report. Three quarters of data for the nearby community of Bairoil are also presented.

6.1.7 Radon Flux Measurements

Regulatory Guide 4.14 indicates that radon flux measurements should be conducted at eight locations within 1.5 km of the mill, during three separate months between spring and fall when the ground is thawed (NRC, 1980). Because there will be no tailings impoundments or evaporation ponds at these ISR sites, radon flux is unlikely to be an applicable radiological parameter for baseline characterization. Radon flux measurements are not planned at this time.

6.1.8 Groundwater Sampling

Baseline groundwater sampling was conducted at the Antelope and JAB Uranium Project areas in general accordance with Regulatory Guide 4.14 protocols (NRC, 1980). In this case, there are no tailings impoundments and respective guidance has been interpreted accordingly. Wells that are or could be used for drinking, livestock watering, or crop irrigation have also been sampled. A map of approximate well locations is shown in Figures 6.1-38 and 6.1-39. Comprehensive information on well locations and all water quality parameters is provided in sections of ISR licensing applications related specifically to groundwater (Section 3.4.3).

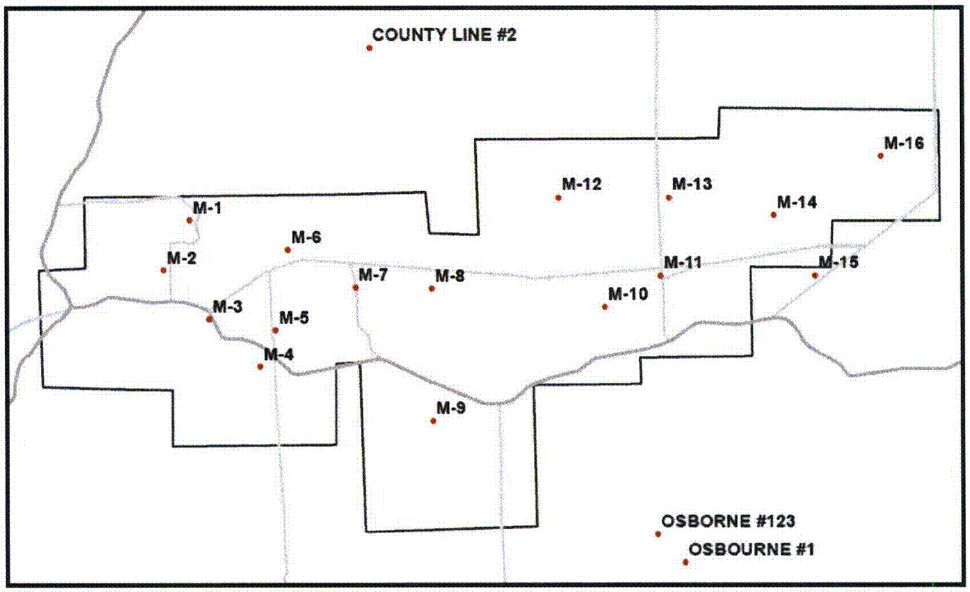


Figure 6.1-38: Antelope: groundwater monitoring well locations.

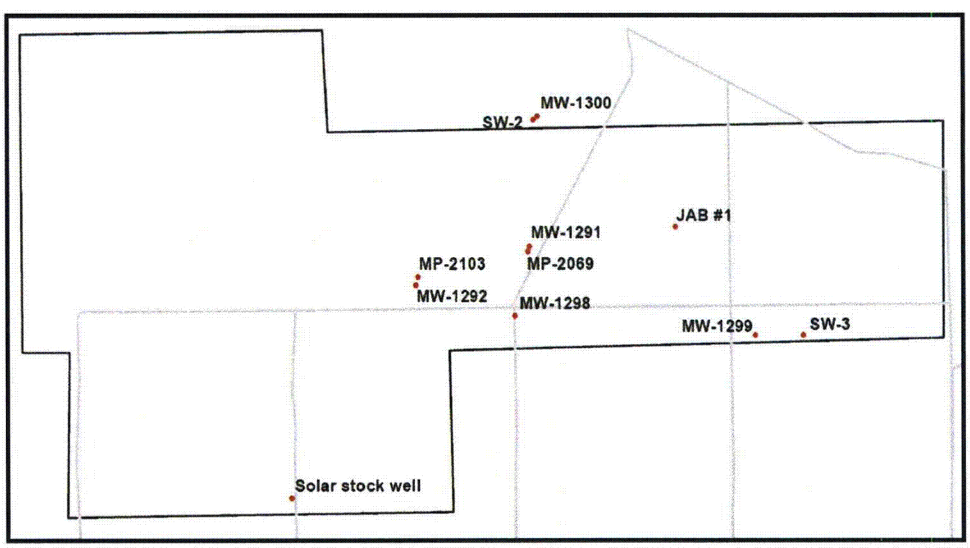


Figure 6.1-39: JAB: groundwater monitoring well locations.

6.1.8.1 Methods

Prior to sampling a well, static water levels are monitored using an electrical measuring line (an "e-line"). All readings are reported to within at least one tenth of a foot and preferably to within a hundredth of a foot. After the static water level is measured, wells are purged at a sufficient volume induce the flow of formation water through the well screen. Wells with a high enough yield are purged for a minimum of three well volumes, and also until one or more indicator parameters are stable. Parameters monitored for stabilization include pH, temperature, and conductivity. For low yielding wells, the wells are pumped dry then allowed to recover. Samples are taken after sufficient well recovery. Accurate records of well purging are maintained to document the number of casing volumes purged from the well before sampling.

Groundwater field measurements and samples are taken as soon as the well is adequately purged. Sampling container(s) are completely filled, so all air is excluded from the container. Field measurements including pH, conductivity, and temperature are taken and recorded. Meters used to take field measurements are calibrated daily.

6.1.8.2 Groundwater Sampling Radiological Results

Results to date for dissolved radiological groundwater parameters are shown in Tables 6.1-9 and 6.1-10. Parameters in suspended form were also evaluated, but many were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 3.4 of the application pertaining specifically to groundwater).

Table 6.1-9: Antelope: analytical results to date for radiological parameters in groundwater samples. Values with less-than qualifiers were below analytical reporting limits.

Well ID	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	U-nat mg/L
Quarter 4, Calendar Year 2007						
M-4	4.1	1.5	22.8	2.9	<0.2	0.0116
M-5	<1.0	<1.0	7.2	4.9	<0.2	0.0058
M-8	-	-	4.1	4.3	-	0.0015
M-9	-	-	6.1	6.8	-	0.0208
M-10	<1.0	<1.0	14.1	<1.0	<0.2	0.0305
M-12	-	-	204	2.5	-	0.129
M-13	-	-	1.8	2.5	-	0.1
M-14	-	-	142	<1.0	-	0.0734
M-16	-	-	223	<1.0	-	0.639
Quarter 1, Calendar Year 2008						
M-1	7	1	1.7	2.9	0	0.235
MU-2	-10.3	0.9	5.1	5.8	0.1	0.0014
M-4	14	0.2	24.3	6.3	0.1	0.037
M-5	3.2	1.6	5.6	5.9	0	0.007
M-6	102	20	269	3.3	0.1	0.366
M-7	7	1.1	1.9	3.2	0	<0.0003
M-8	14.8	1.1	2.3	3.7	0	0.0023
M-9	19.6	2.3	5.2	6.8	0.5	0.016
M-10	-3.6	0.9	13.2	3	0	0.0313
M-11	-4.2	0.5	3.8	2.5	0	0.12
M-12	62.3	3	194	3	0	0.108
M-13	10.9	0.7	4.8	1.5	0	0.0994
MU-13	-3.3	1.9	6.3	1.6	0	0.0734
M-14	32.1	3.6	143	3	0.1	0.0588
M-15	2.8	0.8	3.3	5.9	0	0.0004
M-16	78.1	38	231	2.5	0.4	0.809
MP-16	45.7	3.3	129	3.7	0.3	0.0072
MU-16	11.2	-0.1	4.1	4.2	0	0.0703

Table 6.1-10: JAB: analytical results to date for radiological parameters in groundwater samples. Values with less-than qualifiers were below analytical reporting limits.

Well ID	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	U-nat mg/L
Quarter 2, Calendar Year 2007						
JAB #1	<1.0	<1.0	5.3	6.4	<0.2	0.192
MW1291	16	24	155	4.1	<0.2	0.309
MW1292	<1.0	<1.0	3.3	<1.0	<0.2	0.106
MW1298	<1.0	<1.0	2.8	<1.0	<0.2	0.0918
MW1299	<1.0	<1.0	2.6	3.4	<0.2	0.418
MW 1300	<1.0	<1.0	2.5	<1.0	<0.2	0.0009
Quarter 3, Calendar Year 2007						
JAB #1	11	<1.0	4.2	<1.0	0.8	0.115
MW1291	<1.0	38	143	5.1	<0.2	0.324
MW1292	<1.0	<1.0	2.7	<1.0	<0.2	0.108
MW1298	<1.0	<1.0	1.6	6.4	<0.2	0.431
MW1299	<1.0	<1.0	2.2	5.2	<0.2	0.0553
MW 1300	<1.0	<1.0	5.1	<1.0	<0.2	0.0004
Quarter 4, Calendar Year 2007						
JAB #1	<1.0	1.4	4.0	7.0	<0.2	0.0983
MW1291	-	-	139	8.1	-	0.348
MW1292	-	-	5	2.1	-	0.164
MW1298	-	-	4	2.9	-	0.0956
MW1299	-	-	2.3	5.7	-	0.412
MW 1300	-	-	3	2.3	-	0.0011

6.1.8.3 Conclusions

Radiological baseline groundwater data for the Antelope and JAB Uranium Project areas presented in this section provide a characterization of baseline radionuclide concentrations in groundwater for review by the NRC and WDEQ/LQD with respect to licensing/permitting applications.

6.1.9 Surface Water Sampling

Although significant anthropogenic surface water impoundments were not observed at either of these sites, surface waters from areas of natural ephemeral ponding were sampled (primarily at JAB) during the short snowmelt/runoff period in the spring of 2007. Data for radiological parameters are presented in this section. Data for all surface water quality parameters are provided in the section of ISR licensing applications related specifically to surface water (Section 3.4). Approximate surface water sampling locations are shown in Figure 6.1-40.

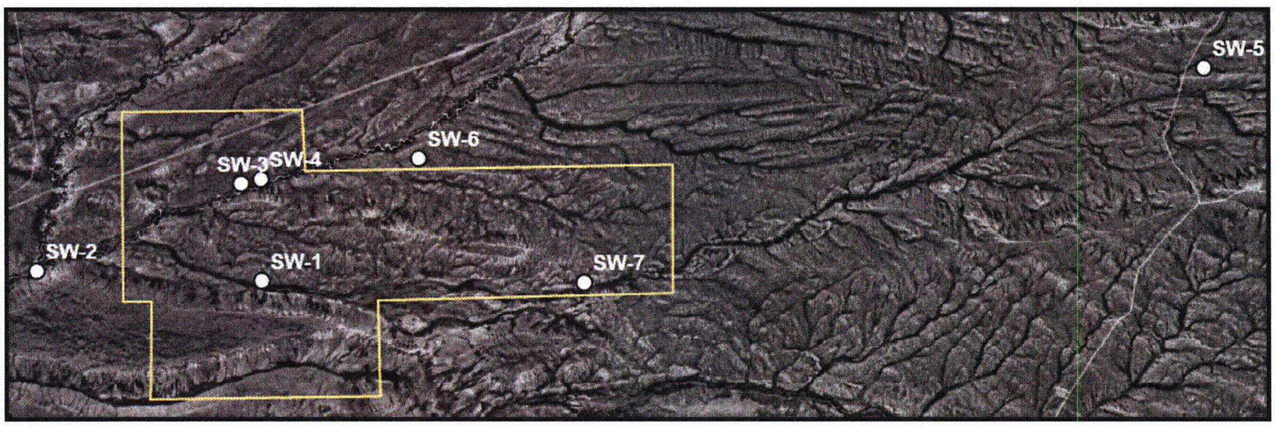


Figure 6.1-40: Surface water sampling locations.

6.1.9.1 Methods

Surface water samples were collected in the appropriate containers provided by the contract laboratory. Field meters were used to measure pH, specific conductance, and temperature of water samples and calibrated before each day's use as directed in the Owner's Manual. Sample containers are flushed with the sample water in order to remove potential contaminants from the container. The bottle is then filled directly from the stream or pond with the with the sample bottle in a manner to prevent collecting debris or filled by using an alternate clean container. All samples analyzed by a contract laboratory are accompanied by a chain of custody to ensure proper analysis is performed and the sample is tracked.

6.1.9.2 Surface Water Sampling Results

Results for dissolved radiological water quality parameters are shown in Table 6.1-11. Most sample results for uranium are at or below analytical reporting limits, and all are well below the U.S. Environmental Protection Agency's (EPA's) 30 μg/L drinking water standard for uranium (EPA, 2000). Based on the conversion factor indicated in Table 6.1-11, an equivalent EPA uranium drinking water standard in units of specific activity is 20 pCi/L.

Though well below this standard, the highest levels of radiological water quality parameters were found along the Arapahoe Creek drainage that runs through the JAB site (locations SW-2 and SW-4). One surface water sample was obtained from a location near the Antelope site (location SW-5). Respective results were consistent with those from the JAB vicinity samples. Given similarities in radiological surface soil and sediment concentrations between the Antelope and JAB sites (see Sections 6.1.2.2.4, 6.1.2.2.5, and 6.1.4.2), occasionally ponded surface runoff water at either site is likely to have generally similar radiological characteristics to those measured during the 2007 spring runoff event.

Table 6.1-11: Analytical results for baseline radiological parameters in surface water samples collected in spring, 2007. Values with less-than qualifiers were below analytical reporting limits.

Surface Water Sampling ID	Sampling Date	Uranium* (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)
SW-1	5/9/2007	<0.2	5.8	5.8	<0.2	1.5
SW-2	5/9/2007	3.0	19.5	14.4	5.2	<1.0
SW-3	5/9/2007	<0.2	5.6	5.7	<0.2	<1.0
SW-4	5/9/2007	2.8	16.8	11	2.2	<1.0
SW-5	5/9/2007	<0.2	1.6	2.1	<0.2	<1.0
SW-6	5/14/2007	0.2	3.8	4.2	<0.2	<1.0
SW-7	5/14/2007	<0.2	1.2	2.3	<0.2	<1.0

***Converted from units of mg/L to activity units of pCi/L using a conversion factor of 677 pCi/mg**

6.1.9.3 Conclusions

Radiological surface water data collected as part of baseline characterizations for these sites were limited due to the relatively infrequent occurrence of ponded surface water existing at these sites. The data obtained should nevertheless provide adequate characterization of baseline radionuclide concentrations in surface waters for review by the NRC and WDEQ/LQD with respect to licensing/permitting applications.

6.1.10 Vegetation Sampling

Vegetation sampling at the Antelope and JAB Uranium Project sites was initiated in August of 2007. Regulatory Guide 4.14 calls for several sampling events during the growing season (NRC, 1980). Vegetation at these sites is primarily comprised of sagebrush. Sagebrush has spring/fall cycles of growth and reproductive activity (Welch, 2005). Vegetation samples were collected in the August of 2007 and late May of 2008. Data from the fall 2007 sampling event are presented in this section. Data from the spring 2008 sampling event will be submitted in a supplementary baseline data report as soon as they are available (expected in June, 2008). Vegetation sampling locations (Figure 6.1-41) were selected based on proximity to potential wellfield areas or plant facilities, along with consideration for prevailing wind directions and practical access.

Figure 6.1-41: Vegetation sampling locations at the Antelope (top) and JAB (bottom).

6.1.10.1 Methods

Vegetation samples were collected using ordinary gardening tools (pruning shears, etc.) as mixed, above-ground growth across several hundred square meter areas at each sampling location. Though all varieties of vegetation at each location that could be practicably sampled were collected and composited into a single sample, sagebrush was by far the predominant species present, easily accounting for over 95% of the biomass that was able to be effectively sampled. An estimated 3-5 kilograms of total vegetation biomass per sample was collected. Samples were collected in large plastic bags and were sent to ELI in Casper, WY along with chain of custody forms. Analytes requested included all radiological parameters as recommended in Regulatory Guide 4.14.

6.1.10.2 Vegetation Sampling Results

Summary statistics for baseline vegetation sampling results to date are presented in Tables 6.1-12 and 6.1-13 and graphically in Figures 6.1-42 and 6.1-43. At Antelope, measured radionuclide levels are similar at each sampling location (Figure 6.1-43), though locations AV-1 and AV-2 show slightly higher values. Locations AV-1 and AV-2 were in the vicinity of areas with higher measured gammas and estimated Ra-226 concentrations (see Figures 6.1-13 and 6.1-21). Similarly at JAB, vegetation at location JV-3 had noticeably higher concentrations of Po-210, Ra-226, and Th-230 relative to other samples, and this sample was collected in the vicinity of higher measured gammas and estimated Ra-226 concentrations (see Figures 6.1-14 and 6.1-22). The higher radionuclide concentrations in vegetation samples at locations noted above may be related to plant uptake and/or dust loading on vegetation.

Table 6.1-12: Summary statistics for all vegetation samples collected in August 2007 for all sampling locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.3E-03	4.2E-04	1.4E-03	1.7E-03	8.7E-04	3
Po-210	1.6E-04	5.9E-05	1.9E-04	2.0E-04	9.4E-05	3
Ra-226	2.3E-04	1.4E-04	2.3E-04	3.7E-04	1.0E-04	3
Th-230	5.1E-05	2.6E-05	5.8E-05	7.3E-05	2.3E-05	3
U-nat	1.0E-04	5.9E-05	1.1E-04	1.6E-04	4.3E-05	3

Table 6.1-13: Summary statistics for all vegetation samples collected in August 2007 for all sampling locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.6E-03	1.7E-04	1.7E-03	1.7E-03	1.4E-03	3
Po-210	4.9E-04	2.3E-04	4.0E-04	7.5E-04	3.1E-04	3
Ra-226	6.2E-04	7.7E-04	1.9E-04	1.5E-03	1.6E-04	3
Th-230	1.1E-04	1.0E-04	5.7E-05	2.3E-04	5.4E-05	3
U-nat	9.0E-05	4.5E-05	7.6E-05	1.4E-04	5.4E-05	3

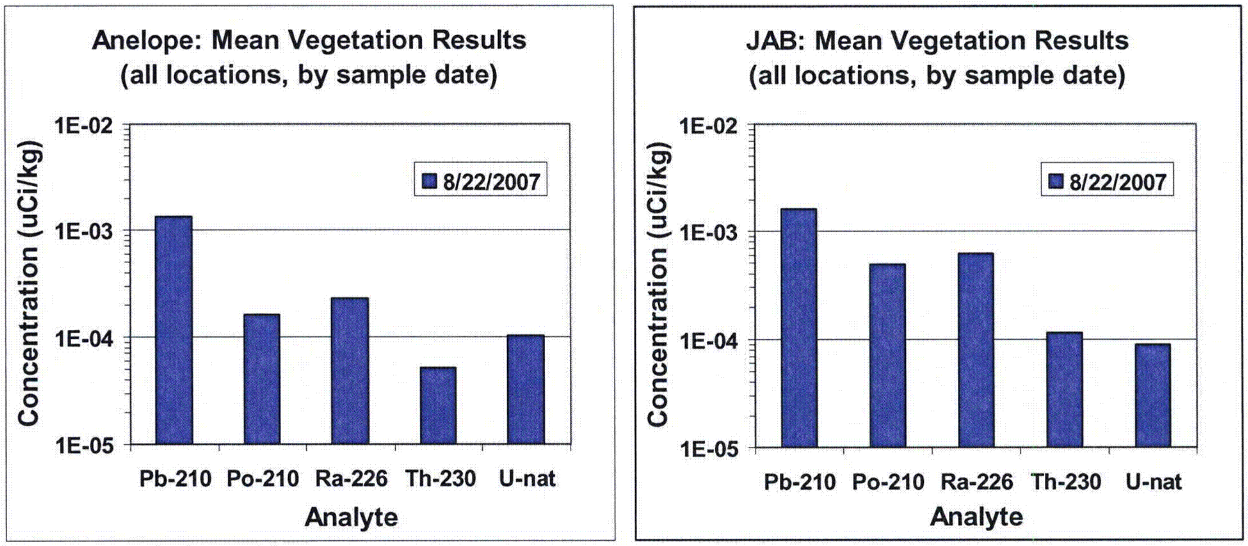


Figure 6-1-42: Analytical results for vegetation samples by sampling date for all locations at Antelope (left) and JAB (right).

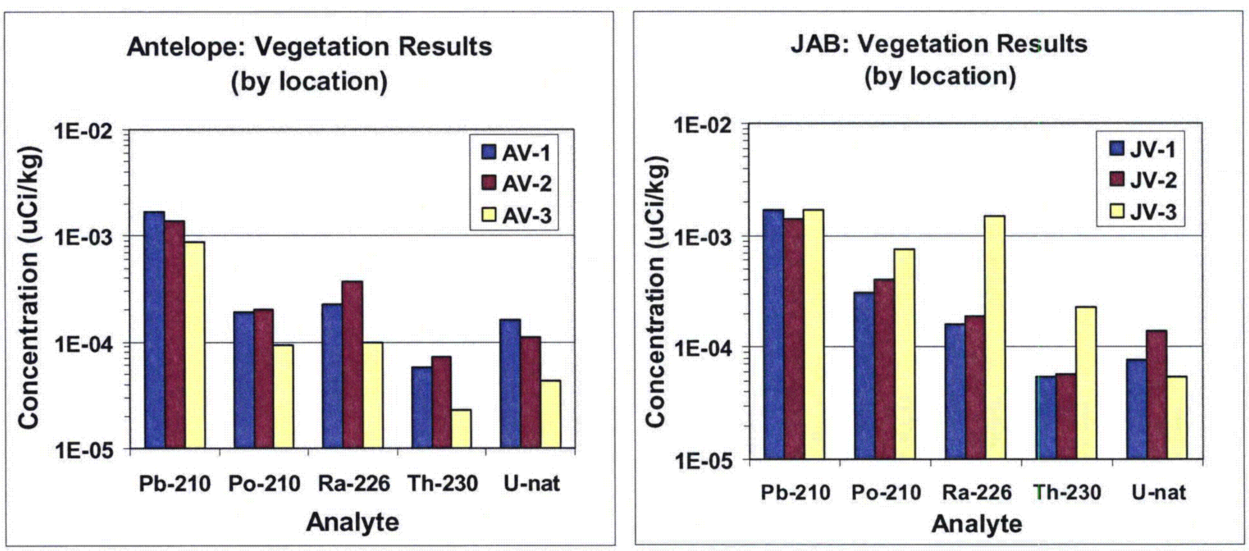


Figure 6.1-43: Analytical results for vegetation samples by sampling location at Antelope (left) and JAB (right).

Across all vegetation samples collected to date, lead-210 has the greatest activity levels of the five radionuclides analyzed, which is likely due to a higher relative abundance of Pb-210 in air particulates from radon decay products. This latter observation is supported by the air particulate data presented in Section 6.1.6 (note in Figures 6.1-36 and 6.1-37 that Pb-210 concentrations are consistently higher than other radionuclides evaluated).

6.1.10.3 Conclusions

Baseline vegetation sampling data for the Antelope and JAB Uranium Project areas are being collected and analyzed according to Regulatory Guide 4.14 protocols. To date, data from the fall 2007 sampling event are available and those results are presented in this section. Data from the May 2008 sampling events are expected in June, 2008 and those data will be subsequently submitted to the NRC and WDEQ/LQD in a supplemental baseline data report. Samples to date with higher results may be a reflection of plant uptake and/or dust loading on vegetative surfaces due to locally higher soil radionuclide concentrations.

6.1.11 Food Sampling

Sampling of food items from the site such as meat from local grazing livestock is not planned at this time. All radiological baseline parameters relevant to food chain dose pathways (e.g. soil, sediment, air particulate samples, water, and vegetation) are comprehensively characterized in this report. Changes in these parameters due to site operations could be used to model corresponding radiological changes in food items such as meat or milk from agricultural livestock. Respective radionuclide transfer factors can be found in the literature (e.g. IAEA, 1994; Yu, 2001). Larger game animals such as deer or pronghorn have extensive ranges and potential for bioaccumulation of radionuclides in these animals due to site operations is unlikely to be significant as they would likely derive only a small fraction of total sustenance from the site.

6.1.12 Summary and Overall Conclusions

Comprehensive baseline radiological surveys of the Antelope and JAB Uranium Project areas in the Great Divide Basin of Sweetwater County, Wyoming have been conducted in a manner consistent with Regulatory Guide 4.14 guidance (NRC, 1980) as part of licensing/permitting application submittals to the U.S. Nuclear Regulatory Commission and Wyoming Department of Environmental Quality / Land Quality Division. As of the effective date of this report, results for certain environmental baseline samples collected in May of 2008 are still pending at the laboratory. Respective sample results include Regulatory Guide 4.14 soil sampling and final sampling events for stream sediments and vegetation. These data will be provided to the NRC and WDEQ/LQD in a supplemental baseline data report as soon as they are available

The gamma exposure rate survey data, collected in the spring and summer of 2007 using the latest GPS scanning system technologies, represent much higher survey coverage than was practical or possible at the time Regulatory Guide 4.14 was published. These data, combined with established analysis techniques and state-of-the-art mapping approaches, provides a very detailed characterization of the magnitude and spatial variability in background gamma exposure rates and soil Ra-226 concentrations across these sites (about 14,700 acres in total area). The approach of high-density gamma scanning, gamma/Ra-226 correlations, HPIC cross-calibrations, and integrated use of GIS for spatial analyses and data presentation should meet or exceed regulatory guidelines for baseline characterizations and is expected to provide significant benefits to all stakeholders.

6.2 PHYSIOCHEMICAL GROUNDWATER MONITORING

6.2.1 Program Description

During operations at the Antelope and JAB Uranium Project, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. Uranium One's operational water monitoring program will include the evaluation of groundwater on a regional basis, groundwater within the licensed area, and surface water on a regional and site specific basis.

6.2.2 Groundwater Monitoring

The groundwater monitoring program is designed to detect excursions of lixiviant outside of the wellfield under production and into the overlying and/or underlying water bearing strata.

6.2.2.1 Private Well Monitoring

All private wells within one kilometer of the wellfield area boundary will be sampled on a quarterly basis with the landowner's consent. Groundwater samples will be analyzed for natural uranium and radium-226.

6.2.2.2 Wellfield Baseline Sampling

Production zone wells (injection and production pattern area) will be sampled four times with a minimum of 2 weeks between samplings during baseline characterization. Wells will be selected based on a density of one well per three acres of mine unit. The first and second sample events will include analyses for all WDEQ LQD Guideline 8, Appendix 1, parts III and IV parameters as shown in Table 6.2-1. The third and fourth sampling events will be analyzed for a reduced list of parameters as defined by the results of the previous sample events. If certain elements are not detected during the first and second sampling events, then those elements will not be analyzed during the third and fourth sample events.

Data for each parameter are averaged. If the data collected for the entire mine unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones. The Restoration Target Values (RTV's) are determined from the baseline water quality data and are used to assess the effectiveness of ground water restoration activities. The average and range of baseline values determined for the wells completed in the Production Zone within the wellfield area constitute the RTV's.

Table 6.2-1
Baseline Water Quality Parameters
WDEQ LQD Guideline 8

Constituents (reported in mg/l unless noted)	*Analytical Method*
Ammonia Nitrogen as N	EPA 350.1
Nitrate + Nitrite as N	EPA 353.2
Bicarbonate	EPA 310.1/310.2
Boron	EPA 212.3/200.7
Carbonate	EPA 310.1/310.2
Fluoride	EPA 340.1/340.2/340.3
Sulfate	EPA 375.1/375.2
Total Dissolved Solids (TDS) @ 180°F	EPA 160.1/SM2540C
Dissolved Arsenic	EPA 206.3/200.9/200.8
Dissolved Cadmium	EPA 200.9/200.7/200.8
Dissolved Calcium	EPA 200.7/215.1/215.2
Dissolved Chloride	EPA 300.0
Dissolved Chromium	EPA 200.9/200.7/200.8
Total and Dissolved Iron	EPA 236.1/200.9/200.7/200.8
Dissolved Magnesium	EPA 200.7/242.1
Total Manganese	EPA 200.9/200.7/200.8/243.1/243.2
Dissolved Molybdenum	EPA 200.7/200.8
Dissolved Potassium	EPA 200.7/258.1
Dissolved Selenium	EPA 270.3/200.9/200.8
Dissolved Sodium	EPA 200.7/273.1
Dissolved Zinc	EPA 200.9/200.7/200.8
Radium-226 (pCi/l)	DOE RP450/EPA 903.1/SM 7500-R-AD
Radium-228 (pCi/l)	SM 7500-R-AD
Gross Alpha (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Gross Beta (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Uranium	DOE MM 800/EPA 200.8
Vanadium	EPA 286.1/286.2/200.7/200.8

6.2.2.3 Monitor Well Baseline Water Quality

Monitor well ring wells are installed within the Production Zone, outside the mineralized portion of the ore zone and production pattern area in a "ring" around the mine area. These wells are used to obtain baseline water quality data and characterize the area outside the production pattern area. Upper Control Limits (UCL's) are determined for these wells from the baseline water quality data used in operational excursion monitoring. As described in Section 2, the distance between these monitor wells will be no more than 500 feet and the distance between these monitor wells and the production patterns will be approximately 500 feet.

Monitor wells will be installed within the overlying aquifer and underlying aquifer at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data to be used in the development of UCL's for these zones.

After completion, wells will be developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears to be stable and consistent with the anticipated water quality of the area. After development, wells will be sampled to obtain baseline water quality. Wells will be purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying and underlying monitor wells will be sampled four times at least two weeks apart. The first sample will be analyzed for the parameters shown in Table 6.2-1. Subsequent samples will be analyzed for the UCL parameters only (i.e., chloride, conductivity, and total alkalinity). Results from the samples will be averaged arithmetically to obtain a baseline mean value determination of upper control limits for excursion detection. If the data collected for the monitor well ring unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones.

6.2.2.4 Water Sampling Methods

Groundwater samples are critical to meeting environmental protection goals at ISR uranium mines. The results of these samples are used to monitor operational environmental protection efforts and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary. This section provides instructions on water level determination, proper well sampling techniques, sample preservation and documentation, and QA/QC requirements. These requirements will be followed for all samples obtained from private wells and monitor wells.

The accurate determination of the static water level in monitor wells provides important information concerning aquifer conditions. Well static water levels are monitored using an electrical measuring line (an "e-line"). An e-line is a device that measures electrical conductance with two electrodes contained in a shielded probe. The probe is mounted to a graduated strip to allow measurement of water levels. The probe is slowly lowered into the well. When the probe contacts the water surface in the well, the circuit is completed and an audible device is actuated. The sampler will take water level readings of all wells before sampling.

It is generally not possible to measure water level in existing private wells without disassembly of pumping and piping systems. If possible, the water level will be measured. If it is not possible to measure water level, the well will be purged for at least five minutes to evacuate any lines or existing pressure tanks of stagnant water. If any particulate matter is identified in the water, the well will be allowed to flow until it no longer contains any particulate.

During regional well sampling, all readings should be reported to within at least one tenth of a foot and preferably to within a hundredth of a foot. It is important to check the e-line length by measuring with a steel tape after the line has been used for a long time, when the length has been altered due to repairs, or after it has been pulled hard in an attempt to free the line. If an e-line's length is altered by these causes, a correction factor should be written on the side of the e-line so readings may be properly adjusted.

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

The well must have a sufficient volume of water removed to induce the flow of formation water through the well screen. Two approaches to purging are provided in ASTM Guide D 4448. The first approach requires purging a large volume of water. ASTM Guide D 4448 recommends that three to five casing volumes be purged for the high volume method, while one casing volume may be acceptable if a lower purge rate near the recharge rate of the well is used. The second approach recommended in ASTM D 4448 requires the removal of stagnant casing water until one or more indicator parameters are stable. Stabilization is considered achieved when the measurements of all parameters are stable within a predetermined range. Parameters that EMC will monitor include pH, temperature, and specific conductivity.

For high and medium yield wells, EPA recommends a minimum purge volume of three casing volumes. For low yield wells, EPA also allows a smaller minimum purge volume of one casing volume if the flow is near the recharge rate of the aquifer.

The Wyoming LQD in Guideline 8, Section IV.A.4.b requires withdrawing at least two casing volumes of water prior to sampling. The sampler will document the pumping rate and the purging time. The LQD alternatively allows purging the well until pH, conductivity, temperature, and water level readings remain constant. The field sampler will document the changes in each field parameter against time in a tabular form. If recharge cannot match minimal pumping rates in a low permeability aquifer, then a sample can be retrieved by pumping the well dry once and then bailing the water that subsequently enters the well.

Accurate records of well purging will be maintained to document the number of casing volumes purged from the well before sampling. These records will include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times. The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a 5-gallon bucket or other container of a known volume.

The following formula will be used to calculate the number of gallons contained in one casing volume:

Casing Volume (Gals) = (Height of water in well in ft) x (Radius of the well^2 in inches) x (π) x (0.052)

Where: $\pi = 3.1416$
The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Field meters will be used to measure pH, specific conductance, and temperature of water samples. The use, calibration, and care of these meters will be in accordance with the owner's manual recommendations.

The groundwater sample will be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample will be obtained as soon as adequate formation water is present in the casing. The sampler will record the following sampling data on a field sampling sheet:

- Identification of the well;
- Well depth;
- Static water level depth and measurement techniques;
- Well yield;
- Purge volume, pumping rate and volume per casing volume;
- Time well purged;
- Collection methods (bail or pump);
- Field observations (such as well condition, sample color, sample smell, sound);

- Name of collector; and
- Climatic conditions, including air temperature.

Once a water sample has been taken, the quality of the sample begins to degrade with time. Because of this, all samples will be kept cool and some must be preserved in order to lengthen the acceptable holding time. The contract laboratory will be consulted when determining proper preservation techniques for samples that require off site analysis. Samples to be analyzed for dissolved metals will be filtered to < 0.45 microns to remove suspended solids that may affect the results.

Preservative (acid) will be added to sample containers either before or immediately after collection and filtration, if required, of samples. The following Table provides a summary of the sampling and preservation recommendations for analytes typically of concern in groundwater. Field sampling personnel will consult the bottle and preservation list provided by the contract laboratory to ensure that the appropriate sample preservation method is used.

Table 6.2-2 Summary of the sampling and preservation recommendations for analytes typically of cconcern in groundwater.

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 μm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

Chain of Custody (COC) forms will accompany every sample sent to off-site contract laboratories. The chain of custody will contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis.

6.2.2.5 Wellfield Hydrologic Data Package

Following completion of the field data collection, the Wellfield Hydrologic Data Package is assembled and submitted to the WDEQ for review. In accordance with NRC Performance Based Licensing requirements, the Wellfield Hydrologic Data Package is reviewed by a Safety and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in NRC regulations or in the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements as previously discussed in Section 5.2 of the Technical Report. The written SERP evaluation will be maintained at the site.

The Wellfield Hydrologic Data Package contains the following:

1. A description of the proposed mine unit (location, extent, etc.).
2. A map(s) showing the proposed production patterns and locations of all monitor wells.
3. Geologic cross-sections and cross-section location maps.
4. Isopach maps of the Production Zone sand, overlying confining unit and underlying confining unit.
5. Discussion of how the hydrologic test was performed, including well completion reports.
6. Discussion of the results and conclusions of the hydrologic test including pump test raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and when appropriate, directional transmissivity data and graphs.
7. Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.
8. Baseline water quality information including proposed UCLs for monitor wells and average production zone/restoration target values.

9. Any other information pertinent to the area tested will be included and discussed.

6.2.2.6 Operational Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration and for which UCLs will be set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits will be set at the baseline mean concentration plus five standard deviations for each excursion indicator. For chloride with a low baseline mean and little noted variation during baseline sampling, the UCL may be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

Operational monitoring consists of sampling the monitor wells at least twice monthly and at least 10 days apart and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. Uranium One requests that in the event of certain situations such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment, NRC allow a delay in sampling of no more than five days. In these situations, Uranium One will document the cause and the duration of any delays.

To assure that water within the well casing has been adequately displaced and/or formation water is sampled, wells will be purged before sample collection to ensure that representative water is obtained. Samples will be taken when field water quality parameters such as pH and specific conductivity appear to be stable and consistent with the anticipated water quality of the area. Low flow purging may also be used in certain instances to prevent pulling of mining fluids to the monitor well from excessive purging and ensure only formation water is sampled.

Water level and analytical monitoring data for the UCL parameters are reported to the WDEQ-LQD on a quarterly basis. This data is retained on site for review by the NRC.

6.2.2.7 Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, the well is resampled within 24 hours of the determination that a sample has exceeded two of the three UCL values and analyzed for the excursion indicators. The verification sample is split and analyzed in duplicate to assess analytical error. If results of the confirmatory sampling are not complete within 30 days of the initial sampling event, then the excursion will be considered confirmed for the purpose of meeting the reporting requirements described below. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the USNRC Project Manager and the WDEQ-LQD is notified by telephone or email within 24 hours and notified in writing within thirty (30) days. A written report describing the excursion event, corrective actions, and corrective action results will be submitted to the NRC within 60 days of the excursion confirmation.

If an excursion is verified, the following methods of corrective action will be instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation will be completed to determine the probable cause.
- Production and/or injection rates in the vicinity of the monitor well will be adjusted as necessary to increase the net bleed, thus forming a hydraulic gradient toward the production zone.
- Individual wells will be pumped to enhance recovery of mining solutions.
- Injection into the well field area adjacent to the monitor well may be suspended. Recovery operations continue, increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status will be increased to once every seven days.

If an excursion is not controlled within 30 days following confirmation of the excursion, the WDEQ requires that a sample must be collected from each of the affected monitoring wells and analyzed for the following parameters: ammonia; antimony; arsenic; barium; beryllium; bicarbonate; boron, cadmium, calcium, carbonate; chloride; chromium; conductivity; copper; fluoride; gross alpha; gross beta; iron; lead; magnesium; manganese; mercury; molybdenum;

nitrate + nitrite; pH; potassium; selenium; sodium; sulfate; radium-226 and 228; thallium; TDS; uranium; vanadium; and zinc.

If the concentration of the UCL parameters detected in the monitor well(s) does not begin to decline within 60 days after the excursion is verified, injection into the production zone adjacent to the excursion will be suspended to further increase the net water withdrawals. Injection will be suspended until a declining trend in the concentration of the UCL parameters is established. Additional measures will be implemented if a declining trend does not occur in a reasonable time period. After a significant declining trend is established, normal operations will be resumed with the injection and/or production rates regulated such that net withdrawals from the area will continue. The declining trend will be maintained until the concentrations of excursion parameters in the monitor well(s) have returned to concentrations less than respective UCLs.

If an excursion is controlled, but the fluid which moved out of the production zone during the excursion has not been recovered within 60 days following confirmation of the excursion, the operator will submit to the WDEQ-LQD and the NRC within 90 days following confirmation of the excursion a plan and compliance schedule meeting the requirements of LQD Rules and Regulations, Chapter 13, Section 13(b).

A monthly report on the status of an excursion shall be submitted to the LQD administrator beginning the first month the excursion is confirmed and continuing until the excursion is over. The monthly report shall contain the requirements described in LQD Rules and Regulations, Chapter 12, Section 12(e). An excursion will be considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion, or if only one excursion indicator exceeds its respective UCL by less than 20%.

6.3 ECOLOGICAL MONITORING

6.3.1 Wildlife

Due to the dynamic nature of wildlife species, Uranium One voluntarily commissioned monitoring of known sage-grouse leks and raptor nest sites in spring 2008 for the Antelope and JAB Uranium Project. Those efforts will transition to annual monitoring once ISR operations are permitted, which will continue through the life of the project. Annual wildlife monitoring surveys should follow the same regimen as other ISR operations in the region to maximize comparisons among survey results and impact assessments. At a minimum, those surveys typically include the following, as modified for site-specific habitats (e.g., no trees, so no bald eagle winter roost surveys):

1. Early spring surveys for, and monitoring of, sage-grouse leks within one mile of the license/permit area, new and/or occupied raptor territories and/or nests, Pygmy Rabbit, Mountain Plover, and T&E species on and within the license/permit area; and

2. Other surveys as required by regulating agencies.

Based on results from previous surveys, the WGFD recommended in late 1999 that big game monitoring be discontinued on all existing surface mine sites in Wyoming. Similarly, results from a three-year big game monitoring program conducted at the Smith Ranch and Highland Uranium Projects during their respective permitting processes documented that those operations were having no significant negative impact on pronghorn or mule deer. Because the entire Antelope and JAB Survey Area is covered by WGFD big game surveys, the BLM did not require such efforts for these baseline wildlife surveys, and no long-term monitoring requirements are anticipated as necessary.

6.4 QUALITY ASSURANCE PROGRAM

A quality assurance program will be implemented at the Antelope and JAB Uranium Projects for all relevant operational monitoring and analytical procedures. The objective of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid. The Uranium One Quality Assurance Plan for Wyoming ISR Operations is provided in Addendum 5-A of the Technical Report.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports will be provided.
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.
- Written procedures for QA activities. These procedures will include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.
- Quality control (QC) in the laboratory. Procedures will cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.
- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

QA procedures will include:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.

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7 BENEFIT-COST ANALYSIS

7.1 BENEFIT-COST ANALYSIS GENERAL BACKGROUND

Benefit-cost analysis (BCA) has established that the proposed development of a new uranium in-situ recovery facility at the Antelope and JAB Projects (Project) is potentially a cost-effective effort to undertake and will provide a net economic benefit to the State of Wyoming.

This analysis has been tailored to meet the requirements established by the Nuclear Regulatory Commission (NRC) NUREG 1569, and includes a description of the economic benefits from the construction and operation of the proposed Project and a discussion of the temporary and long-term external costs. Where possible, benefit and cost estimates are monetized; however, reliable monetary estimates for some potential impacts are not readily available so the narrative examines several factors in non-monetary or qualitative terms.

The following analyses use IMPLAN (IMpact Analysis for PLANning), a standard industry software package that models the economic impacts of capital intensive projects, to calculate the potential economic impacts to the county. It was originally developed by the United States Department of Agriculture (USDA) Forest Service in cooperation with the Federal Emergency Management Agency (FEMA) and the United States Department of the Interior (USDI) Bureau of Land Management (BLM) for land and resource management planning (IMPLAN 2004). Currently, it is being managed by the Minnesota IMPLAN Group, Inc. (MIG).

7.2 ALTERNATIVES AND ASSUMPTIONS

BCA is a widely-used analytical tool for helping decision makers determine whether the cost of a project today will result in sufficient benefits to justify expenditure on a capital intensive project (Brown 2003; Zerbe and Bellas 2006). To provide value and to assist in the decision process, the BCA needs to be clear about the alternatives being considered and the underlying assumptions including quantities of goods, labor costs, market conditions and discount rates used to compute net present value. The following discussion briefly identifies alternatives and key assumptions used throughout the analysis.

7.2.1 Development Alternatives

This BCA evaluates the benefits and costs of building the Project and all the costs and benefits resulting from its ongoing operation in Sweetwater County, Wyoming. The BCA tradeoff under consideration involves comparing a future with the proposed Project to a future that represents a continuance of the no action.

7.2.1.1 No Action Alternative

Under the no action alternative, there would be no change in the current land cover or land and water uses at the site; therefore, there would be no change in the existing underlying socioeconomic and demographic trends.

7.2.1.2 Proposed Antelope and JAB Project Alternative

The proposed alternative involves the construction and operation of a uranium in-situ recovery (ISR) facility. ISR involves leaving the ore where it is in the ground and using liquids which are pumped through it to recover the minerals out of the ore. Consequently, the proposed alternative involves limited surface disturbance at the Project site and no tailings or waste rock would be generated.

7.2.2 Key Assumptions and Limitations

Key assumptions about the costs and benefits associated with the proposed Project involve: (1) The Operating Life of the Project; (2) the Discount Rate used; (3) the Scope of the Impact; and (4) Non-monetary Impacts. Each of these is described in more detail below.

7.2.2.1 Operating Life of Project

The Project will be a single unit of analysis including the well fields, Central Processing Plant, Satellite Facility and outlying related structures. For this analysis, the total effective life of the Project is assumed to be 31 years. Within this time frame, there are three distinct project phases with a distinct suite of costs and benefits:

- 1 year of site development and facility construction

- 8 years of Satellite operation (concurrent with Central Processing Plant operation)
- 15 years of well fields and Central Processing Plant operation
- 15 years of the Central Processing Plant continuing operation after decommissioning the well fields.

7.2.2.2 Discount Rate

Computing the net present value (NPV) of the proposed Project requires that future benefits and costs be discounted. This discounting reflects the time value of money—economic benefits and costs are worth more if they are expected sooner. Following guidelines established by circular A-94 from the United States Office of Management and Budget (OMB), net present value estimates of benefits and costs are reported using a real discount rate of 7 percent (OMB 1992). Circular A-94 was revised in 1992 based on extensive review and public comment and currently reflects the best available guidance on standardized measures of costs and benefits. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years.

7.2.2.3 Scope of Impact

A critical step in any BCA is establishing a viable scope of impact and thus establishing who will be affected by the Project (Zerbe and Bellas 2006). As a practical matter the proposed Project would be limited to the potential impact it may have on Sweetwater County in the State of Wyoming.

7.2.2.4 Non-monetary Impacts and Benefit-Cost Ratio

Conventional BCA uses monetary values to compare goods and services derived from a project or program. The values of goods and services represent their relative importance so that if the total value of the benefits is greater than the total value of the costs, the Project is desirable. The standard result is a quantified benefit-cost ratio (BCR), equal to a project's total net benefits divided by its total cost. BCR's above one have positive net economic impacts. While many inputs in the Project BCR are goods and services (skilled labor, construction material) that are regularly traded in markets at well known and predictable prices, others (changes to land or water, aesthetic impacts) are not directly traded and are more difficult to value. Where reliable monetary values are not available a qualitative approach based on the best available information is required.

7.3 ECONOMIC BENEFITS OF PROJECT CONSTRUCTION AND OPERATION

This section considers the potential economic impacts resulting from construction and operation-related activities over the life of the Project. Economic benefits are those that have the potential to affect the local economy, including the number of jobs created and state and local tax revenues generated from project related business activities.

These analyses use IMPLAN to calculate the potential economic impacts to Sweetwater County. IMPLAN allows the user to build an input-output model tailored to model the potential impact of a proposed project on a specific community or region. The system is flexible and contains a database of over 500 industrial sectors gathered from counties throughout the United States. By identifying the location and industrial sector of the project (i.e., construction and mining), the analyst can therefore estimate the total potential economic impact of a given project. The model requires labor and capital expenditures data as inputs in order to evaluate the potential economic impacts of the project. The output is the potential direct and indirect employment impacts and generated tax revenue.

This analysis focuses on Sweetwater County, Wyoming and two economic sectors most closely associated with the distinct phases of the proposed Project: new construction (IMPLAN code 41) and support activities for mining (IMPLAN code 29). Unfortunately, IMPLAN does not currently have a uranium mining sector for Sweetwater County, so all tax revenue estimates drawn from IMPLAN should be treated as lower-bound estimates given that ad valorem and severance taxes will likely differ for different mining sectors.

7.3.1 IMPLAN Input Data

This analysis assumes that the Project begins in 2009. Construction activities take place for one year employing a total estimated number of 75 construction workers of which 35 (about 50 percent) would likely be from Sweetwater County. Construction capital expenditures are estimated at $50 million for the duration of the construction period (Table 7-1).

Following one year of facility construction, the well fields, Central Plant and Satellite Facility would be fully-operational, employing 80 full-time workers per year for the first 15 years (this is considered the maximum potential number, it is anticipated that there will be less than 80 full time workers). After completion of mining and restoration activities, 60 full-time workers per year for the next 15 years will be required for continuing plant operations (this is considered the maximum potential number, it is anticipated that there will be less than 60 full time workers), accepting loaded ion exchange resin from other satellite facilities for processing. Approximately 50 percent of the workers (40 workers during the first 15 years and 30 workers during the last 15 years) would be located in Sweetwater County. The Project has the potential to incur up to $12 million in non-payroll-related operating costs annually for the first 15 years. Thereafter, the analysis assumes that non-payroll related operating costs will be reduced to 15 percent or $1.8 million per year.

Table 7-1 Input Data for the Antelope and JAB Projects

Activities	IMPLAN Code	Per Year		
		2009	2010 - 2024	2025 - 2039
Construction Expenditures				
Non-payroll[1]	41	$50 M	NA	NA
Payroll[2]	41	35 workers	NA	NA
Operations Expenditures				
Non-payroll	29	NA	$12 M	$1.8 M
Payroll	29	NA	40 workers	30 workers

[1] Does not include land purchase cost
[2] Limited to Sweetwater County

7.3.2 Employment Benefits

Using the above assumptions, Table 7-2 summarizes the potential employment-related effects generated by the Project. IMPLAN defines employment as total wage and salary of employees, including self-employed jobs that are related to the proposed Project. It also includes both full-time and part-time workers and is measured in annual average jobs.

Table 7-2 also shows the potential direct, indirect and induced effects on county-wide employment. The direct employment effects refer to the employment directly generated by the Project. For the initial construction phase in 2009, the model estimates a total of 552 workers directly hired by the Project in Sweetwater County per year including the 35 payroll workers engaged directly in construction activities and the $50 million of non-wage capital expenditures incurred by the Project in 2009.

Potential indirect effects pertain to the inter-industry effects from the direct effects and could include increased labor demand, goods and services required to support the Project (such as restaurant and hotel staff). In addition, new workers living within Sweetwater County would spend their income locally which induces additional income and employment. Construction workers living in the county for the construction period would purchase local goods and services which help generate additional employment. The sum of potential direct, indirect and induced effects represents the total potential employment impacts of the Project.

The results indicate that the Project is expected to create 794 additional jobs per year for the first year of intensive construction, 180 additional jobs per year in the next 15 years during full operation, and 70 additional jobs per year in the last 15 years of operation. It is important to note that the total potential economic impacts from the Project could extend to Fremont, Carbon and Natrona counties. As a result, the total potential employment impacts predicted by this analysis are conservative.

Table 7-2 Employment Effects of the Antelope and JAB Project in Sweetwater County

Years	Employment per Year			
	Direct	Indirect	Induced	Total
2009	552	111	132	794
2010 - 2024	101	41	38	180
2025 - 2039	39	16	15	70

7.3.3 State and Local Tax Revenue Benefits

In addition to aggregate employment effects, IMPLAN provides an estimate of expected state and local tax revenue impacts over the life of the Project associated with mining activities. In order to remain consistent with the scope of impact, federal taxes are not included in this analysis. The results standardized to 2007 dollar equivalents using the OMB recommended real discount rate of 7 percent are presented in Table 7-3.

Potential state and local tax implications associated with the proposed Project are presented in Table 7-3. While IMPLAN includes employee and employer social insurance taxes as well as personal tax items like income tax, property tax and motor vehicle license tax, these tax revenues are not reported here because they are paid by county workers and their families and thus represent a transfer of wealth rather than a net economic gain. Conversely, corporate dividend taxes and indirect business taxes associated with the proposed Project consist of tax items such as property tax and sales tax. These revenues stem directly from the construction and operation of the Project and are paid by the operator of the proposed Project, therefore can be counted as net economic gains when compared to the no action alternative.

As table 7-3 shows, the construction and operation of the Project is expected to generate a net present value of approximately $11.5 million in total enterprise and business tax revenues over the life of the Project. This estimate should be treated as a lower-bound estimate because the ad valorem and severance taxes associated with uranium mining in Sweetwater County are currently not available in IMPLAN.

Table 7-3 State and Local Tax Revenue IMPLAN Projections

	Net Present Value ($ Millions) *		
Activities	**Enterprise (Corporate) Tax**	**Indirect Business Tax**	**Total Taxes**
Construction	0.2	1.3	1.9
Operations	1.5	7.0	9.6
Total	1.7	8.4	**11.5**

*2007 Dollar Equivalents

Additionally, severance taxes associated with uranium mining in Sweetwater County are levied by the State of Wyoming, Mineral Tax Division of the Department of Revenue. The current uranium severance tax is 4% of taxable market value coming from mining operations (Wyoming Department of Revenue—Mineral Tax Division 2007). Current and historical resource estimates for the proposed combined projects are 13.5 million lbs. This does not include reserve estimates as these projections are not yet complete. Assuming that the identified 13.5 million lbs were sold at current long term market prices of approximately $90 per pound, the severance tax would yield approximately $48,600,000 in net economic benefits over the life of the operation.

In sum, the results show that $60.1 million net quantifiable economic benefits can be linked to the proposed project. It is noted that this figure represents a lower bound estimate as it excludes potential reserve resources and potential benefits derived from *ad valorem* taxes, taxes on royalties and lease payments to local landowners stemming from the operation of the proposed project.

7.4 EXTERNAL COSTS OF PROJECT CONSTRUCTION AND OPERATION

In this section of the analysis, external costs of the proposed Project are identified and compared to the no action alternative. Both short-term and long-term external costs that may affect the interest of people other than the owners and operators of the proposed Project are also identified and described.

7.4.1 Short Term External Costs

7.4.1.1 Housing Shortages

The area within a 50-mile radius of the project site includes portions of four counties in central and northeastern Wyoming, namely Sweetwater County, Fremont County, Carbon County and Natrona County. The proposed Antelope and JAB projects are located in Sweetwater County. Approximately 50 percent of the total construction and operations work force for the proposed Project would likely come from Sweetwater County. The remaining workforce would likely be based in Rawlins, located in neighboring Carbon County, as Rawlins provides work force for a number of large-scale construction and energy-related projects in the region.

The IMPLAN model results show that in 2009, the Project is expected to generate 794 new jobs due to construction-related activities. In 2010, 180 new jobs are generated for operations-related activities, which are expected to continue until 2024. In 2025, 70 jobs per year would be needed for central plant operations until 2039.

The nearest substantial housing stock is located in Rawlins. Nearby communities such as Bairoil and Jeffrey City, located in Sweetwater and Fremont Counties respectively also offer potential though relatively small numbers of available housing. Since the Project lies within commuting distance of Rawlins and other communities along the I-80 corridor in Sweetwater and Carbon counties, workers from these counties would likely commute from their homes, hence causing no significant impacts on the housing situation in these communities.

In the event that non-local workers are hired for the short-term construction phase of the Project, it is anticipated that few of the construction work force would purchase or rent housing of any type since rental housing usually require long-term lease contracts. In this situation, the present available stock of motel/hotel rooms would accommodate the temporary workers.

At least 50% of the operations workforce is expected to come from Sweetwater and Carbon counties. Those not located within commuting distance of the proposed Project would likely rent or purchase housing. In the unlikely event that the entire operations workforce are non-local and relocated to these counties, a maximum of 180 housing units would be required to accommodate relocating workers. Under this extreme scenario, the available housing units in Sweetwater and Carbon counties would not meet the demand for housing. On the other hand, the population increase would be a maximum 454 (180 workers times 2.52) based on the 2005 average household size of 2.52 in Wyoming. This increase would account for about one percent of the population of Sweetwater County as of 2006, and is within the county's annual projected population increase of 494 people per year between 2003 and 2010.

7.4.1.2 Impacts on Schools and Other Public Services

The Project Area is located within Sweetwater County School District 1, which serves all of Sweetwater County within 50 miles of the License/Permit Areas. However, the schools closest to the License/Permit Areas that would likely serve the project labor force are located in Carbon County School District #1. The nearest Sweetwater County community that provides education services to residents in the vicinity of the Project Area is the Bairoil Elementary School, which had a 2005 fall enrollment of 10 students. The school is located in Sweetwater County, but is administered through Carbon County School District #1. Rawlins is the closest city to the Project Area that provides a full range of education facilities, including three elementary school (total 2005 fall enrollment of 685) one middle school (2005 fall enrollment of 349), and one high school (2005 fall enrollment of 431) (Carbon County School District #1 2007).

Historic enrollment data indicates a fairly steady decline in school enrollment in the Carbon County School District # 1 from 1996 through 2004. Therefore, families moving into the Sweetwater County School District as a result of the proposed Project are not expected to significantly stress the current school system because it is presently under-capacity

Likewise, there is no significant change anticipated in the demand for local public services such as fire, police, water and utilities. As mentioned, at least 50% of the proposed Project's workforce would likely be local workers. The maximum population increase, primarily coming from operations worker would be 454, based on the 2005 average household size of 2.52 in Wyoming. This maximum possible increase would account for less than one percent of the combined populations of Sweetwater and Carbon Counties in 2006, thereby posing little or no change on the demand for local public services. Therefore impacts to community services such as roads, housing, schools and energy costs would be minor or non-existent and temporary.

7.4.1.3 Impacts on Noise and Congestion

There are no occupied housing units in the vicinity of the proposed Project. Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Livestock grazing is the primary use of the rangeland in the Project Areas. Other uses include oil and gas production and minor dispersed recreation. As a result of the remote location of the Project and the low population density of the surrounding area, impact to noise or congestion within the Project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Sweetwater or other neighboring counties.

7.4.2 Long Term External Costs

7.4.2.1 Impairment of Recreational and Aesthetic Values

While opportunities for developed and dispersed recreation exist throughout the four-county region surrounding the Project, there are currently no developed recreational sites, facilities or special recreational management areas within the Project area or in the surrounding 2.0-mile area. Most developed recreation opportunities within the surrounding 50-mile radius are specialized recreation management areas on public lands or community facilities in townships or urban areas for tourist services and facilities.

The Continental Divide National Scenic Trail runs two miles outside of the northeast boundary of the Project Area. No specific data on recreational use of the Project Areas are available; however, use is likely low because of the relatively small local population, long drives from major population centers, and lack of well-known natural attractions. Hunting is the most important recreational activity in the Project Areas. Hunting occurs primarily during the fall hunting seasons, specifically during September and October.

The general physical remoteness of the proposed Project and the anticipated low volume of recreational interest indicate that there are no significant long-term impairments to recreational values from developing the Project.

7.4.2.2 Land Disturbance

The Project area has been used historically for grazing, prospecting and oil and gas development; therefore, it is unlikely that any undisturbed land area currently exists within the proposed Project area. A significant, pre-existing human footprint on the landscape is evident in existing grazing activities and facilities (stock tanks, fences), oil production facilities and infrastructures that support these activities. Grazing and oil/gas production occur concurrently in any given parcel within the Project Areas. Oil and gas field infrastructure within the Project area and the surrounding 2.0-mile review area includes access roads, overhead electric distribution lines, and cleared rights-of-way for underground utilities, which are generally found along access roads. There would be negligible changes in land cover or land use from existing conditions outside of the 2.0-mile review area.

As the proposed Project would use in-situ recovery instead of conventional surface mining techniques, there would be limited land surface disturbance associated with the well field development and operation of the site. Land surface disturbance associated with well field development would also be short term as interim stabilization with native vegetation species is implemented as soon as construction activities are complete and maintained through the life of the well field. No tailings or waste rock would be generated. The processing plants and new private access roads would be confined to clearly delineated areas within and between the Project areas. While there would be some land use changes from the existing condition within the Project area, potential impacts will be minimal.

7.4.2.3 Habitat Disturbance

Currently, there is no federally or state designated wildlife habitat identified within the proposed Project area. As the Project area has been historically used extensively for livestock grazing and oil and gas development, there are no anticipated long-term losses to wildlife or wildlife habitat relative to the existing conditions resulting from the construction and operation of the proposed Project.

7.4.3 Groundwater Impacts

It is unlikely that any future irrigation development would occur within the proposed Project area due to limited water supplies, topography, soils, and climate. Irrigation within the 2.0-mile review area is anticipated to be consistent with the past. Based on population projections, future water use within the 2.0-mile review area would likely be a continuation of present use; therefore, it is anticipated that there would be no significant changes from the existing conditions for public water supply in the area.

Minimal effects to the existing aquifer as a result of drawdown are anticipated. Following standard mining practice, any contaminated water drawn from the aquifer on site would either be treated before re-injection or disposed through deep injection. Upon decommissioning, wells would be sealed and remaining groundwater would be restored. The primary goal of the groundwater restoration program would be to return groundwater affected by mining operations to baseline values on a mine unit average. The secondary goal would be to return the groundwater to a quality consistent with pre-mining use. Prior to mining in each mining unit, baseline groundwater quality would be determined. This data would be established for each mine unit at the minimum density of one production or injection well per four acres. Upon completion of restoration, a groundwater stabilization monitoring program would begin in which the restoration wells and any monitor wells on excursion status during mining operations would be sampled and analyzed for the restoration parameters.

Given the historically limited irrigation, the lack of domestic groundwater use, and the groundwater restoration program associated with the proposed Project, there would be no permanent commitment of water resources required and any potential long-term changes from the no action groundwater conditions would be limited to those identified and addressed in the groundwater restoration program.

7.4.4 Radiological Impacts

As the proposed Project would be using in-situ recovery techniques, most of the identified radioactivity in the ore body would remain permanently underground. Following standard ISR procedures, routine operational monitoring of air, dust and surface contamination would be undertaken by Uranium One as discussed in Section 5. Prior to process plant decommissioning, a preliminary radiological survey would be conducted to identify any potential radiological hazards. The survey will also support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities.

Decommissioning of process facilities would be scheduled only after agency approval. This would be accomplished in accordance with an approved decommissioning plan and the most current applicable USNRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., would be designated for one of the following removal alternatives:

- Removal to a new location within the Project area for further use or storage;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other non-restricted use by the landowners and others.

It is likely that process buildings would be dismantled and moved to another location or to a permanent licensed disposal facility. Cement foundation pads and footings would be broken up and trucked to a disposal site or to a licensed facility if contaminated. The landowners may request that a building or other structures be left on site for future use. In that case, the building would be decontaminated to meet unrestricted use criteria. At the present time, burial of contaminants on site is not anticipated.

Under the proposed operating and decommissioning conditions, the potential long-term external radiological impacts at the Project are anticipated to be negligible compared to the existing background no action conditions.

7.5 BENEFIT-COST SUMMARY

A primary economic benefit of the Project is the creation of 1,044 new job opportunities within the county, including the direct, indirect and induced employment effects over the construction and operating life of the Project (Table 7-4). Additionally, the Project may generate up to $11.5 million in total state and local business tax revenues and $48.6 million in severance tax revenues over the life of the Project, which is a significant economic gain compared to the no action alternative.

Table 7-4 further shows that the short-terms effects on housing, schools and public facilities and the increased potential for noise and congestion in the county involve little or no change compared to the current conditions. Based on the historical land uses, physical remoteness and proposed reclamation practices, no potential quantifiable long-term impairments appear to significantly offset the benefits of the proposed Project.

The proposed Project is likely to place negligible short-term or long-term cost burdens on the county, while providing increased revenue and employment opportunities; therefore, the development and operation of the proposed Project would provide a net economic benefit to Sweetwater County when compared to the no action alternative.

Table 7-4 Summary of Benefits and Costs for the Antelope and JAB Project

Benefits	Costs
• **Tax revenue** $60.1 million • **Temporary and permanent jobs** 1,044 jobs	• **Housing impacts** Little or no change • **Schools and Public Facilities** Negligible • **Noise and Congestion** None • **Impairment of recreational and Aesthetic values** Negligible • **Land Disturbance** Minor • **Groundwater impacts** Controlled through mitigation • **Radiological Impacts** Controlled through mitigation

7.6 REFERENCES

Campbell, H. and R. Brown. 2003. Benefit-Cost Analysis: Financial and Economic Appraisal Using Spreadsheets. New York: Cambridge University Press.

IMPLAN 2004. IMPLAN Professional Version 2.0 Manual Third Edition. Minnesota IMPLAN Group, Inc. February.

U.S. Office of Management and Budget (OMB). 1992. Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.

Zerbe, R. O. and A.S. Bellas. 2006. A Primer for Benefit-Cost Analysis. Northampton, MA: Edward Elgar.

8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This Environmental Report has characterized the existing baseline environment of the proposed Antelope and JAB Uranium Project and the surrounding area in Section 3. The potential environmental impacts (adverse and positive) of the proposed action were discussed in detail in Section 4. In this impact analysis, Uranium One identified unavoidable impacts of the proposed action. Alternatives for mitigation for these impacts were discussed in Section 5.

This section summarizes the environmental impacts that cannot be avoided. Where available, means of mitigation are also summarized.

Table 8-1 summarizes the unavoidable environmental impacts of the proposed construction, operation, and decommissioning of the Antelope and JAB Project. Each impact is quantified (where possible). All impacts are short-term, i.e., the predicted impact will exist during the construction, operation, and decommissioning of the Antelope and JAB Project. No significant long-term impacts that would extend beyond the duration of the project have been identified. For each impact, mitigative measures are summarized.

Table 8-1: Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Production		
Production of U3O8 (lbs)	13,500,000 pounds	None
Use of Natural Resources		
Temporary Land Surface Impacts (acres)	Significant land surface impacts to 11 acre Antelope central plant site, 5-acre JAB satellite site; minimal disturbance to remaining 1,400 estimated acres of wellfield and roads; impacted for the duration of the project.	Sediment and topsoil management during construction and operation; Surface reclamation following operational activities to return surface to pre-operational condition.
Temporary Land Use Impacts	Restriction of agricultural use of proposed 1,400 acre site; impacted for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Groundwater consumption (net gpm)	30 gpm average net consumptive use from operations and 100 gpm (JAB) to 200 gpm (Antelope) from restoration	None
Groundwater quality impacts	Temporary impacts to groundwater quality in the mining zone.	Proven groundwater restoration following mining to return groundwater quality to baseline or pre-operational water uses.
Visual and scenic impacts	Noticeable minor industrial component in existing agricultural/rural landscape;	Use of harmonizing colors; use of existing vegetation and topography; avoidance of straight line site roads to follow topography; removal of construction debris.
Emissions		
Dust emissions (tons/yr.)	202.93	Dust control measures implemented where appropriate.
Radon emissions (Curies/yr.)	547.76	None

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Table 8-1: Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Radiological Impacts		
Additional maximum predicted dose (mrem/yr.)	0..53	None
Fractional increase to background continental dose (percent)	0.000036	None
Socioeconomic Impacts		
Direct Employment		
Full time employment	60 to 80	None
Contractor employment	10 to 20	None
Part time and contractor employment during construction	75	None
Construction Capital Expenditures	$50,000,000	None
Non-payroll workers (Construction, 2010-2011)	794	None
Non-payroll workers (Full operations, 2011-2024)	180	None
Non-payroll workers (Restoration, Central Plant operations, 2025-2039)	70	None
Total Enterprise and Business Tax revenues	$11,500,000	None
Total Severance Tax revenues	$48,600,000	None
Non-payroll operating costs (operations and restoration, 2011-2024) ($/yr)	12,000,000	None
Non-payroll operating costs (Restoration, Satellite operations, 2020-34) ($/yr)	1,800,000	None
Waste Management Impacts		
Wastewater (gpm)	30 gpm average net consumptive use from operations and 100 gpm (JAB) to 200 gpm (Antelope) from restoration	Permanent disposal in Class I UIC disposal well(s)
Solid waste produced (yd^3/yr.)	4,000	Permanent disposal at license landfill

Table 8-1: Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
11e.(2) byproduct waste produced (yd^3/yr.)	500	Waste minimization; decontamination; permanent disposal at a licensed disposal facility.

9 LIST OF REFERENCES

9.1 REFERENCES FOR SECTION 1, INTRODUCTION OF THE ENVIROMENTAL REPORT

Energy Information Administration, *Summary Production Statistics of the U.S. Uranium Industry*, www.eia.doe.gov/cneaf/nuclear/dupr/usummary.html accessed August 14, 2007.

Energy Information Administration, *2006 Uranium Market Annual Report*, www.eia.doe.gov/cneaf/nuclear/umar/umar.html, accessed August 14, 2007.

9.2 REFERENCES FOR SECTION 2, ALTERNATIVES

Energy Information Administration, *Summary Production Statistics of the U.S. Uranium Industry*, www.eia.doe.gov/cneaf/nuclear/dupr/usummary.html accessed August 14, 2007.

Energy Information Administration, *2006 Uranium Market Annual Report*, www.eia.doe.gov/cneaf/nuclear/umar/umar.html, accessed August 14, 2007.

Driscoll, F.G., *Groundwater and Wells, Second Edition*, (Johnson Division, 1986).

Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*, 2001.

National Fire Protection Association, NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites*, (NFPA, 1996)

Compressed Gas Association, CGA G-4.1, *Cleaning Equipment for Oxygen Service*, (CGA, 2000)

Compressed Gas Association, CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*, (CGA, 1993)

U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Operation of the Teton Project*, NUREG-0925, June 1982. Para. 2.3.5.

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9.3 REFERENCES FOR SECTION 3

Section 3.1 References

DeLorme Maps. 2003. Wyoming Atlas and Gazetteer. Yarmouth, Maine.

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 1986. Lander Field Office EIS/Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 2007a. Bureau of Land Management Allotment Master Report: Wy32001, Green Mountain Cmn. [Web Page] http://www.geocommunicator.gov/NILS-PARCEL2/map.jsp?Map=USFS. Accessed June 8, 2007.

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 2007b. Land and Mineral Use Records Viewer; Oil and Gas Map, Authorized Leases. [Web Page] http://www.geocommunicator.gov. Accessed June 8, 2007.

U.S. Nuclear Regulatory Commission (USNRC). 2007. Locations of Fuel Cycle Facilities. [Web Page] http://www.nrc.gov/info-finder/materials/fuel-cycle. Accessed 6/05/07.

National Agricultural Statistics Service (NASS). 2005. Sweetwater County Agriculture. [Web Page] http://www.nass.usda.gov/wy/internet/cntydata/Sweetwater ? 05.pdf. Accessed on 6/05/07.

Wyoming Department of Transportation (WYDOT). 2005. 2004 Vehicle Miles Traveled. [Web Page] http://www.dot.state.wy.us/Default.jsp?sCode=hompn. Accessed on 6/18/07.

Wyoming Legislative Service Office. 2008. Wyoming Statutes § 35-11-103 (e) (xxvi). Title 35 Public Health and Safety; Chapter 11 - Environmental Quality, Article 1 – General Provisions[WebPage] http://legisweb.state.wy.us/statutes/statutes.aspx?file=titles/Title35/T35CH11.htm. Accessed June 8, 2007.

Section 3.2 References

No References

Section 3.3 References

Case, James C, and Toner, Rachel N., and Kirkwood, Robert, *Basic Seismological Characterization for Fremont County, Wyoming,* (Wyoming State Geological Survey, September 2002)

Case, James C, and Toner, Rachel N., and Kirkwood, Robert, *Basic Seismological Characterization for Carbon County, Wyoming,* (Wyoming State Geological Survey, September 2002)

Case, James C, and Toner, Rachel N., and Kirkwood, Robert, *Basic Seismological Characterization for Sweetwater County, Wyoming,* (Wyoming State Geological Survey, September 2002)

Case, James C, and Toner, Rachel N., and Kirkwood, Robert, *Basic Seismological Characterization for Natrona County, Wyoming,* (Wyoming State Geological Survey, January 2003)

Section 3.4 References

Collentine, M. et. al. 1981. Occurrence and characteristics of ground water in the Great Divide and Washakie Basins, Wyoming: Water Research Institute, University of Wyoming, report for the U.S. Environmental Protection Agency, report code G-008269-79.

Cooper, H.H. and C.E. Jacob. 1946. A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well Field History: American Geophysical Union Transactions, Vol. 27, pp. 526-534.

Fisk, E.P. 1967. Groundwater geology and hydrology of the Great Divide and Washakie basins, south central Wyoming: M.S. Thesis, University of Southern California.

Hantush, M.S. and C.E. Jacob. 1955. Non-Steady Radial Flow in an Infinite leaky Aquifer: Transactions of the American Geophysical Union, Vol. 36, pp. 95-100.

Hydro-Engineering. 1984. Hydrology of the JAB Project Area: Consultant's report prepared for Umetco Minerals Corporation.

Lowham. 1976. Techniques for Estimating Flow Characteristics of Wyoming Streams, U.S. Geological Survey, Water Resources Investigation 76-112.

Mason, J.P. and K.A. Miller. 2005. Water Resources of Sweetwater County, Wyoming. U.S. Department of the Interior and U.S. Geological Survey. Scientific Investigations Report 2004-5214.

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-Frequency Atlas of the Western United States: Volume II – Wyoming. U.S. Department of Commerce. National Oceanic and Atmospheric Administration Stock Number 0317-00155.

Schlumberger Water Services. 2008. Aquifer Test Pro 4.2™, Aquifer Test data analysis software package.

Theis, C.V. 1935. The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well using Groundwater storage: Trans. American Geophysical Union, Vol. 16, pp. 519-524.

U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency. 2002. National Hydrography Dataset. http://data.geocomm.com/. Accessed May 26, 2008.

Welder, G.E. and L.J. McGreevy. 1966. Ground-water reconnaissance of the Great Divide and Washakie Basins and some adjacent areas, southwestern Wyoming: U.S. Geological Survey Hydrologic Investigations Atlas HA-219.

Whitehead, R.L. 1996. Ground water Atlas of the United States: Montana, North Dakota, South Dakota, Wyoming: U.S. Geological Survey Hydrologic Investigations Atlas HA 730-I. http://capp.water.usgs.gov/gwa/ch_i/index.html.

Wyoming State Engineers Office. 2002. Water Rights Database http://seo.state.wy.us/wrdb/index.aspx. Wyoming State Engineer's Office. Accessed April, 2008.

U.S. Fish and Wildlife Service. 2007. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79-31. U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation. http://wetlandsfws.er.usgs.gov. Accessed May 26, 2008.

Section 3.5 References

Vegetation

Dorn, R.D. 2001. Vascular Plants of Wyoming, 3rd ed. Mountain West Publishing, Cheyenne, Wyoming. 412 pp.

Wyoming Department of Environmental Quality, Land Quality Division. 1997 (November Revised). Guideline 2.

2007 Declared Weed and Pest List. Wyoming Weed and Pest Council. July 11, 2007. <http://www.wyoweed.org/>.

2006 Federal and State Protected Plants in Wyoming. United States Fish & Wildlife Service. October 9, 2006. <http://plants.usda.gov>.

Wetlands

Dorn, R.D. 2001. Vascular Plants of Wyoming. 3rd Edition. Mountain West Publishing, Cheyenne, Wyoming. 289 pp.

U.S. Army Corps of Engineers. (2006). Interim *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region.* ed. J.S. Wakeley, R.W. Lichvar, and C.V. Noble. ERDC/EL TR-06-16. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Fish and Wildlife Service. 1997. National List of Vascular Plant Species that Occur in Wetlands: 1996 National Summary.

Wyoming Game and Fish. 2007. National Wetlands Inventory Mapping from 1976.

Wildlife

Cerovski, A., M. Gorges, T. Byer, K. Duffy, and D. Felley, editors. 2001. *Wyoming Bird Conservation Plan, Version 1.0.* Wyoming Partners in Flight. Wyoming Game and Fish Department, Lander, Wyoming.

Cerovski, A.O., M. Grenier, B. Oakleaf, L.Van Fleet, and S. Patla. 2004. *Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming.* Wyoming Game and Fish Department Nongame Program, Lander, Wyoming.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. *Mammals of Colorado.* Denver Museum of Natural History, Denver, Colorado.

Grenier, Martin. 2003. *An Evaluation of Black-footed Ferret Block Clearances in Wyoming: Completion Report*. Wyoming Game and Fish Department. Lander, WY. 16pp.

Hill, D.P. 1998. *Status of the long-billed curlew (Numenius americanus) in Alberta.* Alberta Environmental Protection, Wildlife Status Report No. 16, Edmonton, AB.

Holt, D.W. and S.M. Leasure. 1993. *Short-eared owl* (*Asio flammeus*). *In* The Birds of North America, No. 62 (A. Poole and F. Gill, Eds.) The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Knight, D. H. 1994. *Mountains and Plains: the ecology of Wyoming Landscapes.* Yale University.

Prescott, D.R.C, and R.R. Bjorge. 1999. *Status of the loggerhead shrike (Lanius ludovicianus) in Alberta.* Alberta Environment, Wildlife Status Report No. 24, Edmonton, AB.

U.S. Department of Agriculture Forest Service. 2002. *Updated Land and Resource Management Plan for the Thunder Basin National Grassland, Medicine Bow-Routt National Forest, Rocky Mountain Region.* USDA Forest Service, Medicine Bow-Routt National Forest, Rocky Mountain Regional Office, Denver, Colorado.

U.S. Department of Interior Fish and Wildlife Service. May 2, 2002. Migratory bird species of management concern in Wyoming non–coal list. Wyoming Field Office of the U.S. Fish and Wildlife Service, Cheyenne.

Walker, B. 2004. *Effects of management practices on grassland birds: Brewer's Sparrow*. Northern Prairie Wildlife Research Center, Jamestown, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Online.

http://www.npwrc.usgs.gov/resource/literatr/grasbird/brsp/brsp.htm (Version 12AUG2004).

With, K. A. 1994. *McCown's longspur (Calcarius mccownii). In* A. Poole and F. Gill, editors. The Birds of North America, Number 96. The Academy of Natural

Sciences, Philadelphia, Pennsylvania, and The American Ornithologists' Union, Washington, D.C.

Wyoming Game and Fish Department. 2006. Big Game Job Completion Reports. Wyoming Game and Fish Department. http://gf.state.wy.us/wildlife/JobCompletionReports

Section 3.6 References

Curtis, J. and K. Grimes, 2007: *Wyoming Climate Atlas.* Available: http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/ [2007,May 2].

Martner, B.E.,1986: *Wyoming Climate Atlas*. University of Nebraska Press, Lincoln, NE.

National Climatic Data Center, 2007: *Surface Data, Monthly Extremes.* Available: http://gis.ncdc.noaa.gov/website/ims-cdo/extmo/viewer.htm?Box=-110.307738654357:41.4493000825986:-102.349767058746:45.2536595444503 [2006, July 13].

Western Region Climate Center, 2007: *Local Climate Data Summaries*. Available: http://www.wrcc.dri.edu/summary/lcd.html [2006, Jan 28].

Lost Creek Project, *NRC Technical Report*, Volume 1 [2007, October].

Sweetwater Uranium Project, *Revised Environmental Report*, Kennecott Uranium Company [1994, August].

Section 3.7 References

No references.

Section 3.8 References

Graves, A., and Hahn, A., *Energy Metals Corporation US, JAB Uranium Project Class III Cultural Resource Inventory Sweetwater County, Wyoming,* ARCADIS U.S., Inc. Project Number: CO001252.0002, September 2007.

Graves, A., and Hahn, A., *JAB Uranium Project, Addendum, Sweetwater County, Wyoming,* ARCADIS U.S., Inc. Project Number: CO001252.0002, June 2007.

Landem, M. J., *Uranium One, Americas Antelope Uranium Project Cultural Resource Inventory Report, Sweetwater County Wyoming,* Jones and Stokes Project number: 00178.07 002, April 2008.

Section 3.9 References

United States Department of the Interior (USDOI), Bureau of Land Management (BLM). 1986a. Lander Field Office EIS/Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

BLM. 1986b. Visual Resource Inventory (VRM). BLM Manual Handbook 8410-1.

BLM. 1986c. Visual Resource Contrast Rating. BLM Manual Handbook 8431-1.

BLM. 1985. Rawlins Field Office EIS/Resource Management Plan. [Web Page] http://www.blm.gov/rmp/WY/application/rmp_toc.cfm?rmpid=101. Accessed June 8, 2007.

BLM. 2005. Draft Environmental Assessment for the Pappy Draw Coalbed Natural Gas Pilot Project. U. S. Department of Interior Bureau of Land Management Lander Field Office. August 2005.

Section 3.10 References

U.S. Department of Commerce, Bureau of Economic Analysis (BEA). 2006. 2005 Personal Income for Wyoming.

BEA. 2007. Employment by Industry; Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce. [Web Page] http://www.bea.gov/regional/reis/. Accessed on June 14, 2007

Carbon County School District #1. 2007. Schools in Carbon County. [Web Page] http://www-rawlins.crb1.k12.wy.us/Schools.htm. Accessed on June 22, 2007.

Carbon County School District. 2007. [Web Page] http://www.Carbonschools.org/about/choice/midwest.pdf. Accessed on June 13, 2007.

Rawlins Chamber of Commerce. 2007. [Web Page] Accommodations. http://www.Rawlinswyoming.info/ lodging.php. Accessed June 14, 2007.

Thomas, C., M. Enzi, and B. Cubin. 2004. Letter to Phillip Merrill, President and Chairman of the Import Export Bank of the United States regarding the application by the bank to finance the construction of a soda ash plant in Turkey. Dated September 20, 2004. [Web Page] http://lautenberg.senate.gov/~enzi/exim.pdf. Accessed June 19, 2007.

U.S. Department of Commerce, Bureau of Census. 2000. Decennial Census of Population, Wyoming.

U.S. Department of Commerce, Bureau of Census. 2007. Population Estimates Program; 2000 – 2006.

Wyoming Department of Administration and Information, Economic Analysis Division. 2004. Wyoming Population Estimates and Forecasts from 1991 to 2010.

Wyoming Department of Education. 2007. Profile Reports for Sweetwater and Carbon County School Districts. [Web Page] https://wdesecure.k12.wy.us/. Accessed on June 13, 2007.

Wyoming Community Development Authority. 2007. Profile of Wyoming Demographics, Economics and Housing; Semiannual Report, Ending December 31, 2006. Volume I Final Report Sponsored by the Wyoming

WDAI EAD. 2005. 10 Year Outlook Wyoming Economic and Demographic Forecast 2005 to 2014. [Web page] http://eadiv.state.wy.us. Accessed on June 14, 2007

Housing Database Partnership, February 2007. [Web Page] http://www.wyomingcda.com/Homebuyer/ Home_Demographics.html. Accessed on June 13, 2007.

Bureau of Land Management (BLM). 2005. Draft Environmental Assessment for the Pappy Draw Coalbed Natural Gas Pilot Project. U. S. Department of Interior Bureau of Land Management Lander Field Office. August 2005.

Section 3.11 References

Eisenbud, M and Gesell, T., Environmental Radioactivity from Natural, Industrial and Military Sources. Academic Press, Inc. 4th Edition.

Davis, V.A., Wyoming Department of Employment, Wyoming Labor Force Trends, Volume 44 No.12, 2007

Section 3.12 References

No References.

9.4 REFERENCES FOR SECTION 4, ENVIRONMENTAL IMPACTS

American National Standards Institute, Safety Requirements for the Storage and Handling of Anhydrous Ammonia, 1989.

Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses, 2001.

COGEMA Mining, Inc., Wellfield Restoration Report, Irigaray Mine, June 2004.

Compressed Gas Association, Inc., CGA G-4.4, Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems, 1993.

Compressed Gas Association, Inc., CGA-G-4.1, Cleaning Equipment for Oxygen Service, 1996.

Office of Pipeline Safety, 2007. Pipeline Statistics 2006. [Web Page] located at http://ops.dot.gov/stats/stats.htm#average, Accessed August 24, 2007.

U.S. Department of the Interior, Bureau of Land Management, Wyoming State Office, Buffalo Field Office, Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project, WY-070-02-065, January 2003.

U.S. Department of the Interior, Bureau of Land Management, Wyoming State Office, Buffalo Field Office, Record of Decision and Resource Management Plan Amendments for the Powder River Basin Oil and Gas Project, WY-070-02-065, April 2003.

U.S. Nuclear Regulatory Commission, NUREG-1508, Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico. 1997.

U.S. Nuclear Regulatory Commission, NUREG–0706, Final Generic Environmental Impact Statement on Uranium Milling—Project M–25, September 1980.

U.S. Nuclear Regulatory Commission, NUREG–1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, June 2003.

U.S. Nuclear Regulatory Commission, Regulatory Guide 3.59, Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations, March 1987.

U. S. Nuclear Regulatory Commission, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material (May 1987).

9.5 REFERENCES FOR SECTION 5, MITIGATION MEASURES

COGEMA Mining, Inc., *Wellfield Restoration Report, Irigaray Mine*, June 2004.

U.S. Nuclear Regulatory Commission, *Review of Power Resources, Inc.'s A-Wellfield Ground Water Restoration Report for the Smith Ranch-Highland Uranium Project*, June 29, 2004.

U.S. Nuclear Regulatory Commission, *Technical Evaluation Report, Review of Cogema Mining, Inc.'s Irigaray Mine Restoration Report, Production Units 1 through 9, Source Materials License SUA-1341*, September 2006.

U.S. Nuclear Regulatory Commission, NUREG-1569, *Standard Review Plan for In situ Leach Uranium Extraction License Applications."* 2003.

Argonne National Laboratory, C. Yu, A. J. Zielen, J.-J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H. Peterson. *User's Manual for RESRAD Version 6.* 2001.

Argonne National Laboratory, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*, 1993.

U.S. Nuclear Regulatory Commission, Regulatory Guide No. 8.30, *Health Physics Surveys in Uranium Recovery Facilities*, May 2002.

ICRP, 1995. ICRP Publication 69. "Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 3 Ingestion Dose Coefficients." 1995. International Commission on Radiation Protection. Elsevier Science Inc., 660 White Plains Road, Tarrytown, New York 10591

NRC, 1992, NUREG/CRR-5512 (PNL-7994) Vol. 1, *"Residual Radioactive Contamination from Decommissioning,"* U.S. Nuclear Regulatory Commission, Washington, D. C. 20555.

NRC, 2001. NUREG/CR-5512, Vol. 2. "Residual Radioactive Contamination From Decommissioning. User's Manual," draft, April 2001. U. S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC 20555-0001

9.6 REFERENCES FOR SECTION 6, ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills*. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1982. Regulatory Guide 3.46. *Standard Format and Content of License applications, Including Environmental Reports, for In Situ Uranium Solution Mining*. Nuclear Regulatory Commission Office of Nuclear Regulatory Research. Washington, D.C.

Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD). 2007. In Situ Mining Permit Application Requirements Handbook. *Application Content Requirements – Adjudication and Baseline Information*. March, 2007

EMC (Energy Metals Corporation US). 2007. *Application for US NRC Source Material License, Moore Ranch Uranium Project.* Technical Report, Volume II. NRC website, ADAMS accession number ML072851268

Johnson, J.A. Meyer, H.R., and Vidyasagar, M. 2006. *Characterization of Surface Soils at a Former Uranium Mill.* Operational Radiation Safety. Supplement to Health Physics, Vol. 90, February, 2006.

Lost Creek ISR, LLC. 2007. *Application for US NRC Source Material License, Lost Creek Project.* (Docket No. 40-9068). Technical Report, Volume 2 of 3. October, 2007.

Meyer, R.; Shields, M.; Green, S. 2005a. *A GPS-based system for preliminary or remedial action gamma scanning.* American Nuclear Society Topical Meeting on Decommissioning,
Decontamination, & Reutilization. Denver, Colorado, August 7-11, 2005.

Meyer, R.; Shields, M.; Green, S.; Johnson, J. 2005b. *A GPS-based system for radium/uranium contamination gamma scanning.* Uranium Mining and Hydrogeology IV. Broder J. Merkel, Andrea Hasche-Berger (Editors). Uranium in the Environment, conference proceedings, Freiberg, September 2005.

Tetra Tech Inc. 2006. *Gamma Data Map Viewer software.* Tetra Tech Inc., 3801 Automation Way, Ft. Collins, CO 80525.

U.S. Nuclear Regulatory Commission (NRC). 1994. *Background as a Residual Radioactive Criteria for Decommissioning (Draft Report).* NUREG/1501. U.S. Nuclear Regulatory Commission.

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills.* Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1982. Regulatory Guide 3.46. *Standard Format and Content of License applications, Including Environmental Reports, for In Situ Uranium Solution Mining.* Nuclear Regulatory Commission Office of Nuclear Regulatory Research. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1.* NUREG 1575. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2003. *NUREG-1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications.* Final Report. U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards. Washington, D.C.

Whicker, R., Cartier, P., Cain, J., Milmine, K., Griffin, M. 2008. *Radiological Site Characterizations: Gamma Surveys, Gamma/^{226}Ra Correlations and Related Spatial Analysis Techniques.* Operational Radiation Safety. Supplement to Health Physics. *In Press.*

Whicker, R., Whicker, M, Johnson, J. Meyer, B. 2006. *Mobile soils lab: on-site radiological analysis supporting remedial activities.* Operational Radiation Safety. Supplement to Health Physics, Vol. 91(2), August, 2006.

Foster, B. 1993. *Radon: An Invisible Threat.* National Conference of State Legislatures. Energy, Science and Natural Resources Program. State legislative Report, Vol. 18, No. 8, July 1, 1993.

U.S. Environmental Protection Agency (EPA). 2000. *National Primary Drinking Water Regulations; Radionuclides; Final Rule.* Federal Register: December 7, 2000 (Volume 65, Number 236).

Welch, B.L. 2005. *Big sagebrush: A sea fragmented into lakes, ponds, and puddles.* General Technical Report RMRS-GTR-144. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 210 p.

International Atomic Energy Agency (IAEA). 1994. Handbook of parameter values for the prediction of radionuclide transfer in temperate environments. Technical reports series No. 364. International Union of Radioecologists and International Atomic Energy Agency, Vienna, Austria.

Yu, C., et al. 2001. User's manual for RESRAD, Version 6, ANL/EAD-4, Argonne national Laboratory, Argonne, Illl., July.

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Campbell, H. and R. Brown. 2003. Benefit-Cost Analysis: Financial and Economic Appraisal Using Spreadsheets. New York: Cambridge University Press.

IMPLAN 2004. IMPLAN Professional Version 2.0 Manual Third Edition. Minnesota IMPLAN Group, Inc. February.

U.S. Office of Management and Budget (OMB). 1992. Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.

Zerbe, R. O. and A.S. Bellas. 2006. A Primer for Benefit-Cost Analysis. Northampton, MA: Edward Elgar.

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