Power Resources, Inc.

REYNOLDS RANCH AMENDMENT

PERMIT TO MINE NO. 1548 - SMITH RANCH-HIGHLAND URANIUM PROJECT

VOLUME I

CHAPTERS 1-10

DECEMBER 2004

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CHAPTER 1
PROPOSED ACTIVITIES

1.1 INTRODUCTION

The Smith Ranch-Highland Uranium Project (SR-HUP) is a commercial in situ leach (ISL) facility located in the South Powder River Basin, Converse County, Wyoming. The current U.S. Nuclear Regulatory Commission (NRC), License Number SUA-1548 was issued in conformance with the License Renewal process to Power Resources, Inc. (PRI) on August 18, 2003. The expiration date of this license is September 30, 2010. License SUA-1548 is a consolidation of the Highland Uranium Project (HUP), Smith Ranch Project (SRP), Gas Hills Project (GHP), Ruth/North Butte Project (R/NBP). Currently, the GHP and the R/NBP are non-producing uranium properties that will potentially be used as Satellite production centers to the SR-HUP in the future. Commercial ISL production of uranium is currently continuing at both the Smith Ranch and Highland sites. Commercial production began at the HUP in January 1988 and at the SRP in June 1997.

PRI also controls the proposed Reynolds Ranch Project, which is a proposed Satellite Facility to the SR-HUP. The Reynolds Ranch Satellite Facility lies directly north, and adjacent to, the SR-HUP license area. A portion of the Reynolds Ranch proposed southern boundary is shared with a portion of the northern boundary for SR-HUP, thereby producing contiguous property between the two license areas. PRI desires to amend the existing NRC License SUA-1548 to operate a commercial uranium in situ leach (ISL) Satellite Facility and accompanying wellfields at the proposed Reynolds Ranch Satellite Facility. Accordingly, this License Amendment Request submitted herein intends to accomplish these actions by revising the current SUA-1548 Volume 1, Chapters 1-10, and submitting baseline information for Reynolds Ranch contained in Appendices A through E.

Reclamation Performance Bonds that cover aquifer and surface reclamation are held by the WDEQ. The amount of the Performance Bonds is updated annually via the Annual Surety Estimate Revision to account for new areas as they are disturbed and/or to reflect completion of decommissioning/reclamation. Both the NRC and WDEQ review and approve the annual revisions.

Additionally, PRI will be applying to the WDEQ for a Mine Permit Amendment and an Aquifer Exemption for wellfield areas associated with the Reynolds Ranch Satellite Facility.

1.2 GENERAL SOLUTION MINING PROCESS

The mechanics of uranium ISL mining are relatively straightforward. A carbonate/bicarbonate leaching solution and oxidant are injected into the ore bearing sandstone formation through a series of wells that have been drilled, cased, cemented, and tested for mechanical integrity. The leach solution is comprised of native ground water combined with oxygen and carbon dioxide. As the leaching solution moves through the formation and contacts the ore, the uranium is oxidized, becomes soluble and dissolves into the leaching solution. The uranium bearing solution is drawn to a recovery well where it is pumped to the surface and transferred to the recovery plant. In the plant the uranium is recovered from the leach solution by ion exchange (IX) and the solution is re-injected to extract additional uranium.

1.3 ADVANTAGES OF ISL URANIUM MINING

ISL uranium mining is a proven technology that has been successfully demonstrated commercially in Texas and Nebraska, and at the SR-HUP, and other operations in Wyoming. ISL mining of uranium is environmentally superior to conventional open pit and underground uranium mining as evidenced by the following:

1. ISL mining results in significantly less surface disturbance as mine pits, waste dumps, haul roads, and tailings ponds are not needed.

2. ISL mining requires much less water demand as pit dewatering, conventional milling, and tailings transport are avoided.

3. The lack of heavy equipment, haul roads, waste dumps, etc. result in very little air quality degradation at ISL mines.

4. Fewer employees are needed at ISL mines, thereby reducing transportation and socioeconomic concerns.

5. Aquifers are not excavated, but remain intact during and after ISL mining.

6. Tailings ponds are not used, thereby eliminating a major ground water pollution concern.

7. ISL uranium mining results in leaving the majority of other contaminants where they naturally occur instead of moving them to waste dumps and tailings ponds where their presence is of more environmental concern.

1.4 ORE AMENABILITY TO ISL URANIUM MINING

Amenability of the uranium deposits in the SR-HUP area to ISL mining was demonstrated initially through core studies, four pilot projects and commercial operations at the SR-HUP.

Results of the core studies were confirmed in the two pilot research and development (R&D) projects at the Smith Ranch site using bicarbonate/carbonate leaching solutions with hydrogen peroxide and oxygen. The pilots were authorized by Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD) Permits 5RD and 13RD and by NRC License SUA-13387. These tests, conducted in uranium deposits at depths of 500 feet and 750 feet, have demonstrated the feasibility of mining the uranium reserves in the project area using ISL methods.

The initial ISL pilot, the Q-Sand pilot, operated until May 1986. Uranium recovery from the pilot exceeded the forecast recovery and aquifer restoration, completed in May 1986, was deemed acceptable, as was the completion of a one-year aquifer stability demonstration period. The second ISL pilot, the O-Sand pilot, was initiated in July 1984 and performed as forecast, confirming the amenability of the ore to ISL mining.

Two pilot R&D projects were completed at the Highland site by Exxon during the period 1972 to 1981. These projects were operated under WDEQ-LQD Permit No. 218-C and NRC License SUA-1064. The first pilot R&D project, known as the "Original R&D", was operated from 1972 to 1976. This project investigated the technical feasibility of in situ uranium mining utilizing different concentrations of sodium bicarbonate and hydrogen peroxide within the leach fluid.

The second pilot R&D Project, known as the "Expanded R&D", which was operated from December 16, 1978 to September 1981, demonstrated the technical feasibility of in situ mining utilizing gaseous oxygen, sodium bicarbonate and gaseous carbon dioxide within the leach fluid, the ability to control leach fluids within the mining zone, and the restorability of the affected ground water to its original use suitability. Reports concerning the results of the pilot activities, including restoration of affected ground water, were previously submitted to NRC and WDEQ.

Currently, active in situ mining is being conducted at the Smith Ranch-Highland Uranium Project utilizing gaseous oxygen and carbon dioxide. These mining operations have demonstrated the ability to mine uranium using in situ processes in a profitable manner, and have also demonstrated the ability to contain mining fluids and to complete ground water restoration.

Based on information and experience gained during the pilot programs and active mining operations, PRI desires to proceed with commercial uranium ISL mining operations at Reynolds Ranch Satellite Facility and believes the pilots and active mining have demonstrated that such a program can be implemented with only minimal short-term environmental impacts and with no significant risk to the public health or safety. The remainder of this application describes the Mining and Reclamation plans for this project and the concurrent environmental monitoring programs to be employed to ensure that any impact to the environment or public is minimal.

CHAPTER 2
SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

The SR-HUP permit area for the uranium mining project is located in the North Platte River drainage of the southern Powder River Basin, Converse County, Wyoming. The Main Office and the Central Processing Plant (CPP) complex located at Smith Ranch is approximately 17 air miles (22 road miles) northeast of the town of Glenrock, Wyoming and 23 air miles (25 road miles) northwest of Douglas, Wyoming. Access to the site from the intersection of State Highway 93 and Highway 95 is by Ross Road, a paved county road. The Reynolds Ranch amendment area is located in the Little Cheyenne River drainage of the southern Powder River Basin and is located directly north of, and adjacent to, the current SR-HUP permit area. Figure 2-1 shows the general location and access to the project area.

Plate 1 shows the lands controlled by the SR-HUP and the locations of facilities, including; Satellite buildings, wellfields, major roads, the Main Office, Central Processing Plant area, and the proposed Reynolds Ranch amendment area. Currently, four Satellite facilities and one Central Plant are located at the SR-HUP. One Satellite facility will be located at the Reynolds Ranch amendment area, which will accommodate eight planned wellfields. The SR-HUP mine permit area encompasses approximately 30,760 acres (approximately 14,560 acres in the former HUP area and 16,200 acres in the former SR area). The combined acreage of 30,760 acres for the SR-HUP mine permit area differs slightly from the historic acreage for the individual operations as the operations previously shared "over-lapping" mine permit areas. The Reynolds Ranch Amendment area will add approximately 8,704 acres to the current SR-HUP license area.

The current land surface ownership of SR-HUP includes approximately 22,660 acres of private ownership, 3,300 acres of State of Wyoming ownership, 3,075 acres of U.S. Government ownership (administered by the Bureau of Land Management (BLM)), and 1,725 acres directly owned by PRI. The Reynolds Ranch amendment area contains approximately 720 acres of U.S. Government ownership (administered by the BLM), 640 acres of State of Wyoming ownership, 240 acres directly owned by PRI, and 7,135 acres of other private ownership.

Names and addresses of the surface and mineral owners of record within the current SR-HUP permit area were previously provided in Appendix A, B, and C of previous applications. Names and addresses of the surface and mineral owners of record within and around the proposed Reynolds Ranch amendment area are listed in Appendix A and surface and mineral owners of record within one-half mile of the permit area are listed in Appendix B of this amendment application. Figures A-1 and A-2 show the surface and mineral owners within the amendment area and within one-half mile of the amendment area. These appendices also list owners of record with valid legal estate in the permit area and on adjacent lands. Appendix C shows the location of lands by legal subdivision, section, township, range, county, and municipal corporation.

The Main Office and Central Processing Plant are located at the former Bill Smith underground mine site in the NW ¼ Section 36, T36N, R74W. The HUP Office/Central Plant complex, which went on "standby" status in late 2002, is located in the NW ¼ Section 29, T36N, R72W.

2.2 USES OF ADJACENT LANDS AND WATERS

2.2.1 General

Lands contained within the SR-HUP mine permit and Reynolds Ranch amendment area have historically been used for sheep and cattle grazing. PRI controls mineral and surface rights in the areas scheduled for uranium mining and development. The only residential site within the mine permit area is the Vollman Ranch, which is located in the NW ¼ Section 27, T36N, R73W (see Plate 1). The ranch house is located approximately 2000 ft from the F-Wellfield and 2.1 and 1.5 miles from Satellite Nos. 2 and 3, respectively. The only other residential sites near the SR-HUP include the Sundquist (Smith) Ranch and Fowler Ranch, Reynolds Ranch, Hornbuckle Ranch, Lenzen Ranch, and Baker Ranch, which are all located outside the current mine permit area and Reynolds Ranch amendment area.

The proposed use of the land for the immediate future includes continued livestock grazing and in situ uranium mining on a commercial scale. Currently ,approximately 1200 acres at the SR-HUP have been excluded from livestock by fencing. The majority of the excluded acreage results from fencing of wellfield and Satellite areas and the two land application (irrigation) facilities. A breakdown of the current approximate acreage of fenced areas is as follows:

Area	Acres
Wellfields/Satellites	800
Satellite No. 1 Irrigation Facilities/Reservoir	125
Satellite No. 2 Irrigation Facilities/Reservoir	180
Smith Ranch Main Office/Central Plant Area	45
Highland Main Office/Central Plant Area	50

A maximum of 325 acres of Wellfields/Satellite are expected to be excluded from livestock at the Reynolds Ranch amendment area.

After mining activities are completed, the land will be returned to the pre-mining use of livestock grazing and wildlife use. The Reclamation Plan included in Chapter 6 of this application describes how affected areas will be decommissioned and reclaimed after the completion of mining activities.

2.2.2 Agricultural Activity

Livestock grazing is the main source of food production and agricultural activity on the permit area and the adjacent lands. Due to the short growing season, the forage provided by natural vegetation, although nutritious, is sparse. According to personnel from the U.S.D.A. Soil Conservation Service Office in Douglas (November 10, 1986), the stocking rate in the vicinity of the mine site averages one-fourth to one-third of an animal unit per acre, per month, on range that is in good condition. In the past, some isolated areas were homesteaded and dry farmed. Most of these dry farms ultimately were abandoned and left to revegetate by natural processes, or seeded with crested wheat grass or other grasses for grazing purpose.

2.2.3 Recreation

Major recreational activities within a fifty mile radius of the proposed mine site are mostly outdoor activities, such as camping, hunting, picnicking, hiking, skiing and snowmobiling. Water sports, such as water skiing, boating, canoeing and fishing are popular in public use areas designated by the state and counties along the North Platte River and at Alcova Lake and the Glendo Reservoir. In addition to State and Community designated parks and recreation areas, a portion of the Medicine Bow National Forest, approximately forty miles south of the site, provides additional area for recreational activities. Figure 2-2 shows the approximate location of these major facilities and points of interest in the general area.

2.2.4 Water Rights

Appendix D-6 (Hydrology) of the previous License Application lists surface and ground water rights for the SR-HUP area. Adjudicated surface water rights are limited to several stock ponds and ditches that retain surface water runoff on a limited basis. The majority of ground water rights in the SR-HUP area are associated with monitoring wells and the production areas at the ISL mining operations. For the Reynolds Ranch amendment area, records on file in the Office of the Wyoming State Engineer indicate that there is one adjudicated water right in the permit area or within one half mile of the permit boundary. PRI does not hold any adjudicated water rights within the permit area. The majority of the wells within the Reynolds Ranch amendment area were installed by Solution Mining Corp., Rio Algom Mining Corp., and PRI for the purpose of collecting ground water quality data and to determine ground water aquifer characteristics. Appendix D-6 submitted with this amendment application shows the location of adjudicated water rights and all known wells inside and within ½ mile of the Reynolds Ranch amendment area.

As is the case with many of the intermontane basins in Wyoming, water in the vicinity of the permit area is available primarily from ground water. The ground water sources may receive sporadic recharge due to runoff from the limited precipitation in the region. However, this quantity of this recharge is relatively insignificant since it can only occur at sandstone surface outcrops of the aquifers that constitute a very limited receiver relative to the entire Powder River Basin. None of the principle sources of ground water outcrop or receive recharge within the permit area.

The SR-HUP and permit area and proposed Reynolds Ranch amendment area have several known stock ponds consisting of small earthen dams across dry stream channels that collect the small quantities of runoff. Two of these ponds are supplemented by ground water pumped from a well by a windmill. Some water also accumulates in small excavations or natural depressions at low points in the Sage Creek and Duck Creek drainage. No other significant waterbodies are present in the permit area. During underground mining the local rancher constructed a small reservoir to collect water discharged from the Bill Smith Mine and used the water for irrigating approximately 160 acres of alfalfa and native grass. However, with the absence of pumping from the mine after it was reclaimed and abandoned, the reservoir is dry most of the time but is still used as a stock pond when there is runoff.

Wells in the vicinity of the current and proposed permit areas, excluding those monitoring wells owned by PRI, are rather uniformly distributed over the area. Most of these wells are associated with windmills used for livestock watering. As such, these wells are usually shallow, less than 180 feet in depth. Only four wells in the current SR-HUP permit area, Reynolds Ranch amendment area, and on adjacent lands are known to be used for domestic water supply.

These wells include the water well at the Sundquist (Smith) Ranch located approximately 2.6 miles southwest of the Smith Ranch Main Office/CPP site, the Vollman Ranch well located approximately 1.5 miles east of Satellite No. 3, the Fowler Ranch well located just north of the permit area approximately 2.5 miles north of the Highland Central Plant, and the Mason House (unoccupied) located near the proposed Reynolds Ranch Satellite Facility. Plate 1 shows the locations of these dwellings. Water wells at the Satellite buildings, the Highland Central Plant, and the Smith Ranch Main Office/CPP site only supply water for plant operations and washing purposes. These water supplies are not used for drinking as bottled water is supplied for this purpose.

The four ranch wells in the area are all completed (screened) at depths stratigraphically above the zones planned for ISL mining and are also located distant from planned wellfield areas. The Sundquist (Smith) Ranch well is 105 ft in depth, the Vollman Ranch well is 180 ft in depth, the Fowler Ranch well (used very intermittently as fulltime residents do not reside at the site) is 212 ft deep, and the Mason House (unoccupied) is 118 ft deep. No mining is planned for the zones these wells are completed in as there is no uranium mineralization of economic significance in these zones. Since these wells are located laterally from proposed mine areas and are vertically separated from the ore zones by at least 300 to 400 ft of alternating layers of shale, siltstone, and sandstone, it is very unlikely that the wells will be affected by mining related activities. The intensive ground water monitoring program utilized during operation would detect any problems prior to these wells being adversely affected.

Appendix D-6 of this amendment application contains a detailed Hydrologic analysis of the proposed Reynolds Ranch amendment area.

2.3 POPULATION DISTRIBUTION

The population within fifty miles of the Smith Ranch Main Office/CPP site is centered within the communities of Casper, Douglas and Glenrock, Wyoming as shown on Figure 2-2. These urban areas are significant in that they provide the major locations of public services such as schools, churches, medical care facilities, and public parks. These communities also provide the majority of the cultural and scenic attractions for the residents of Converse and Natrona Counties.

Casper, Wyoming is the County Seat of Natrona County. In 1986 Casper claimed to be the largest city in the state. Casper has developed into a regional retail trade center serving a 150 mile radius which includes all or part of seven counties. Its regional prominence as a retail center is supported by the Eastridge Mall, which opened in the Fall of 1982. The Casper labor force and population peaked in Spring of 1982 and has declined since that time.

Casper has doubled its acre size during the ten years between 1975 and 1985. This growth can be contributed to the energy boom in the late 1970s and early 1980s. From 1970 to 1980 the city experienced a 30% increase in its population. Decreases in the price and demand for both oil and uranium have contributed to a population loss between 1980 and 1990. As can be seen on Table 2-1, the population in Casper fell from 51,016 in 1980 to 46,742 by 1990 – a loss of 4274 people. After 1990, the Casper area began to recover from the energy-related population decline. Between 1990 and 1995, the population increased by 2041, bringing the population total to 48,783 (see Table 2-1). However, referring to Table 2-1 again, will show that another population decline has occurred between 1995 and 1999. During this period, the population fell by 500, resulting in the 1999 total of 48,283.

Douglas is the County Seat of Converse County. Glenrock, also in Converse County, is the closest town to the SR-HUP/Reynolds Ranch site with the site being approximately 22 road miles northeast of the town. Between 1970 and 1980 both Glenrock and Douglas experienced phenomenal growth, 80.6% and 136.9%, respectively. However, with the change in energy demand, through 1984 Glenrock lost 27% of its population and Douglas lost 17% of its population. Although Glenrock and Douglas experienced population changes similar to those in Casper between the years 1970 and 1995, population growth continued in Glenrock and Douglas between 1995 and 1999 (see Table 2-1).

The reduction in employment in the area of uranium operations illustrates the loss of jobs to the area. In March 1980, uranium producers reported 1,264 people directly employed in the uranium mining and milling operations in Converse County. In September 1987 the same uranium producers reported less than 100 employees in Converse County with many of these employees working on reclamation projects that were completed within 2 years. Startup of this uranium mining project has increased company employment in the area to about 80 people and provided jobs for 20 to 40 contractor employees. Most of the new positions were filled from the local population.

The only occupied dwelling within the permit area is the Vollman Ranch, which is located approximately 1.5 miles east of Satellite No. 3 and 4.2 miles east-northeast of the Smith Ranch Main Office/CPP site. The nearest dwelling to the Smith Ranch Main Office/CPP site is the Sundquist (Smith) Ranch located 2.6 miles to the southwest. A total of seven people normally reside at these ranch homes for an occupational density of 0.09 persons per square mile for the area within a five mile radius of the plant. There are no permanent residences in the proposed Reynolds Ranch amendment area or within 5 miles of the amendment area. The nearest dwellings are the Reynolds Ranch site (5.6 miles northeast of the Satellite), the Hornbuckle Ranch site (6.2 miles northeast of the Satellite), the Lenzen Ranch site (5.6 miles southwest of the Satellite), the Baker Ranch site (6.8 miles northeast of the Satellite) and the Vollman Ranch (6.8 miles southeast of the Satellite). A total of thirteen people normally reside at these ranch homes.

2.4 HISTORIC, SCENIC AND CULTURAL RESOURCES

Six Cultural Resource Surveys have been conducted on lands comprising the SR-HUP. These surveys are included in Appendix D-3 of the application and are summarized as follows:

2.4.1 Smith Ranch Area

A Class III Cultural Resource Inventory for the proposed permit area was completed in November 1985 by Frontier Archaeology of Worland, Wyoming. These data are presented in Appendix D-3. Eighteen sites were located. Ten of the sites are historic and eight are prehistoric. Following review of these sites by the BLM and the Wyoming State Archives, Museums and Historical Department during the Spring 1986, it was determined that only two sites could be potentially affected by the project. The mitigation and protection of these sites are discussed in Chapter 5. Appendix D-3 contains the Cultural Resource Class III Survey plus the appropriate letters from the SHPO, etc. The report also includes a listing of cultural resource (i.e. The Bozeman Trail) sites known in the vicinity of the permit area. This list was compiled through review of the State Archives, WSHPO and Casper BLM office.

Another Cultural Resource Class III Survey was conducted in December 1998 by Pronghorn Archeological Services of Mills, Wyoming. The scope of the survey covered the areas within the permit area not previously surveyed in the 1985 survey. The 1998 survey identified three new historic sites, thirteen prehistoric sites, and twenty-two isolated artifacts. Of those, twelve of the prehistoric sites were considered to be eligible for inclusion to the National Register of Historic Places, and none of those sites are located where mining activities are planned. The BLM and WSHPO have reviewed the report. Appendix D-3 contains this report and supporting correspondence. A significant portion of Appendix D-3 contains information that falls under the confidentiality requirement for archeological resources under 43 CFR 7.18, "Confidentiality of archaeological resource information". Therefore, PRI requests that all portions of Appendix D-3 remain "CONFIDENTIAL" for the purpose of Public Disclosure of this application.

2.4.2 Highland Uranium Project Area

Several detailed archeological surveys have been conducted on lands comprising the Highland Uranium Project and adjacent areas. Surveys for the original permit area (1985 Everest Minerals permit application), the Section 14 Amendment area and the West Highland Amendment area are included as Addenda D3-1, D3-2 and D3-3A respectively.

The North Morton Ranch property was acquired from the Tennessee Valley Authority in September, 1985. Much of the northern portion of the Highland area lies within the former North Morton Ranch permit area. The cultural resource inventory performed as a part of the North Morton application (Permit No. 230C) is provided as Addendum D3-3B.

The extreme western portion of the Highland area was previously surveyed by Kerr McGee Nuclear in 1985 as a part of the South Powder River Basin Solution Mining Project application submitted to WDEQ in April, 1988. Appropriate portions of this cultural resources inventory are provided as Addendum D3-3C.

All addenda are included in a separate binder in order that the information can be kept confidential. It is concluded in all surveys within the Highland area that the sites mapped are of no significant historical or archeological value.

2.4.3 Reynolds Ranch Amendment Area

A Class III Cultural Resource Inventory for the proposed permit area was completed in September, 1997 by Pronghorn Archaeological Services of Mills, Wyoming. This data is presented in Appendix D-3. Thirteen sites were located. Six of the sites are historic and seven are prehistoric. In addition, eighteen isolated artifacts were recorded. All of the sites are considered not eligible for inclusion to the National Register of Historic Places and no further work was recommended for any of the sites. If during mining operations any cultural or significant paleontological evidence are exposed during any excavation or other installation work in the permit area, such activities will be delayed until the appropriate state office has been notified and a qualified person has examined the evidence.

In addition, another assessment of the potential impacts to the Bozeman Trail and other historical sites within the Reynolds Ranch area was conducted by Rosenberg Historical Consultants of Cheyenne, Wyoming in 1997. The assessment included a 3.3-mile long segment of the Bozeman Trail known as the Holdup Hollow Segment (T36N, R74W, Sec. 15,10, and 3), as well as 2.5 miles of trail just North of the Permit Area. The Holdup Hollow Segment is listed in the National Register of Historic Places.

It was recommended in the assessment that no ground disturbing activity of any kind associated with in situ mining should occur within the recognized boundaries of the Holdup Hollow Segment, as well as no exploratory drilling. As a result of this recommendation, the sections of land in which the Holdup Hollow Segment is located were not included in the proposed permit area for Reynolds Ranch. Therefore, no ground disturbing activities, in situ mining activities, or exploratory drilling will occur in that area.

The segment located just north of the Reynolds Ranch amendment area was considered noncontributing. A No Effect determination was recommended and no further historical work was believed necessary. A cultural clearance is recommended for this area with no stipulations.

In addition to the Bozeman Trail, three historic period dry land homesteads were recorded and evaluated. All of these sites are considered to be ineligible to the National Register of Historic Places and a determination of No Effect is recommended. A cultural clearance is recommended for this area with no stipulations.

2.5 METEOROLOGY

2.5.1 General

The project permit area is located in eastern Wyoming, where climate can generally be classified under the Koppen System (C. R. Itchfield, 1974) as semiarid and cool. The climate in the area is rather dry due to the effective barrier to moisture from the Pacific Ocean offered by the Cascades, Sierra Nevada, and the Rocky Mountains when winds are from the west and northwest. The mountain ranges in the west-central portion of the state, which are oriented in a general north-south direction, are perpendicular to the prevailing winds. These ranges also tend to restrict the passage of storms and thus restrict precipitation in the eastern part of Wyoming.

The official weather station closest to the permit area is located at the Natrona County International Airport near Casper, Wyoming. Meteorological data (wind speed, wind direction, and temperature) for the project area are taken from the Natrona County International Airport near Casper, Wyoming. Figure 2-3 includes a wind rose for Casper and more detailed climatology data is included in Appendix D-4.

2.5.2 Precipitation

Mean annual precipitation for the area is approximately 13 inches (Normals, Means & Extremes, NOAA, Casper, WY, 2000) and the average yearly total evaporation is reported as 44 inches (U.S. Weather Bureau, NOAA, 1985). The net evaporation for the area is taken as the difference between these numbers and is calculated to be 31 inches per year.

The bulk of the annual precipitation is received from moisture laden easterly winds, particularly during spring months. Most of this precipitation is in the form of rain although occasional heavy wet snowfalls in spring months are not uncommon, but these snows are short-lived. Summer precipitation is almost exclusively from thundershower activity and under normal conditions provides sufficient moisture to maintain growth or rangeland grasses. Seasonal snowfall averages about 72 inches, but the water content of winter snow is low owing to the cold temperatures at which it usually occurs. The very dry strong west and southwest winds following these winter snows tend to clear the snow from the rangelands thereby permitting winter grazing of livestock.

The average number of days throughout the year with one hundredth of an inch of precipitation is near 90, most of which occur during the spring and summer. Consequently the absence of rain clouds or clouds usually associated with precipitation results in bright days with considerable sunshine throughout the winter season.

2.5.3 Temperature

The dryness of the air has a considerable modifying effect in preventing discomfort during the warm summer months as well as during periods of subzero temperatures in the winter. The average maximum temperature during summer months of June, July and August is 84° F, while during the winter, the average minimum temperature is 14° F. The average temperature is 67° F in the summer and 26° F in the winter. Extreme temperatures in these respective seasons have reached as high as 104° F and as low as –40° F, between 1961 and 1990. The average length of the growing season is 129 days, with the average date of the last freezing temperature in spring May 22, and the first freezing temperature in fall September 28.

2.5.4 Wind

Wind speed data from the Natrona County International Airport is used to estimate wind speed and direction for the project site. The mean annual wind speed at the airport for the years 1961-1990 is 13 miles per hour from the southwest. The highest mean monthly wind speed occurs in January and is 16.4 miles per hour from a west-southwesterly direction. The lowest mean monthly wind speed occurs in July and is reported as 10.1 miles per hour from the west-southwesterly direction. The maximum observed wind speed maintained for longer than one minute was 81 mph from the southeast during March, 1956. Figure 2-3 is a wind rose diagram for the Casper area indicating that the prevailing winds are from the southwest. See Appendix D-4 for more detailed climatology data.

2.6 GEOLOGY AND SEISMOLOGY

2.6.1 Regional Geology

The permit area is located in the southern portion of the Powder River Basin, which is in the unglaciated Missouri Plateau section of the Great Plains physiographic province (Thornbury, 1969). The Missouri Plateau includes the part of the Great Plains north of the northern boundary of Nebraska, with the exception of the Black Hills. It is bounded by the Pine Ridge Encarpment to the south, the Bighorn and Laramie mountains to the west, the Missouri Escarpment to the east, and the glacial moraine plains north of the Missouri River to the north. The Missouri Plateau has often been mistakenly classified as a plain, in fact, it comprises a number of basins separated by uplifts.

The Powder River Basin, named after the north-flowing Powder River covers approximately 2000 square miles. It is bounded on the west by the Bighorn Mountains and the Casper Arch and on the south by the Laramie Range-Hartville Uplift. The northern and eastern margins of the basin are less distinct. The broad Black Hills Uplift forms the eastern demarcation, the Miles City Arch forms the northern boundary.

The Powder River Basin is synclinal, with the synclinal axis oriented in a general northwest-southeast direction along the western margin of the basin. East of the axis, the sedimentary rock strata exposed at the surface dip gently (about 1° to 2°) to the west. West of the axis, the strata dip more steeply (as much as 20°) to the east.

The basin incorporates a sedimentary rock sequence that has a maximum thickness of about 15,000 feet along the synclinal axis. The sediments range in age from Recent (Holocene) to early Paleozoic (Cambrian) (500 million to 600 million years ago) and overlie a basement complex of Precambrian-age (more than a billion years old) igneous and metamorphic rocks. Of particular interest in the permit area are the Tertiary-age formations:

Formation	Age (Years)
White River (Oligocene)	25-40 million
Wasatch (Eocene)	40-60 million
Fort Union (Paleocene)	60-70 million

The uranium-bearing sandstones to be mined lie within the Fort Union and Wasatch formations. With the exception of the Quaternary sediments in the drainage valleys, these are the only formations that crop out in the permit area.

The Powder River Basin represents a localized depression in what was, for long geologic time, a large basin extending from the Arctic to the Gulf of Mexico. During Paleozoic and Mesozoic time, the configuration of this expansive basin changed as the result of uplifts on its margins. The northern and southern connections of the basin to the open ocean also changed position several times before they both finally closed. By the end of the Cretaceous, many intrusive uplifts had occurred and the remaining portions of the large basin were well removed from connections to the sea.

In the late Paleocene marked uplift, inland masses surrounding the Powder River Basin and accelerated subsidence in the southern portion of the basin resulted in thich sequences of arkosic sediments being deposited. Arkosic sediments were derived from the granitic cores of the Laramie and Granite Mountains exposed to weathering and erosion by the Laramide uplift. Uranium mineralization contained in these arkosic facies constitute the oldest ore zones in the permit area.

Continued acceleration of uplift in the Laramie and Granite Mountains in central Wyoming resulted in further deposits of coarse clastic sediments. Since drainage was generally northward, the finer sediments were carried north toward the center of the basin.

Rapidly flowing streams cut channels through the accumulating sediments near the basin margins. These streams eventually filled with coarse clastic sediments, providing zones of high transmissivity for mineralizing solutions that entered the area later. During that time, and well into the Eocene, the Powder River Basin remained largely flat and portions of it were intermittently cut off from the main channels of surface water flows. However, ample water, provided by runoff from the mountainous uplifts, produced substantial swamps that eventually became large coal deposits.

The Eocene deposits (Wasatch Formation) in the Powder River Basin characteristically consist of nearly 1000 feet of clays and siltstones containing widespread discontinuous lenses of coarse, cross-bedded arkosic sandstones. The coarsest of these are to be found in the southwestern portion of the basin and are the host rock for the uranium deposits to be mined. These sediments gradually diminish in size northward. North of Pumpkin Buttes, the Wasatch sediments become markedly finer-grained and similar in appearance to the Fort Union Formation.

Near the end of the Eocene, northward tilting and deep weathering with minor erosion took place in the basin. Uranium migration and concentrations occurred at that time. Subsidence resumed in the late Oligocene and continued through the Miocene and Pliocene. A great thickness of tuffaceous sediments was deposited in the basin during at least a part of this period of subsidence. By the late Pliocene, regional uplift was taking place, leading to a general rise in elevation of several thousand feet. The massive erosional pattern that characterizes much of the Powder River Basin began with this Pliocene uplift and continues to the present.

The tectonic change at the end of the Paleocene is reflected in some locations by either a depositional or an erosional disconformity between the Fort Union Formation and the overlying Wasatch Formation. As uplift of the highlands continued into the Eocene epoch, the Fort Union Formation was eroded at the margins of the basin and the material redeposited toward the center. The rapidly accumulating sediments of the Wasatch Formation were deposited increasingly farther out into the basin.

2.6.2 Site Geology

The Wasatch Formation is the youngest bedrock unit throughout most of the permit area. It consists of interbedded claystones, silty sandstones, and relatively clean sandstones. In the vicinity of the Pumpkin Buttes, approximately 40 miles north of the permit area, the Wasatch Formation is known to be 1575 feet thick (Sharp and Gibbons, 1964). However, active stream erosion has left only about 500 feet of the formation in the central and east-central portions of the permit area, and none of the formation in the southwestern portion of the area. The surface contact between the Wasatch Formation and the underlying Fort Union Formation roughly parallels the axis of the Powder River Basin through the southwestern portion of the permit area. The interbeded claystones, siltstones, and relatively clean sandstones in the Wasatch vary in degree of lithification from uncemented to moderately well cemented sandstones, and from weakly compacted and cemented claystones to fissile shales.

The Fort Union Formation in the Powder River Basin is lithologically similar to the Wasatch Formation. Throughout the permit area, the Fort Union includes interbedded silty claystones, sandy siltstones, relatively clean sandstones, and claystones with a few thin coal seams occurring locally. The degree of lithification is quite variable, ranging from virtually uncemented sands to moderately well cemented siltstones and sandstones. The total thickness of the Fort Union in the area is approximately 3000 feet.

Both the Wasatch and Fort Union strata are highly lenticular, with numerous facies changes within short lateral distances. In some cases it is essentially impossible to trace even relatively thick stratigraphic units more than a few thousand feet. On the other hand, some units can be traced for miles.

One shale, marking the top of the Fort Union Formation, is believed to persist throughout the permit area. This shale, designated locally as the "P" shale, averages over 60 feet thick. Approximately 500 feet of alternating sandstones and shales of the Wasatch Formation overlie the "P" shale in the vicinity of the Smith Ranch Main Office/CPP. The sandstone beds generally are 40 to 100 feet thick and alternate with shales that range from 20 to 50 feet thick. Some of the lower sands in the Wasatch are mineralized. Below the "P" shale are about 400 feet of sediments, largely sandstone, that include the mineralized zones to be mined. See Appendix D-5 for additional regional and site geological data for the Reynolds Ranch amendment area.

2.6.3 Seismology

The area of east central Wyoming, where the project site is situated, lies in a seismically relatively quiet region of the United States. Although distant earthquakes may produce shocks strong enough to be felt on the Powder River Basin, the region is ranked to be one of minor seismic risk, as shown on Figure 2-4. Few earthquakes capable of producing damage have originated in this region as indicated on the Regional Seismicity Map provided on Figure 2-5. The seismically active region closest to the site is the Intermountain Seismic Belt of the Western United States, which extends in a northerly direction between Arizona and British Columbia. It is characterized by shallow earthquake foci between 10 and 25 miles in depth, and normal faulting. Part of this seismic belt extends along the Wyoming-Idaho border, more than 250 miles west of the permit area, and would be the most probable source of earthquakes affecting the project site.

Table 2-2 lists the largest recorded earthquakes that have occurred within 300 miles of the SR-HUP site and gives the maximum ground acceleration that would be realized at the site as a result of these disturbances from a period of 1870 through 1995 (Source USGS, 2000). The earthquake of highest intensity that occurred nearest the site is presumed to be the Casper, Wyoming earthquake of 1897. This earthquake has been assigned a probably maximum intensity of VII, based on damage incurred. Figure 2-6 provides a means for estimating the intensity of earth tremors at the Smith Ranch site originating from such an epicentral intensity 47 miles away. The small figure insert shows that the probable magnitude for an earthquake with an epicentral intensity of VII is 5.67 on the Richter Scale. Assuming that the distance from the CPP to the epicenter is approximately 47 miles, then the acceleration of the ground at the site would be 0.04 g, or slightly greater than intensity V.

No faulting in the project area has been reported, nor is any faulting evident from geophysical log interpretations. The ground accelerations reported in Table 2-2 (.01 g to .04 g) are not considered to be of a magnitude that would disturb the operations or facilities in the unlikely event that an earthquake occurred during the life of the mine.

2.7 HYDROLOGY

2.7.1 Surface Waters

The SR-HUP permit area is located in the southern part of the Powder River Basin in the Sage Creek drainage of North Platte River drainage system and the Box Creek drainage of the Cheyenne River drainage system. The only natural surface water in the permit area is ephemeral runoff in response to limited rainfall and snowmelt. Surface runoff is very limited, as reflected by a 1957-1958, USGS survey of the Box Creek drainage system which starts near the center of the permit area and flows east. The recorded mean flow from the 109 square mile drainage for 1957 and the first half of 1958 was 1.79 CFS (Table 2-3). Stock ponds collect some runoff for watering livestock, however, these ponds are dry much of the time.

The proposed Reynolds Ranch amendment area is located in the Duck Creek, Willow Creek, and Brown Springs Creek drainages all attendant to the Dry Fork drainage of Little Cheyenne River. The Little Cheyenne River is part of the Cheyenne River drainage system in the southern part of the Powder River Basin. The only natural surface water in the permit area is emphemeral runoff in response to intermittent precipitation and seepage into small basins at low points in the Duck Creek, Willow Creek, and Brown Springs Creek drainages. Surface runoff is very limited, surrounding stock ponds collect some runoff for livestock and wildlife consumption, but are dry most of the year. Some stock ponds on the permit area are fed by a pumped well and will contain water for longer durations.

2.7.2 Ground Water

Descriptions of the geologic formations of the Powder River Basin and their hydrologic properties have been discussed in numerous publications (Hodson, et al., 1973; Hodson, 1971; Whitcomb, et al., 1958; Huntoon, 1976; Davis, 1976) and summarized in Appendix D-5 (Geology). The primary hydrologic units beneath the permit area include alluvial deposits, the Wasatch Formation, the Fort Union Formation, and the Cretaceous-age Lance and Fox Hills formations (see Table D-6.1 of Appendix D-6). Some of these units are classified as aquifers and can yield ground water to wells and springs. The locations of ground water sources in the SR-HUP area are shown in Appendix D-6 submitted with the previous License Application. The locations of ground water sources in the proposed Reynolds Ranch amendment area are shown in Appendix D-6 of this application.

Alluvium. The alluvial deposits within the permit area consist of thin, unconsolidated, poorly stratified clays, silts, sands, and gravels. The total thickness of these deposits is estimated to range from less than 1 foot to 30 feet. There are no known wells within the permit area less than 30 feet deep and only three wells less than 100 feet deep, therefore very little information on water in the alluvial deposits, if any, is available.

Small amounts of precipitation infiltrate the alluvium during part of the year and the intermittent flow in drainage channels across the alluvium may provide some recharge to localized perched water tables in the alluvium. However, since the water table is typically more than 100 feet below the land surface throughout the permit area, most of the recharge flows through the alluvium to the Wasatch formation. In a drainage in the southwest portion of the area, a shallow water table appears to be the source of water for a small water hole but the potential for the development of the alluvium as a ground water supply is not promising.

Wasatch Formation. The Wasatch Formation typically is lenticular fine- to coarse-grained sandstones with interbedded claystones and siltstones. This formation ranges from 0 to approximately 500 feet thick in the permit area and includes some of the more important shallow aquifers in the Powder River Basin.

Most properly constructed wells completed in a Wasatch aquifer yield from 5 to 15 gallons per minute (gpm). However, the water supply well (WW-103) for the SR-HUP located at the Smith Ranch Main Office/CPP can produce 140 gpm from a completion interval of approximately 120 feet containing four separate lenses. This well is 474 feet deep.

For the most part, the upper Wasatch aquifers occur under water table (unconfined) conditions. Artesian (confined) aquifers near the base of the formation are separated from overlying formations and from each other by impermeable claystone or mudstone layers.

The Wasatch formation is considered a good water supply for limited development, however, the formation does crop out in the permit area and the amount of ground water available is difficult to assess. Hydrologic characteristics calculated from the Q-Sand pump test are believed representative of the deeper Wasatch aquifers.

Fort Union Formation. The Fort Union Formation underlies the Wasatch Formation beneath most of the permit area but in the southwestern portion of the area, the Fort Union lies directly beneath the surface. Typically, it is comprised of lenticular sandstones with interbedded claystones and siltstones. The Fort Union is as much as 3000 feet thick beneath the Smith Ranch Main Office/CPP site.

The Fort Union Formation also include important aquifers in the Powder River Basin, and most of the wells in the vicinity of the plant site penetrate this formation. While most wells tap these aquifers for small (5 to 20 gpm) water volumes, test wells completed in the Fort Union have produced as much as 560 gpm.

The Wasatch and Fort Union aquifers are separated by a relatively thick impermeable shale (locally designated the "P" shale). Similar separation of aquifers within the Fort Union are common, and wells completed in these layers are often found to be under artesian pressure.

Substantial volumes of water can be produced from the Fort Union in the Southern Powder River Basin as demonstrated by the Bill Smith Mine. The mine produced 1500 to 1700 gpm from initial development until the mine was allowed to flood, a period of several years. Hydrologic characteristics of the Fort Union have been illustrated by previous pump tests at the SR-HUP provided in the previous application, and O-Sand and U/S-Sand pump tests summarized in Appendix D-6 of this application.

Lance and Fox Hills Formations. These formations underlie the Fort Union Formation beginning at depths of about 3000 feet in the permit area. Data from other areas indicate well yields seldom exceed 100 gpm from these aquifers, and the ground water reserves may not be large. Little is known of their hydrologic characteristics, as no water wells are known to tap these aquifers in the vicinity of the permit area. It appears unlikely that these formations will be tapped for water supply in the near future because of depth and availability of water from the Wasatch and Fort Union Formation.

The Wasatch and the Fort Union aquifers are of the greatest importance to the proposed mining activities since they contain all the mineralized zones currently proposed for development. Results of the initial pump tests conducted in these formations were included in Appendix D-6 submitted previously. Results of pump tests conducted at the Reynolds Ranch amendment area are provided in Appendix D-6 of this amendment application.

2.8 ECOLOGY

Topography in the SR-HUP permit area has a general gradient from northwest to the southeast. The northern and southwestern portions of the permit area contain the higher ground. The ephemeral channel of Sage Creek runs to the southeast while the ephemeral channel of Box Creek drains to the east.

Topography in the Reynolds Ranch amendment area has a general gradient from southwest to northeast. The northern and southwestern portions of the permit area contain the higher ground. The ephemeral drainages of Duck Creek, Willow Creek, and Brown Springs Creek run to the northwest. The Duck Creek drainage begins in the permit area from two areas, Section 35 and 36, T37N, R74W, and Section 12, T36N, and R74W, and runs northeasterly exiting in the northeast portion of Section 31, T37N, R73W. Willow Creek enters the permit area in Section 13, T36N, R74W and runs northeasterly exiting the permit area in the middle of Section 7, T36N, R37W. Brown Springs Creek runs outside the northwest corner of the permit boundary, however, two ephemeral tributaries starting in Sections 26 and 35, T37N, R74W flow northeast directly into Brown Springs Creek. Brown Springs Creek runs in a northwest direction. The Reynold's Ranch Satellite Plant will be located in the Duck Creek drainage.

Soils on the hilltops and higher areas are shallow and sometimes associated with materials from rock outcrops. The soils become deeper on the side slopes of the hills and in the lower areas and drainages. Soils in the permit area generally pose no special problems and are rated as good for reclamation purposes. A low intensity soil survey, as well as detailed soils information for SR-HUP has been submitted previously. Soil survey results as well as detailed soils information for the Reynolds Ranch amendment area is contained in Appendix D-7 of this amendment application.

Vegetation is a typical northern plains short grass prairie forage characteristic of areas of low annual precipitation. Dominant plant species present are Sage brush, Western Wheatgrass, Needlegrasses, Blue Gramma and Threadleaf Sedge. Detailed vegetation information for the SR-HUP has been previously submitted. A vegetation study conducted for the Reynolds Ranch amendment area is presented in Appendix D-8 and provides details such as productivity and cover information.

The wildlife in the area is typical for the region. Studies and observations of wildlife on the SR-HUP permit area and in the surrounding vicinity have been previously submitted. Results of wildlife studies conducted at the Reynolds Ranch amendment area are presented in Appendix D-9 of this amendment application. Important game species include the Pronghorn Antelope, Cottontail Rabbit, Sage Grouse, Mourning Dove and Mule Deer. Non-game species are typical of the sage brush grassland habitat in the region. No rare or endangered species have been observed in the SR-HUP or Reynolds Ranch areas.

2.9 BACKGROUND RADIOLOGICAL CHARACTERISTICS

A background pre-mining radiological survey of the O-Sand pilot area was conducted and results were submitted in previous applications. Background radiation for the surface were normal and no anomalies were found. Background gamma surveys were conducted on a 200 foot grid pattern for Wellfield Nos. 1 through 4. The results of these surveys show that the average background gamma radiation levels range from 10 to 17 μR/hr. Comparison of these data with historic background data collected from the Smith Ranch and HUP Air Monitoring Stations shows that the gamma levels are in close agreement.

A description of air particulate, radon-222, and gamma radiation background data from the Air Monitoring Stations is provided in Chapter 5. Radiological data concerning ground water in the vicinity are reported in the baseline water quality data previously submitted for SR-HUP and in Appendix D-6 of this application for the Reynolds Ranch amendment area.

A background pre-mining radiological survey of a portion of the Reynolds Ranch amendment area was conducted by Solution Mining Corporation as part of efforts to develop a mine permit application for the area (referred to as the Blizzard Heights Project). Background radiological surveys conducted included surface gamma radiation survey, soil radionuclide analysis, ground water and surface water radionuclide analysis in locations in the vicinity of the proposed Satellite Plant and and wellfield areas. Surface gamma levels determined during this survey is consistent with surface gamma surveys conducted for the SR-HUP and therefore can be considered representative of the entire Permit Area. This survey is contained in Appendix D-10 of this application

Background gamma and radon-222 data has been collected at the Reynolds Ranch amendment area since April of 2004 using a gamma ball and radon cup placed near the proposed location of the Reynolds Ranch Satellite Plant. This data is summarized in Table 2-4 along with data from a background location. The background location is referred to as "Dave's Water Well" and is considered the background air monitoring station for the SR-HUP, and also considered a representative background station for the Reynolds Ranch area. As shown in Table 2-4, radon-222 and gamma data for these two areas are very consistent with each other.

2.10 BACKGROUND NON-RADIOLOGICAL CHARACTERISTICS

Background non-radiological characteristics of the site are discussed in the applicable sections of Appendix D. Ground water background concentrations of substances that could potentially be mobilized by leaching such as trace metals are presented with other baseline values as part of the ground water quality data in Appendix D-6.

Because of the relatively low surface disturbance necessary to construct the wellfield and recovery facilities, no additional atmospheric pollution in the form of dust is anticipated resulting in significant change to the existing air quality.

TABLE 2-1

POPULATION TRENDS IN

CONVERSE AND NATRONA COUNTIES

1970-1999

Place	1970	1980	1990	1995	1999
Casper	39,361	51,016	46,742	48,783	48,283
Glenrock	1,515	2,736	2,153	2,291	2,357
Douglas	2,677	6,030	5,076	5,435	5,655
Converse Co.	5,938	14,069	11,128	11,937	12,396
Natrona Co.	51,264	71,856	61,226	63,801	63,151

Sources: Population Estimates for Places, Annual Time Series, July 1, 1990 to July 1, 1998. U.S. Census Bureau, Washington, DC.

Population Estimates Program Population Division, U.S. Census Bureau, Washington, DC. March 2000.

Wyoming Data Handbook 1985, Department of Administration and Fiscal Planning Control, Division of Research and Statistics.

Table 2-2

MAXIMUM EXPECTED EARTHQUAKE INTENSITIES AND GROUND ACCELERATIONS AT THE SMITH RANCH SITE

	Maximum Epicentral Intensity of Record	Distance from Epicenter to Smith Ranch Site	Maximum Probable Intensity at Smith Ranch Site	Maximum Ground Acceleration At Smith Ranch Site
Hebgen Lake, Montana (1959)	X	285 miles	III-IV	Less than 0.01 g
Northeastern Nebraska (1934)	VI	121 miles	IV	Approximately 0.02 g
Black Hills, South Dakota (1928)	V	100 miles	III-IV	Less than 0.02 g
Powder River Basin (1967)	VI	36 miles	IV	Approximately 0.02 g
Casper, Wyoming (1897)	VII	47 miles	V-VI	Approximately 0.04 g

Table 2-3

Geological Survey Water Supply Paper 1509
Extracted From
Surface Water Supply of the United States - 1957
Part 6-A Missouri River Basin
above Sioux City, Iowa

Cheyenne River Basin
Box Creek near Bill, Wyoming

Location - Lat 43°06', long 105°15', in SE¼ sec. 9, T36N, R70W, on left bank 12 ft below bridge on State Highway 59 and 9.7 miles south of Bill.
Drainage area - 109 sq mi
Records available - July 1956 to September 1957
Gage - Water-stage recorder. Datum of gage is 4,694.12 ft above mean seal level (State Highway benchmark).
Extremes - 1956: No flow during period July to September.
1956-57: Maximum discharge during water year, 1,190 cfs June 9 (gage height, 7.26 ft), from rating curve extended above 70 cfs on basis of slope-area determination of peak flow; no flow at times.
Remarks - Records good except those above 70 cfs, which are fair, and those for period of ice effect or no gage-height record, which are poor. No flow July 14 (first day of record) to Dec. 7, 1956. Many small stock reservoirs above station.

Rating table, water year 1956-57 (gage height, in feet, and discharge, in cubic feet per second)
(Shifting-control method used May 16-18, 20, 21, 25-27, July 29 to Aug. 9)

2.4	0	2.8	1.6	4.0	45
2.5	.1	3.0	4.2	4.5	92
2.6	.4	3.3	11	5.0	175
2.7	.8	3.6	22	6.0	470

Discharge, in cubic feet per second, water year October 1956 to September 1957

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1			0		0	0	0	0	5.7	22	0	0.1
2			0		0	0	0	.1	3.1	*7.2	0	.1
3	(*)		0		0	0	0	.1	1.8	3.8	0	.1
4			0		0	0	0	.1	1.4	2.1	0	.2
5			0		0	0	0	.1	*1.2	1.4	*0	.2
6			0		b.1	0	0	.1	1.0	.9	0	.2
7			0		b.1	0	0	.1	1.0	.5	0	.2
8		(*)	.2		b.1	0	0	.2	1.2	.4	.1	.2
9			.4		b.2	.1	0	.2	*51	.3	.1	.2
10			.4		b.2	.1	0	.2	182	.2	.1	.2
11			.1		b.2	.1	0	.1	11	.1	0	.2
12			.1		*b.2	.1	0	.3	5.0	*.1	0	.2
13			.1		b.2	*.1	0	.4	*3.4	1.3	0	*.6
14			*.1		b.2	.1	0	1.1	3.2	.6	0	.2
15			.1		.1	.1	0	.9	2.3	.2	.1	.2
16			0		.1	.1	0	1.4	2.3	.1	.1	.2
17			0		0	.1	0	*7.7	2.6	.1	*.1	.2
18			0		0	.1	0	3.6	4.2	.1	.1	.2
19			0		0	.1	0	2.9	2.6	.1	.1	.2
20			0		0	.1	.4	3.9	*1.6	.1	.1	.2
21			0		0	.1	.3	28	*29	.2	.1	.2
22			0		0	.1	.1	6.8	*22	.1	.1	.2
23			0	(*)	0	.1	0	3.9	9.2	.1	.1	.2
24			0		.1	.1	.3	4.6	4.4	.1	.1	.2
25			0		0	.1	.5	*67	2.7	.1	.1	.2
26			0		0	.1	.4	13	2.1	.1	.1	.1
27			0		0	.1	.2	*8.9	2.1	.1	.1	.1
28			0		0	.1	.1	6.3	2.0	.1	.1	.1
29			0		-	.1	*0	*3.4	1.4	.1	.2	.1
30			0		------	.1	0	37	208	.1	.2	.1
31		------	0		------	.1	------	35	------	.1	.1	------
Total	0	0	1.5	0	1.8	2.3	2.3	237.5	570.5	42.8	2.2	5.6
Mean	0	0	0.05	0	0.06	0.07	0.08	7.66	19.0	1.38	0.07	0.19
Ac-ft	0	0	3.0	0	3.6	4.6	4.6	471	1,130	85	4.4	11

Calendar year 1956: Max - Min - Mean - Ac-ft -
Water year 1956-57: Max 208 Min 0 Mean 2.37 Ac-ft 1,720

Peak discharge (base, 100 cfs). - May 21 (4 a.m.) 116 cfs (4.59 ft); May 25 (11 a.m.) 190 cfs (4.95 ft); May 30 (9 a.m.) 141 cfs (4.83 ft); June 9 (11:30 p.m.) 1,190 cfs (7.25 ft); June 21 (5 p.m.) 121 cfs (4.76 ft); June 30 (6 a.m.) 840 cfs (6.7 ft).
*Discharge measurement or observation of no flow made on this day.
b Stage-discharge relation affected by ice.
Note - No gage-height record Sept. 14-30; discharge estimated on basis of recorded range in stage.

Table 2-3 (Cont.)

U.S. Geological Survey Water Supply Paper 1559
Extracted From
Surface Water Supply of the United States - 1958
Part 6-A Missouri River Basin
above Sioux City, Iowa

Cheyenne River Basin
3796. Box Creek near Bill, Wyoming

Location - Lat 43°06', long 105°15', in SE¼ sec. 9, T36N, R70W, on left bank 12 ft downstream from bridge on State Highway 59 and 9.7 miles south of Bill.
Drainage area - 109 sq mi.
Records available - July 1956 to June 1958 (discontinued).
Gage - Water-stage recorder. Datum of gage is 4,694.12 ft above mean sea level (State Highway bench mark).
Extremes - Maximum discharge during period, 15 cfs May 7 (gage height, 3.37 ft); no flow at times.
1956-58: Maximum discharge, 1,190 cfs June 9, 1957 (gage height, 7.26 ft), from rating curve extended above 70 cfs on basis of slope-area measurement of peak flow; no flow at times each year.
Remarks - Records fair. Many stock reservoirs above station.

Rating table, Oct. 1 to June 30, 1958 (gage height, in feet, and discharge, in cubic feet per second)

2.4	0
2.5	.5
2.6	1.6
2.7	2.9
3.0	8.2

Discharge, in cubic feet per second, October 1957 to June 1958

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1		0.1	0.1	0.1	0.1	0.2	3.4	1.4	0.6			
2		.1	.1	.1	.1	.1	*3.4	1.1	.6			
3		.1	*.1	.1	.1	.1	*2.4	.6	.6			
4		.1	0	.1	*.1	.1	2.8	.5	.6			
5		.1	0	0	.1	.1	5.9	.4	.7			
6		.1	.1	0	.1	*.1	5.9	.3	.7			
7		.1	0	0	.1	.1	4.4	2.6	.7			
8	0.1	0	0	0	.1	.2	3.0	6.0	.6			
9		0	0	*0	.1	.2	2.5	2.2	.6			
10		.1	0	0	.1	.1	2.2	1.5	.6			
11		.1	.1	0	.1	.1	*2.2	1.1	*.8			
12		.1	0	.1	.1	.1	2.0	.8				
13		.1	0	0	.1	.1	1.9	.6				
14		.1	.1	.1	.1	.1	1.6	*.5				
15	*.1	.1	.1	.1	.1	.1	1.2	1.2				
16	.1	.1	.1	.1	.1	.1	1.1	1.9	.6			
17	.1	.1	.1	.1	.1	.1	1.0	1.6				
18	.1	.1	.1	.1	.1	.1	.7	1.4				
19	.1	.1	.1	.1	.2	.4	.8	1.0				
20	.1	.1	.1	.1	.2	1.4	.7	.8				
21	.1	.1	.1	.1	.2	2.0	.8	.6				
22	.1	.1	0	.1	.2	1.9	1.2	.6				
23	.1	.1	.1	.1	.2	1.7	1.6	.6				
24	.1	0	.1	.1	.2	1.9	2.0	.7				
25	.1	0	.1	.1	.2	1.4	2.6	.8	.3			
26	.1	0	.1	.1	.2	1.6	3.5	.5				
27	.1	0	0	.1	.1	2.2	2.8	.4				
28	.1	0	0	.1	.3	2.1	2.0	.4				
29	.1	.1	0	.1	-	2.1	1.7	.4				
30	.1	.1	0	.1		4.0	1.7	.5				
31	.1	------	0	.1	------	6.7	------	.6	------			------
Total	3.1	2.3	1.7	2.3	3.8	31.5	69.0	33.8	15.2			
Mean	0.10	0.06	0.05	0.07	0.14	1.02	2.30	1.09	0.51			
Ac-ft	6.1	4.6	3.4	4.6	7.5	62	137	67	30			

Calendar year 1957: Max 208 Min 0 Mean 2.39 Ac-ft 1,730
Water year 1957-58: Max - Min - Mean - Ac-ft -

Peak discharge (base, 100 cfs). - No peak above base.

* Discharge measurement made on this day.
Note - No gage-height record Oct. 1-14, June 12-30; discharge estimated on basis of weather records, recorded range in stage, and normal recession.

TABLE 2-4

REYNOLDS RANCH BASELINE GAMMA AND RADON-222 MONITORING

GAMMA

2nd Quarter 2004	Mean Ambient Dose Equivalent (mrem)
Reynolds Ranch	33
Daves Water Well	35

RADON-222

2nd Quarter 2004	Average Radon Concentration (pCi/L)
Reynolds Ranch	1.6
Daves Water Well	1.7

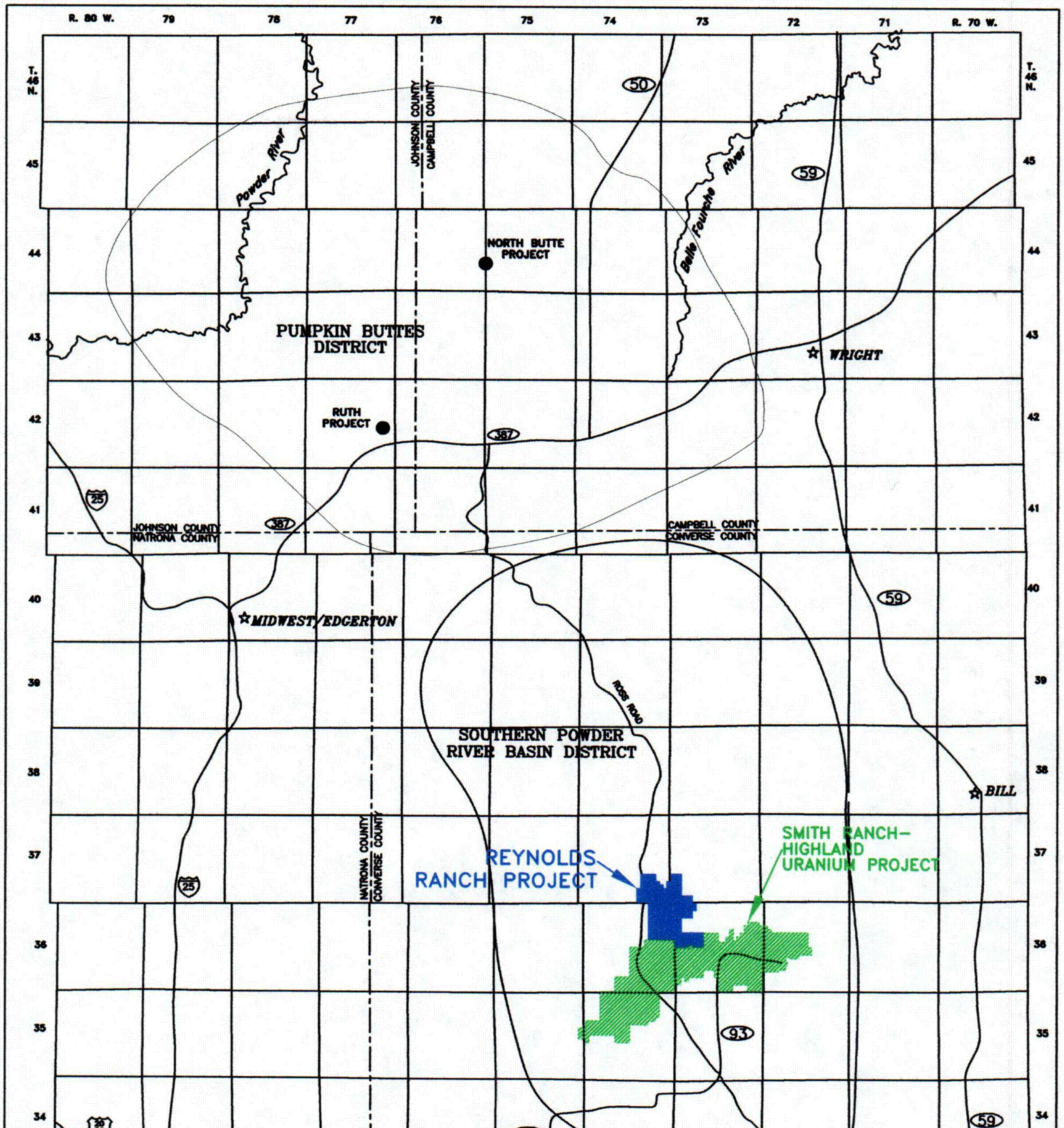
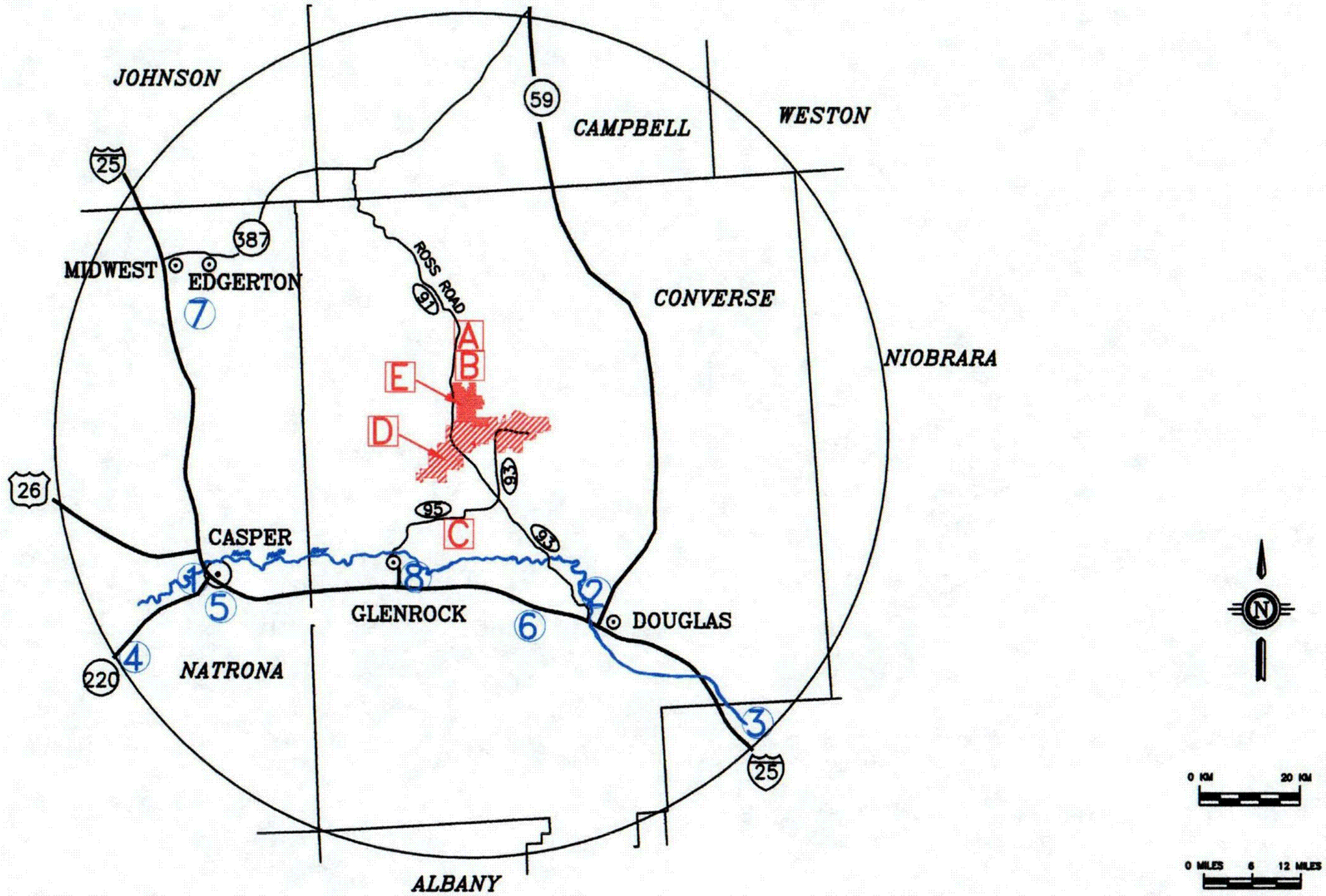


FIGURE 2-1
POWER RESOURCES, INC.
REVISIONS
REYNOLDS RANCH PROJECT
SITE LOCATION MAP
PORTIONS OF CONVERSE, NATRONA, JOHNSON & CAMPBELL COUNTIES

C01



A URANIUM MINING AREAS

- A BEAR CREEK URANIUM CO. (RECLAIMED)
- B PIONEER NUCLEAR (RECLAIMED)
- C LEUENBERGER SITE (RECLAIMED)
- D SMITH RANCH – HIGHLAND URANIUM PROJECT
- E REYNOLDS RANCH URANIUM PROJECT

① LOCATION OF POINTS OF INTEREST

1. FORT CASPER
2. FORT FETTERMAN
3. GLENDO STATE PARK
4. ALCOVA RECREATION AREA
5. CASPER MTN. RECREATION AREA
6. AYRES NATURAL BRIDGE
7. SALT CREEK OILFIELD – TEAPOT DOME
8. DAVE JOHNSTON COAL POWER PLANT

FIGURE 2-2

POWER RESOURCES, INC.

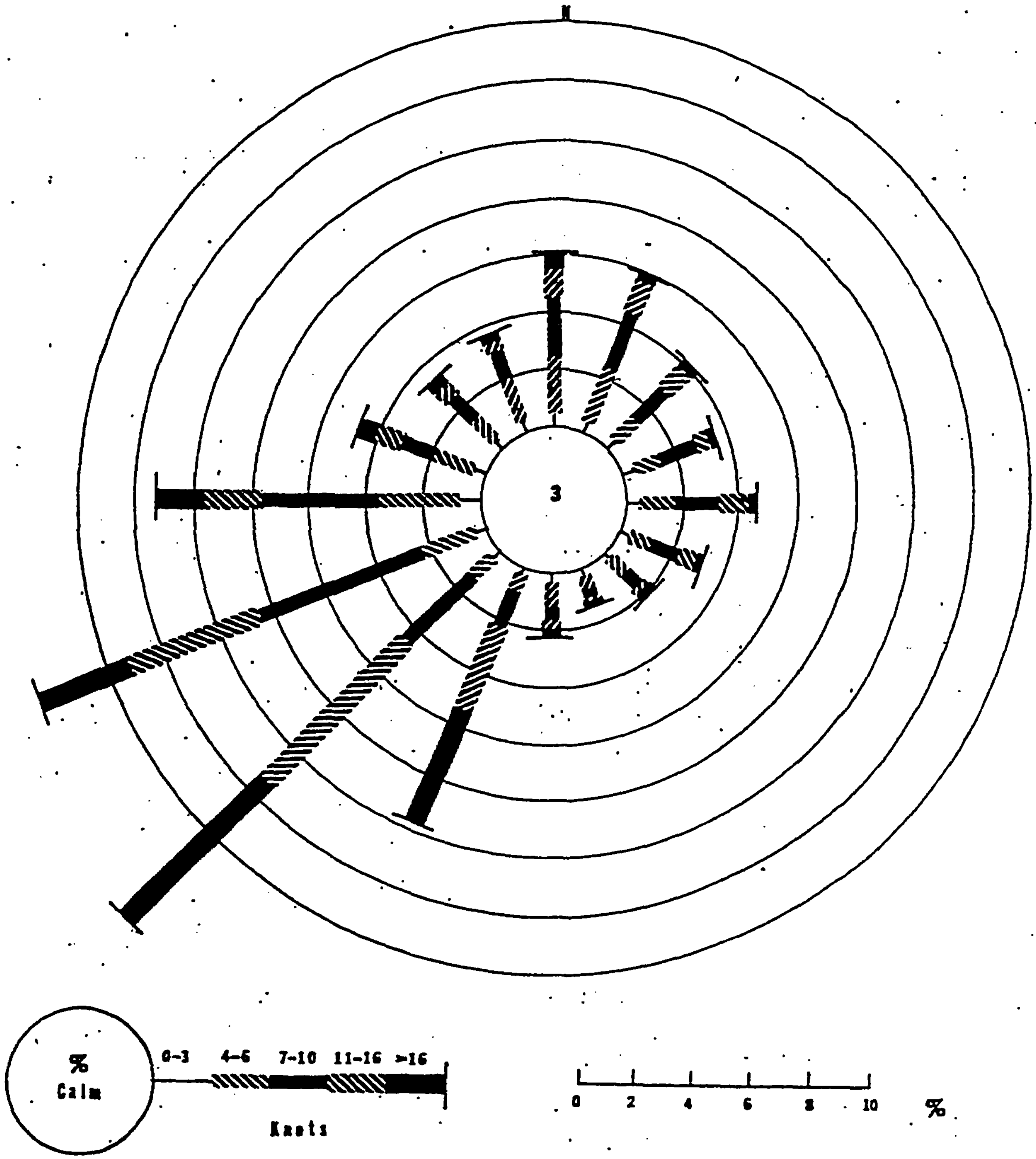
P.O. Box 1210 Glenrock, WY 82637 (307) 358-6541 (307) 235-1628

REYNOLDS RANCH URANIUM PROJECT
POPULATION & ACTIVITY CENTERS WITHIN 50 MILES OF THE REYNOLDS RANCH URANIUM PROJECT OFFICE & CENTRAL PROCESSING PLANT SITE

REVISIONS		
NO.	DATE	BY

C02

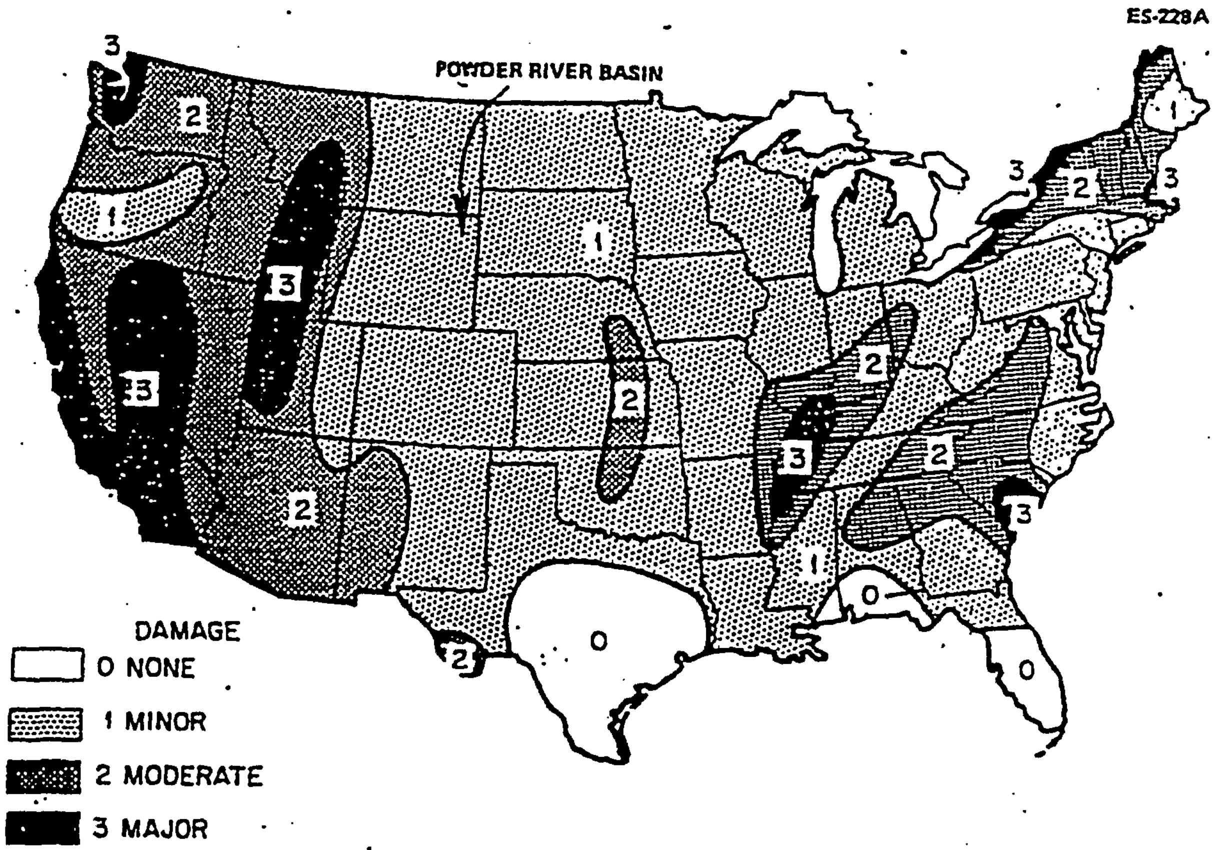
FIGURE 2-3



SOURCE: Based on the National Climatic Center's STAR program calculation for Casper (U.S. Department of Commerce, 1973).

Figure 2-3 – ANNUAL WIND ROSE FOR CASPER, WYOMING (Period of Record, 1967 – 1971)

FIGURE 2-4



Seismic risk map of the United States. Source: S. T. Algermissen, *United States Earthquakes*, Fig. 2.4, U.S. Government Printing Office, Washington, D.C., 1968.

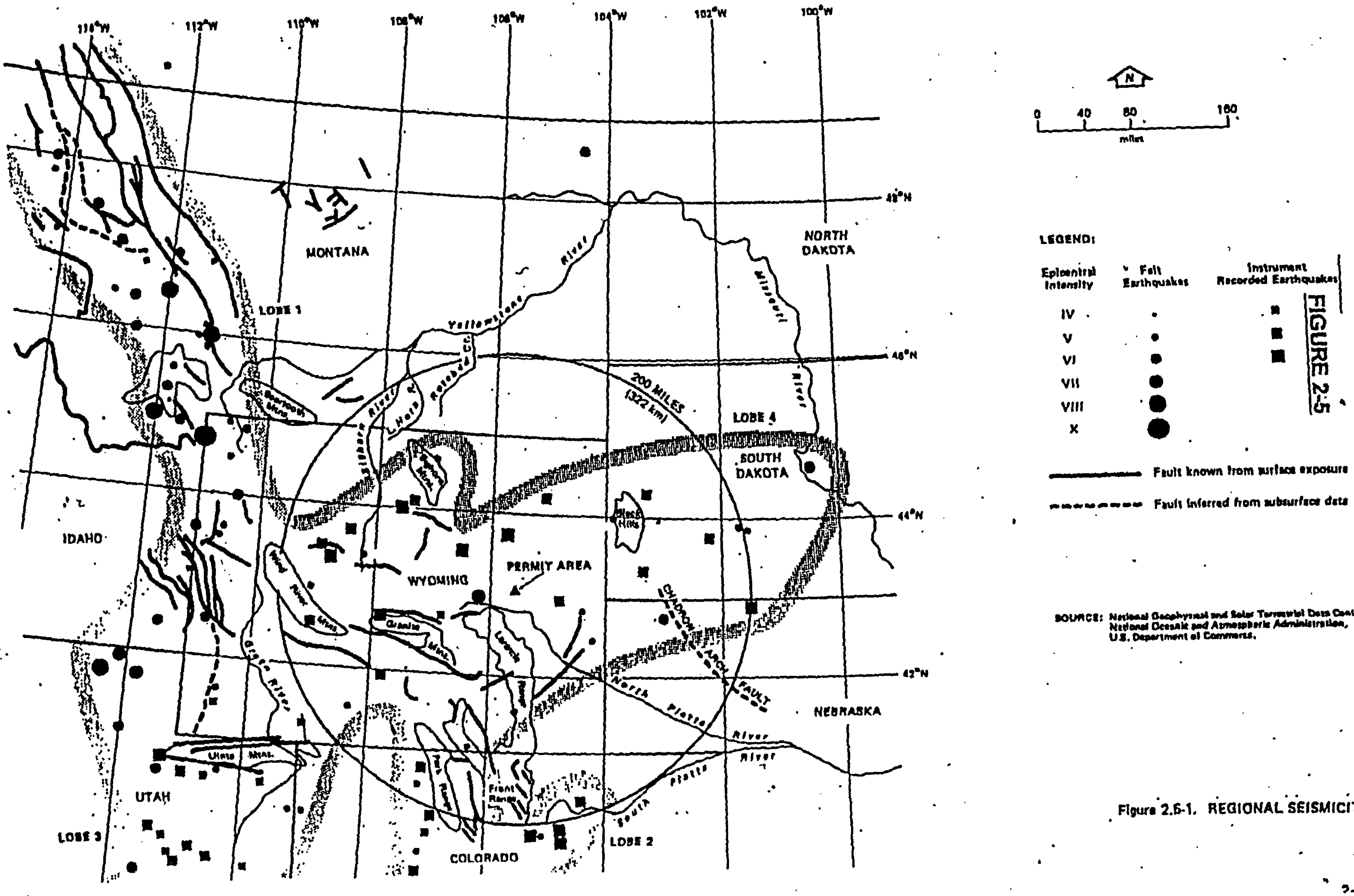
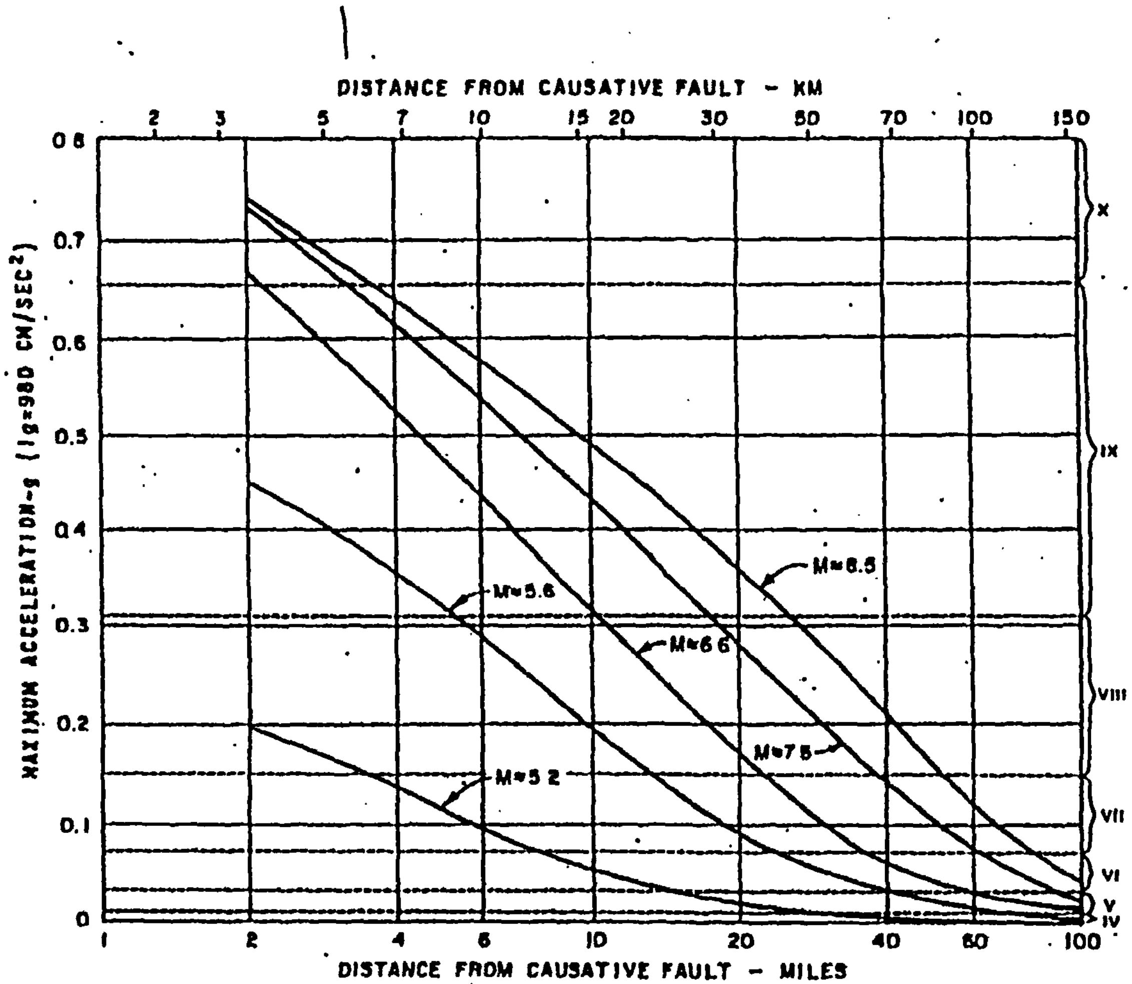


Figure 2.5-1. REGIONAL SEISMICIT



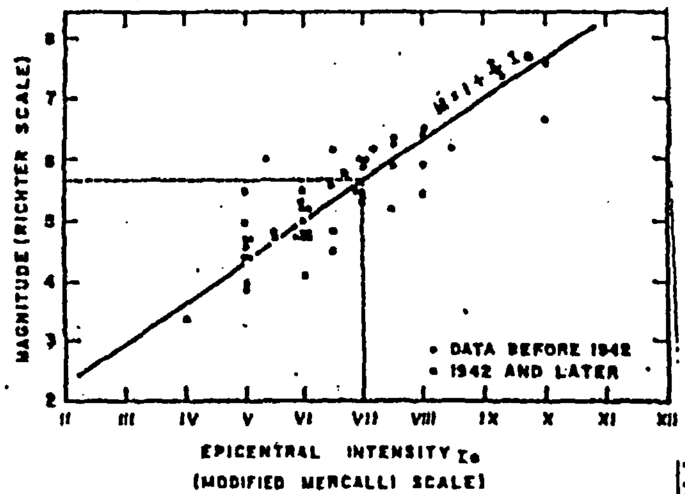
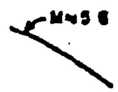


FIGURE 2-6



MAXIMUM ACCELERATION vs. DISTANCE CURVE : CURVE REPRESENTS THE RELATIONSHIP BETWEEN DISTANCE FROM THE CAUSATIVE FAULT AND THE MAXIMUM AVERAGE ANTICIPATED ACCELERATION FOR AN EARTHQUAKE OF GIVEN RICHTER MAGNITUDE (M) WHICH RANGES FROM 1 TO 9 TO DATE.

Source: Schnabel and Seed, 1972.
Woodward-Clyde Consultants, 1977.

Figure 2.5-2. CORRELATING FACTORS FOR ESTIMATING EARTHQUAKES

CHAPTER 3
DESCRIPTION OF THE FACILITIES

The permit area for the combined SR-HUP properties contains 30,760 acres. The total surface area to be affected by the proposed operation is within the permit area and will total approximately 1,800 acres. The Reynolds Ranch amendment area will add 8,704 acres and the total surface area to be affected will total approximately 300 acres.

The wellfields, two purge storage reservoirs and two irrigators, the two Office/Processing Plant areas, five Satellite facilities, and evaporation ponds are the significant surface features associated with the uranium in situ leaching mining operation.

The total wellfield area to be used for the injection and recovery of leaching solution over the twenty-five year mine life will be approximately 1,020 acres, including the Reynolds Ranch amendment area. The areas fenced to limit access by livestock to wellfield areas will be slightly greater than that encompassed by the areas to be mined. The main facilities at the SR-HUP, besides the wellfields, include the two yellowcake processing plant sites and related facilities that are located within the former Bill Smith Mine Site (Smith Ranch Main Office CPP Complex) and the former Exxon Highland Mine Site (HUP Central Plant/Office Complex). Currently (December 2004) the HUP facilities remain on stand-by status, with all yellowcake processing, office and related activities occurring at Smith Ranch.

In association with the Smith Ranch CPP is a lined, two-celled evaporation pond to assist with wastewater disposal. Additional lined evaporation ponds consisting of 5 to 15 acre cells will be constructed as needed. Wastewater is also disposed at two deep disposal wells at Smith Ranch and one deep disposal well at Highland. One deep disposal well is planned for the Reynolds Ranch amendment area.

Currently, there are four Satellite IX facilities constructed and three in operation. Satellite Nos. 1, 2 and 3 are located at Highland and Satellite No. SR-1 is located at Smith Ranch. It is likely that one additional Satellite facility will require construction at Smith Ranch in order that existing uranium reserves can be recovered. One Satellite facility is planned for the Reynolds Ranch amendment area. This Satellite will be very similar to SR-1 in design.

3.1 IN SITU LEACHING PROCESS AND EQUIPMENT

The SR-HUP uses processes and technology developed and demonstrated during Q-sand and O-sand R&D programs conducted at Smith Ranch, R&D Programs conducted at Highland, as well as techniques and processes developed at other ISL facilities that utilize best practices and industry experience. The Reynolds Ranch Satellite and wellfields will be operated consistent with operations at SR-HUP.

3.1.1 Uranium Dissolution

In Situ Leach (ISL) mining of uranium requires the circulation of a solution that will oxidize the uranium to a soluble state and form stable uranium complexes that can easily be recovered from the ore body. The project uses a carbonate leaching solution consisting of varying concentrations and combinations of sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$), oxygen, hydrogen peroxide (H_2O_2), and carbon dioxide (CO_2) added to the native ground water. The carbonate/bicarbonate leaching solution is used because of its selectivity for uranium and minor reaction with the gangue minerals. The pilot tests were conducted using sodium bicarbonate, carbon dioxide, hydrogen peroxide, and oxygen in the leaching solutions. When the leaching solution is injected into the ore zone, the dissolved oxidant reacts with the uranium mineral and brings the uranium to the U^{+6} oxidation state.

The U^{+6} species form complexes with some of the carbonates in the leaching solution to create uranyldicarbonate ions $(UO_2\ (CO_3\ )_2\ )^{-2}$ and/or an uranyltricarbonate ion $(UO_2\ (CO_3)_3)^{-4}$, both of which are soluble and stable species in solution. When the uranium is removed by leaching, a small portion of the radium content also is mobilized. Depending on site conditions, contaminants such as arsenic, selenium, and/or vanadium, may also be oxidized and mobilized in low concentrations. Results from the ISL pilot operations in the project area and operating wellfields have shown elevated selenium values but no evidence of other trace elements being significantly mobilized during leaching. Figure 3-1 shows the primary chemical reactions expected to occur in the Production Zone.

The dissolution and complexing of uranium occur as the leaching solution flows through the ore body from the injection wells to the production wells. Leaching solutions will continue to be circulated through a given area of the production zone as long as uranium recovery from that area is economically attractive.

3.1.2 Resin Loading/Elution Circuit

The uranium-bearing solution or pregnant leaching solution pumped from the wellfield is piped to the ion exchange plant for extraction of the uranium by use of ion exchange units. As the solution passes through the IX resin in the IX columns the uranyldicarbonate and uranyltricarbonate are preferentially removed from the solution. The barren solutions leaving the ion exchange units normally contain less than 2 ppm of uranium. After the resin in a column is "loaded" with uranium, the vessel is isolated from the normal process flow and the resin is removed from the column for elution. For Satellite IX facilities, this transfer is performed by moving the uranium loaded resin from the Satellite to the CPP using truck transport. In the elution process the resin is contacted with a strong sodium-chloride salt solution, which regenerates the resin in a process very similar to regenerating a conventional home water softener. The eluted resin is then placed back in service for additional uranium recovery. For Satellite facilities, freshly eluted resin is transferred from the Central Processing Plant to the IX facility using truck transport.

After the barren solution leaves the ion exchange columns, carbon dioxide and/or carbonate/bicarbonate is added as necessary to return the carbonate/bicarbonate concentration to the desired operating level. The solution is then pumped back to the wellfield, with the oxidant (O_2 gas and/or H_2O_2) added either as it leaves the CPP or Satellite, or just before the solution is re-injected into the Production Zone.

The piping and metering system for production and injection leaching solutions consists of buried trunk lines between the recovery plant and the operating wellfield areas with metering and flow distribution headers in the wellfield header buildings. The individual well flows and pressures are adjusted and controlled within the header buildings.

3.1.3 Precipitation Circuit

In the elution circuit, the uranyldicarbonate and uranyltricarbonate ions are removed from the loaded resin by a relatively small volume of strong chloride solution providing a solution (rich eluate) from which the uranium can be precipitated.

The rich eluate containing the uranium is routed to tankage for temporary storage in front of the batch or small continuous precipitation circuit. To initiate the precipitation cycle hydrochloric or sulfuric acid is added to the uranium bearing solution to breakdown the uranyl carbonate present in the solution. Hydrogen peroxide or ammonia is then added to the acidified eluate to effect precipitation of the uranium as uranyl peroxide or ammonium diuranate. The addition of hydrogen peroxide drives the pH of the solution down, and to optimize crystal growth and settling, a base (e.g. sodium hydroxide or ammonia) is added as a pH adjustment. The uranium precipitate is allowed to settle. The uranium depleted supernate solution is removed and stored for re-use in future elutions or disposed. Sodium chloride and sodium carbonate are added to the clean eluate as needed for reconstitution.

Deep injection wells and/or lined evaporation ponds are used to collect and dispose process wastewaters such as the excess eluate. The evaporation ponds may have multiple cells and each cell will be lined with a hypalon or similar membrane liner. A system of perforated pipes will be installed in a sand bed under the pond liner and will be monitored to ensure that if a leak were to occur, it would be quickly detected.

The precipitation cycle procedures and methods to be employed for this project have been used extensively in ISL programs and in conventional uranium milling operations.

3.1.4 Product Filtering, Drying and Packaging

After precipitation, the settled yellowcake is prepared for drying and product packaging. The yellowcake from the elution/precipitation circuit is washed with fresh water to remove excess chlorides and other soluble contaminants and then de-watered. This slurry may be routed to holding tanks in the precipitation area prior to filtering and drying. The yellowcake is dried and packaged in 55 gallon steel drums for storage and shipment.

Currently (December 2004) the yellowcake is dried in a vacuum dryer at the SR CPP. With this type of dryer, the off-gases generated during drying are filtered and scrubbed to remove entrained particulates. The water sealed vacuum system provides ventilation while the dryer is being loaded and unloaded into drums. This type of dryer minimizes airborne effluents. The drying system is described in more detail in Chapter 4.

An enclosed warehouse, adjacent to the yellowcake drying area, is provided for the storage of yellowcake. Onsite inventory of drummed yellowcake typically is less than 200,000 lbs. However, in periods of inclement weather or other interruptions in product shipments, all production will be stored on-site in designated storage areas.

The drummed yellowcake is shipped by exclusive use transport to another licensed facility for further processing. All yellowcake shipments are made in compliance with applicable regulations. A flow diagram showing the major process components of the uranium recovery plant is included as Figure 3-2.

3.1.5 Major Process Equipment

Principal equipment used in the process consists of surge tanks (optional), ion exchange vessels, elution/precipitation tanks, vacuum drying systems, and the piping, pumps and valves required to control and move the solutions among the various process components. The continuous flow portion of the circuit (the ion exchange circuit) has instrumentation designed to monitor key fluid levels, flow rates and pressures. The elution/precipitation portion of the recovery plant circuit is designed for batch and semi-continuous operations. The number of batch cycles are increased as uranium production increases. The elution circuit operates under automated controls.

3.2 SITE FACILITIES LAYOUT

Major existing surface facilities at the SR-HUP are shown on Plate 1 and include the Smith Ranch Main Office-Central Processing Plant (CPP) and associated facilities, the Highland Office-Central Processing Facility Complex (on stand-by status as of March 2003), operating wellfields, potential future wellfields, Satellite Building Nos. 1, 2, 3 and SR-1, the proposed Reynolds Ranch Satellite, the Boner Storage Building, three deep disposal well facilities, the Satellite No. 1 Radium Settling Basin, Purge Storage Reservoir Nos. 1 and 2, and Irrigation Area Nos. 1 and 2.

3.2.1 Smith Ranch Main Office-Central Processing Plant

The Smith Ranch Main Office-Central Processing Plant (CPP) is located within the 30 acre fenced area in the NE¼ , NW¼, Section 36, T36N, R74W (see Plate 1). The northern end of the CPP houses IX facilities while the remainder of the building contains the resin elution and yellowcake processing and drying/packaging areas. The yellowcake drying/packaging area may process 9,750 pounds U_3O_8 per day (3.5 million pounds per year). However, normal operations are expected to be about 1 to 2 million pounds per year. The CPP IX facilities currently (December 2004) serve Wellfield 1, Wellfield 2, and portions of Wellfield 4. This area also contains the Evaporation Ponds, Pilot Plant Building, Construction and Maintenance Shops, and Warehouse facilities. Figure 3-3 shows the plan view of these facilities. Figure 3-4 shows the general layout of the process equipment in the CPP.

In concert with the acquisition of the Smith Ranch operation by PRI in July 2002, all resin and yellowcake processing operations were moved to the Smith Ranch CPP in September 2002, with the Highland Central Plant and associated facilities being placed on stand-by status at that time. It is anticipated that all resin and yellowcake processing will continue to be conducted only at the Smith Ranch CPP until the uranium market improves such that additional yellowcake processing capacity is needed, or if a major shutdown condition occurred at the Smith Ranch CPP.

3.2.2 Highland Central Processing Facility

The Highland Central Processing Facility (CPF) is located within the 40 acre fenced area in the NE¼ NW¼, Section 29, T36N, R72W (see Plate 1). Currently (December 2004), the Highland CPF remains on stand-by status. The Central Plant building houses the majority of the process equipment, such as the uranium extraction circuit, yellowcake precipitation, dewatering, drying and packaging equipment. All buildings at the CPF were obtained from the previous Exxon open pit uranium mine/mill operation. The yellowcake drying/packaging area at the Highland CPF may process up to 2 million pounds U_3O_8 per year. However, when operational, production has typically been less than 1.5 million pounds per year. The general layout of the CPF area is shown on Figure 3-5. The process equipment layout is shown on Figure 3-6.

3.2.3 Satellite Buildings

The Satellite buildings house the ion exchange (IX) columns, water treatment equipment, resin transfer facilities, pumps for injection of lixiviant, a small laboratory and an employee break room. Bulk carbon dioxide and oxygen are stored in compressed form adjacent to each Satellite building or in the wellfield. Gaseous carbon dioxide is added to the lixiviant as the fluid leaves the Satellite building for the wellfield and headerhouses.

The locations of Satellite buildings and associated structures are shown on Plate 1. There are four Satellite buildings in operation and one more Satellite planned at the combined SR-HUP. There is one Satellite building planned for the Reynolds Ranch amendment area. Satellite No. 1 is located in the NW ¼ Section 21, T36N, R72W. The building occupies approximately 8,000 ft^2. The layout of Satellite No. 1 is shown on Figure 3-7. Satellite No. 1 serves the A and B-Wellfields (Section 21, 20-Sand and Section 21, 30-Sand Wellfields, respectively). Since July 1991 Satellite No. 1 has only been used for ground water restoration activities at the A and B-Wellfields. During production operations this facility had a capacity of approximately 1800 gpm.

Satellite No. 2 is located in the NE ¼ Section 14, T36N, R73W (see Plate 1). The building occupies approximately 13,000 ft^2. Satellite No. 2 serves the C-Wellfield (Section 14, 50-Sand Wellfield), D-Wellfield (Section 22/23, 40-Sand Wellfield), E-Wellfield, and the H-Wellfield. Satellite No. 2 will also potentially be used to produce the planned I-Wellfield. The Satellite No. 2 facility is designed to operate with a maximum through-flow of 3200 gpm during production operations. As of March 2003 the A, B, and C-Wellfields are undergoing ground water restoration while the D, D-Extension, E, F, and H-Wellfields are still in production. The layout of Satellite No. 2 is shown on Figure 3-8.

Satellite No. 3 is located in the SE ¼, Section 20, T36N, R73W (see Plate1). Satellite No. 3 and associated facilities serve the D-Extension and F-Wellfields and additional wellfields proposed for western portions of the permit area. The building occupies approximately 13,000 ft^2. The Satellite No. 3 facility is designed to operate with a maximum through-flow of 4,000 gpm during production operations. The layout of Satellite No. 3 is shown on Figure 3-9.

Satellite No. SR-1 is located in the SE ¼ Section 27, T36N, R74W (see Plate 1). The building occupies approximately 13,000 ft^2. Currently (December 2004), this facility serves Wellfield 3, portions of Wellfield No. 4 and planned future wellfield areas. The Satellite No. SR-1 facility is designed to operate with a maximum through-flow of 4500 gpm during production operations. The layout of Satellite No. SR-1 is shown on Figure 3-10.

The proposed Reynolds Ranch Satellite will be located in the SE 1/4 of Section 35, T37N, R74W. The building will occupy approximately 13,000 ft^2. This Satellite will serve all wellfields planned for the Reynolds Ranch amendment area. This Satellite facility is designed to operate with a maximum through-flow of 4500 gpm during production operations. The layout of the Reynolds Ranch Satellite is shown on Figure 3-11.

An additional Satellite is planned for future operations in the northwest corner of the current SR-HUP permit area. This Satellite will serve three potential wellfields (Wellfields 9, 10, and 11). Construction of this Satellite will be in conjunction with development of these wellfields.

The Boner storage building, which covers approximately 5,000 ft^2, is located just east of Satellite No. 2 (see Plate 1) and is used for wellfield equipment and materials storage and fabrication of various structures predominately used in the construction of wellfields.

3.2.4 Wellfields

3.2.4.1 Ore Deposits

The ore deposits in the SR-HUP and Reynolds Ranch amendment area generally occur at depths of 450 feet to 1,000 feet below the surface in long narrow trends varying from a few hundred to several thousand feet long and 20 to 300 feet wide. The depth depends on the local topography, the dip of the formation and stratigraphic horizon. At Smith Ranch, the shallower ore deposits are contained within the Q-Sand and the mineable ore in this sand occurs at depths of 450 to 500 feet. At the Reynolds Ranch amendment area, the shallower ore deposits are contained within the U/S-Sand and the mineable ore in this sand occurs at approximate depths of 380 to 525 feet. Most of the remaining uranium mineralization at the Smith Ranch and Reynolds Ranch occurs in the O-sand formation at a depth of 700 to 900 feet. The Q-Sand pilot and O-Sand pilot were conducted at depths of approximately 500 feet and 750 feet respectively. These ore body sands are synonymous with the 30, 40, 50, and 60-Sands located at Highland.

A typical stratigraphic interval to be mined by the in situ mining method is shown by the geologic cross sections of the Production Wellfields as found in the Wellfield #1, #3, #4, and #4A Pre-Operational Data Submittals, dated May 27, 1999, June 1, 1998, April 26, 1999, and July 18, 2000, respectively. The designations of the intervals identified on the cross sections are Company designations. For an ISL wellfield, the production zone is the geological sandstone unit where the leaching solutions are injected and recovered.

3.2.4.2 Wellfield Areas

Wellfield areas are developed as needed to meet production requirements and are generally about 50 acres each. Injection and recovery wells in a wellfield are completed in the mineralized intervals of only one production zone at any one time. Injection and recovery wells are completed as described in Section 3.2.4.5 to isolate the open hole or screened ore bearing interval from all other aquifers. Production zone monitor wells are located in a ring around the wellfield units. Monitor wells for overlying and underlying aquifers are installed at a density of one for each four acres of wellfield area. The distance between overlying or underlying monitor wells in the same zone shall not exceed 1,000 feet and all such wells are installed within the confines of the wellfield unit area.

When areas within a prospective wellfield are encountered which exhibit very thin or absent vertical confining layers, PRI evaluates the local stratigraphy and may adjust the monitoring and operating programs to account for such a situation. These adjustments may include placement of the overlying/underlying monitor wells in different stratigraphic horizons within the same wellfield, and perhaps in the same sandstone unit containing the mineralized intervals (at different horizons), or in some instances overlying or underlying wells may not be needed. Additional operational controls may also be instituted in the absence or breach of a confining layer, such as localized increased rates of over-recovery.

There are currently 14 wellfields installed at the SR-HUP. Locations of the wellfields are shown on Plate 1. Wellfields A, B, C, D, E, F, D-Extension, H, and I are located at Highland. The A and B-Wellfields were the first wellfields installed at Highland in 1987 and are currently in ground water restoration status. Active ground water restoration was completed in the A-Wellfield in 1999 and approved by WDEQ in 2003, and the NRC in 2004. Ground water restoration in the B-Wellfield is currently (December 2004)in the stability monitoring phase and is expected to be completed in 2005. It is anticipated that the surface reclamation will follow soon after the regulatory agencies concur with ground water restoration. The C-Wellfield was installed in 1989 and is currently undergoing ground water restoration as well.

The D-Wellfield was installed in 1990 and 1991 and started production in mid-1991. The D-Wellfield is currently in production. The E-Wellfield was installed in 1991 and 1992 and started production in February, 1992. The E-Wellfield is currently in production. The F-Wellfield was sequentially installed during 1993-1996, with production beginning in May 1994. The F-Wellfield is currently in production. The H-Wellfield was sequentially installed during 1996 and 1997 with production beginning in 1997. The H-Wellfield is currently in production. The D-

Extension Wellfield was installed during 2000 and is currently in production. The I-Wellfield is the newest wellfield at the Highland Project and was installed in 2004 and in operation in 2004.

There are currently (December 2004) five wellfields (1, 2, 3, 4, and 4A) installed and in production at Smith Ranch. Wellfield 15 will be installed in 2005 and will also begin operation in 2005. No wellfields at Smith Ranch are currently in ground water restoration, however restoration is planned to begin in 2005 for Wellfield 1. Production operations began at Wellfield 1 in 1997, Wellfield 3 in 1998, Wellfield 4 in 1999, Wellfield 4A in 2001, and Wellfield 2 in March 2003. Currently, production operations are occurring in all of these wellfields. Plate 1 also shows planned wellfield areas that will be potentially mined, dependent on uranium market conditions and economic feasibility.

There are currently 8 wellfields planned for the Reynolds Ranch amendment area. Anticipated locations of these wellfields are shown on Plate 1. Construction of the Satellite facility and delineation drilling is anticipated to begin in 2006, and construction of the first wellfield is anticipated to begin in 2007. At this time, Wellfield 21 is anticipated to be the first wellfield in production at the Reynolds Ranch Satellite. Production at this wellfield is anticipated to begin in 2008.

3.2.4.3 Wellfield Injection/Production Patterns

The wellfield injection/production pattern employed is based on the conventional square five spot pattern which is modified as needed to fit the characteristics of the orebody (see Figure 3-12). The standard production cell for the five spot pattern contains four injection wells surrounding a centrally located well. The cell dimensions vary depending on the formation and the characteristics of the orebody. The injection wells in a normal pattern are expected to be between 75 feet and 150 feet apart. All wells are expected to be completed so they can be used as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the ground water in the most efficient manner. During operations, leaching solution enters the formations through the injection wells and flows to the recovery wells. Within each wellfield, more water is produced than injected to create an overall hydraulic cone of depression in the production zone. Under this pressure gradient the natural ground water movement from the surrounding area is toward the wellfield providing additional control of the leaching solution movement. The difference between the amount of water produced and injected is the wellfield "bleed."

The minimum over production or bleed rates will be a nominal 0.5% of the total wellfield production rate and the maximum bleed rate typically approaches 1.5%. Over-production is adjusted as necessary to ensure that the perimeter ore zone monitor wells are influenced by the cone of depression resulting from the wellfield production bleed.

Each injection well and recovery well is connected to the respective injection or recovery manifold in a wellfield Headerhouse building. The manifolds deliver the leaching solutions to the pipelines carrying the solutions to and from the ion exchange facilities. Flow meters and control valves are installed in the individual well lines to monitor and control the individual well flow rates and pressures. Wellfield piping is high density polyethylene (HDPE) pipe, PVC and/or steel. The wellfield piping will typically be designed for an operating pressure of 150 psig, and it will be operated at pressures equal to or less than the rated operating pressure of the pipe and other in-line equipment. If a higher design pressure is needed, the pressure rating of the materials will be evaluated and if necessary, materials with a higher pressure rating will be used.

The individual well lines and the trunk lines to the ion exchange facilities are buried to prevent freezing. The use of field header buildings and buried lines is a proven method for protecting pipelines. A typical wellfield development pattern is illustrated in Figure 3-12.

3.2.4.4 Wellfield Operations

The production areas have been divided into wellfields for scheduling development plans and for establishing baseline data, monitoring requirements, and restoration criteria. A wellfield will consist of a reserve block generally about 50 acres and will represent an area that is expected to be developed, produced and restored as a unit. Up to 20 such units may be required to develop the total project area. A wellfield will typically have a flow rate in the 1000-4000 GPM range. Aquifer restoration of a wellfield will begin as soon as practical after mining in the unit is complete. If a mined out unit is adjacent to another unit being mined, restoration of a portion of the unit may be deferred to minimize interference with the mining operation. The wellfields as currently projected are shown in Plate 1. However, the size and location of the wellfields will be modified as needed based on final delineations of the ore deposit, performance of the area and development requirements.

The projected mining schedule for existing and proposed wellfields along with the anticipated ground water restoration and decommissioning schedule is provided in Figure 3-13. It should be realized that it is not possible to determine a precise schedule of future operating wellfields due to the types of activities involved and the over-riding fluctuating uranium market conditions. As a result, the only proposed wellfield shown on Figure 3-13 is Wellfield 15A at the Smith Ranch Project, J-Wellfield at the Highland Project, and Wellfield 21 at the Reynolds Ranch amendment area. It is anticipated that Wellfield 15A will be the next wellfield to go into production at the combined SR-HUP. The exact schedule for other proposed wellfields (as shown in Plate 1) will depend on future economic analyses of ore reserves and anticipated production costs.

The development schedule provided in Figure 3-13 is affected by various factors. These factors typically involve adjustments as necessary to meet production schedules and contractual agreements, longer (or shorter) than predicted mining or restoration times or delays in wellfield installations. To account for such changes, PRI provides an Annual Report to the WDEQ with a map of the permit area showing the wellfields being developed, in production, in restoration, and areas where restoration has been completed. New areas where production or restoration is expected to begin in the subsequent year will also be identified in the Annual Report.

3.2.4.5 Well Completion

Pilot holes for monitor, production, and injection wells are drilled to the top of the target completion interval with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The hole is logged, reamed, casing set, and cemented to isolate the completion interval from all other aquifers. The cement will be placed by pumping it down the casing and forcing it out the bottom of the casing and back up the casing-drill hole annulus.

Typical well completion schematics for production wells, injection wells, and monitor wells are shown on Figures 3-14 through 3-16, respectively. The well casing will be fiberglass or PVC. A typical fiberglass casing will be Centron's 2.1 pound per foot well casing with a 0.175 inch wall thickness or similar casing. The Centron casing has a standard joint length of 30 feet and is rated for 950 pounds per square inch operating pressure. PVC well casing is 4.5 or 5 inch Schedule 40 or SDR-17 (or equivalent). The PVC casing joints normally have a length of approximately 20 feet each. When Schedule 40 PVC casing is used, each joint is bonded with PVC cement and secured with three self-tapping screws. When SDR-17 PVC casing is used, each joint is connected by a water tight o-ring seal which is located with a high strength nylon spline. Currently, all production and injection wells are constructed with SDR-17 PVC casing that utilizes the o-ring seal and nylon spline.

Three casing centralizers, located approximately 30 feet, 90 feet and 150 feet above the casing shoe, are normally run on the casing to ensure it is centered in the drill hole and that an effective cement seal is provided. The purpose of the cement is to stabilize and strengthen the casing and plug the annulus of the hole to prevent vertical migration of solutions. The volume of cement used in each well is determined by estimating the volume required to fill the annulus and ensure cement returns to the surface. In almost all cement jobs, returns to the surface are observed. In rare instances, however, the drilling may result in a larger annulus volume than anticipated and cement may not return all the way to the surface. In these cases the upper portion of the annulus will be cemented from the surface to backfill as much of the well annulus as possible and stabilize the wellhead. This procedure is called "topping off".

After the well is cemented to the surface and the cement has set, the well is drilled out and completed either as an open hole or it is fitted with a screen assembly (slotted liner), which may have a sand filter pack installed between the screen and the underreammed formation. The well is then air lifted for about 30 minutes to remove any remaining drilling mud and/or cuttings. A small submersible pump is frequently run in the well for final clean-up and sampling.

3.2.4.6 Well Casing Integrity

After an injection or production well has been completed, and before it is made operational, a Mechanical Integrity Test (MIT) of the well casing is conducted. In the integrity test, the bottom of the casing adjacent to or below the confining layer above the production zone is sealed with a plug, downhole packer, or other suitable device. The top of the casing is then sealed in a similar manner or with a threaded cap, and a pressure gauge is installed to monitor the pressure inside the casing. The pressure in the sealed casing is then increased to a specified test pressure. A well must maintain 90% of this pressure for 10 minutes to pass the test.

If there are obvious leaks, or the pressure drops by more than 10% during the 10 minute period, the seals and fittings will be reset and/or checked and another test is conducted. If the pressure drops less than 10% the well casing is considered to have demonstrated acceptable mechanical integrity.

If a well casing does not meet the MIT criteria, the casing will be repaired and the well re-tested. If a repaired well passes the MIT, it will be employed in its intended service. If the well defect occurs at depth, the well may be plugged back and re-completed for use in a shallower zone provided it passes the MIT. If an acceptable test cannot be obtained after repairs, the well will be plugged and abandoned.

During wellfield operations, injection pressure at the injection well heads will not exceed the integrity test pressure. In no event will injection wells be used for injection purposes if they do not demonstrate mechanical integrity.

The MIT of a well is documented to include the well designation, date of the test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs are maintained on site and are available for inspection by NRC and WDEQ. In accordance with WDEQ and EPA requirements, the results of MITs are reported to the WDEQ on a quarterly basis. In accordance with WDEQ and EPA requirements, MITs are repeated once every five years for all wells used for injection of lixiviant, or injection of fluids for restoration operations.

Additionally, a MIT will be conducted on any well to be used for injection purposes after any well repair where a downhole drill bit or underreaming tool is used. Any injection well with evidence of suspected subsurface damage will require a new MIT prior to the well being returned to service.

3.2.4.7 Monitoring of Wellfield Flow and Pressure

Injection well and production well flow rates and pressures are monitored in order that injection and production can be balanced for each pattern and the entire wellfield. This information is also needed for assessing operational conditions and mineral royalties. The flow rate of each production and injection well is determined by monitoring individual flow meters in each wellfield headerhouse. Production well flow rates are determined on a daily basis. Injection well flow rates are determined at least every three days. Injection well flow rates are monitored less often than production well flow rates as there are no royalty considerations with injection wells. Additionally, through operating experience and the fact that injection pressures remain relatively constant, PRI has found that monitoring injection well flow rates at least every three days is more than adequate to ensure that wellfield patterns are adequately balanced.

The pressure of each production well and the production trunk line are determined in each wellfield headerhouse on a daily basis. The pressure of the injection trunk line is also determined daily in each wellfield headerhouse. The surface injection pressures will not exceed the maximum surface pressures posted in each headerhouse.

Data records for these monitoring activities are maintained on-site.

3.2.4.8 Pipeline Monitoring

Pressure and flow indicators on the main pipelines to and from the recovery plant will also be recorded daily to ensure the pressures and flows are maintained within the safe working limits of the pipeline.

3.2.5 <u>Chemical Storage Facilities</u>

Chemical storage facilities at the SR-HUP include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, are stored outside and segregated from areas where licensed materials are processed and stored. Other non-hazardous bulk process chemicals (sodium chloride, sodium carbonate) that do not have the potential to impact radiological safety are stored within the Central Plant facilities.

Chemical storage facilities at the Reynolds Ranch Satellite will include bulk carbon dioxide and oxygen storage tanks. Also, bulk fuel storage facilities for vehicles may be constructed at the Reynolds Ranch Satellite.

3.2.5.1 Process Related Chemicals

Hazardous materials, which have the potential to impact radiological safety, include anhydrous ammonia, hydrogen peroxide, and acid (sulfuric and/or hydrochloric). Anhydrous ammonia and hydrogen peroxide are used for pH control in the precipitation circuit at the Smith Ranch CPP. Sulfuric acid is also used at the CPP to initiate the precipitation cycle. These hazardous materials are stored outside of the CPP in a chemical tank farm area where they are segregated from process areas until their point of use within the process system. All outside bulk liquid storage tanks are contained within concrete curbed secondary containment structures. A similar setup for bulk process chemicals is utilized at the Highland CPF. Currently, the Highland CPF is on standby status and no bulk process chemicals are used and/or stored in this area. The locations of existing chemical storage areas at the Smith Ranch CPP and Highland CPF are shown in Figures 3-3 and 3-5, respectively.

Additional process-related chemicals stored in bulk at the SR-HUP include carbon dioxide and oxygen. Carbon dioxide is typically stored adjacent to the Central Plant and/or Satellite facilities where it is added to the lixiviant prior to leaving the IX facilities. Oxygen is also typically stored at the Central Plant and Satellite facilities, or within wellfield areas, where it is centrally located for addition to the injection stream in each header house. Currently, carbon dioxide is stored at the Smith Ranch CPP and Satellite Nos. 2, 3, and SR-1, while oxygen is stored at the Smith Ranch CPP, Satellite Nos. 2 and SR-1, and at a storage pad at the east end of the F-Wellfield. Carbon dioxide and oxygen is also anticipated to be stored at the Reynolds Ranch Satellite. The locations of existing carbon dioxide and oxygen storage tanks are shown on Plate 1.

Hazardous materials typically used during ground water restoration activities include the use of an acid (hydrochloric acid) for pH control and the addition of a chemical reductant (sodium sulfide or hydrogen sulfide gas). To minimize potential impacts to radiological safety, these materials are stored outside of process areas. Currently, bulk hydrochloric acid is stored at Satellite No. 1. Additional hydrochloric acid tanks may be located near other Satellite facilities as ground water restoration commences in other wellfield areas. All hydrochloric acid tanks will be contained within sufficient secondary containment structures.

Sodium sulfide is currently used at the SR-HUP as a chemical reductant during ground water restoration. The material consists of a dry flaked product and is typically purchased on pallets of 55-pound bags or super sacs of 1,000 pounds.

The bulk inventory is stored outside of process areas in a cool, dry, clean environment to prevent contact with any acid, oxidizer, or other material that may react with the product. No hydrogen sulfide gas is currently (December 2004) stored at the site. In the event that hydrogen sulfide is used as a chemical reductant, proper safety precautions will be taken to minimize potential impacts to radiological and chemical safety. Additionally, bioremediation is also used during ground water restoration. Chemicals utilized for bioremediation include methanol, molasses, and phosphoric acid. Methanol is stored in bulk at the Satellite area (where restoration is occurring) in 500 or 2000-gallon tanks. Molasses and phosphoric acid are stored inside the restoration Satellite in small quantities.

As part of the EHS Management System, a risk assessment was completed to recognize potential hazards and risks associated with chemical storage facilities (and other processes) and to mitigate those risks to acceptable levels. The risk assessment process identified anhydrous ammonia as the most hazardous chemical with the greatest potential for impacts to chemical and radiological safety. The anhydrous ammonia storage and distribution system at the Smith Ranch CPP (see Figure 3-3) has a maximum capacity of approximately 90,000 lbs. Administrative controls limit ammonia storage in the tank to 80% of maximum capacity. Strict unloading procedures are utilized to ensure that this limit is not exceeded and that other safety controls are in place during the transfer of anhydrous ammonia. Process safety controls are also in place at the CPP where anhydrous ammonia is added to the precipitation circuit. These safety controls include the installation of a process area ammonia detector and alarm and emergency shut off solenoid for isolation of the ammonia distribution system in the event of a major release.

The ammonia system at the Smith Ranch CPP is covered under the EPA's Risk Management Program (RMP) regulations. The RMP regulations require certain actions by covered facilities to prevent accidental releases of hazardous chemicals and minimize potential impacts to the public and environment. These actions include measures such as accidental release modeling, documentation of safety information, hazard reviews, operating procedures, safety training, and emergency response preparedness.

3.2.5.2 Non-Process Related Chemicals

Non-process related chemicals that are stored at the SR-HUP and Reynolds Ranch Satellite include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities are stored outside of process areas at the CPP and Satellite facilities. All gasoline and diesel storage tanks are located above ground and within concrete curbed secondary containment structures.

3.3 INSTRUMENTATION AND CONTROL

Smith Ranch CPP monitoring and alarm instrumentation are employed to provide centralized monitoring of key process components. Operator control of key elements will be maintained with a series of remotely controlled valves and power switches. In addition to alerting the operations personnel of upset conditions within the facility, the instrumentation also monitors the operations and records routine operational data for both production and regulatory reporting requirements.

When operating parameters move outside specified normal operating ranges, an alarm will notify the operator to initiate corrective action to alleviate the problem. Excessively high or low levels or pressure alarms activate automatic shutdown of the related equipment. Operational areas such as pipelines, headerhouses, and the disposal wells comprise a significant component of the automatic shutdown system since those areas provide the greatest risk to large spills of source and byproduct material to the environment. These systems use high and low pressure alarms to automatically shutdown headerhouses, wellfields, and/or ion exchange facilities depending on the location and scale of the alarms. The CPP also has alarms for high/low pressures, high/low flow, or low vacuum (in the case of the rotary vacuum dryers) that will alert the operator of the upset condition to either initiate a corrective action or shutdown that operational area.

Alarm responses as well as recovery from automatic shutdowns will follow designated procedures as provided in the Standard Operating Procedures. The system was designed and installed to minimize the risk of uncontrolled releases of leaching solutions or other fluids and provide maximum safety and protection for the CPP Operators and Maintenance personnel.

FIGURE 3-1
Primary Chemical Reactions Expected in the Aquifer
South Powder River Basin In-Situ Leach Uranium Mining
Converse County, Wyoming

Uranium Extraction

Oxygen is added to the injection solution to oxidize the uranium in the formation.

Uranitite Oxidation

$$UO_2(s) + \frac{1}{2}O_2 + 2H^+ = 2UO_3^{2+} + H_2O \qquad \text{(eq. 1)}$$

Leaching and Complexing

$$UO_3 + Na_2CO_3 + NaHCO_3 = UO_2(CO_3)_2^{2-} + 3Na^+ + 2H^+ \qquad \text{(eq. 2)}$$

The soluble uranyl dicarbonate complex moves to the production wells in solution and is recovered in the processing plant. The uranium is collected on ion exchange beads where the chloride ions are exchanged with the uranyl dicarbonate complex, and chloride is added to the lixiviant as a contaminant for restoration.

$$2RCl + (UO_2)(CO_3)_2^{2-} = R_2UO_2(CO_3)_2 + 2Cl^-$$

(R is ion exchange resin) (eq.3)

Sediment Derived Contaminants

Two principle contaminants derived from ISL mining are calcium as Ca^{2+} and sulfate SO_4^{2-}.

Calcium (derived from consolidation of formation sands and clays)

$$CaCO_3(s) + H^+ = Ca^{2+} + HCO^- \qquad \text{(eq. 4)}$$

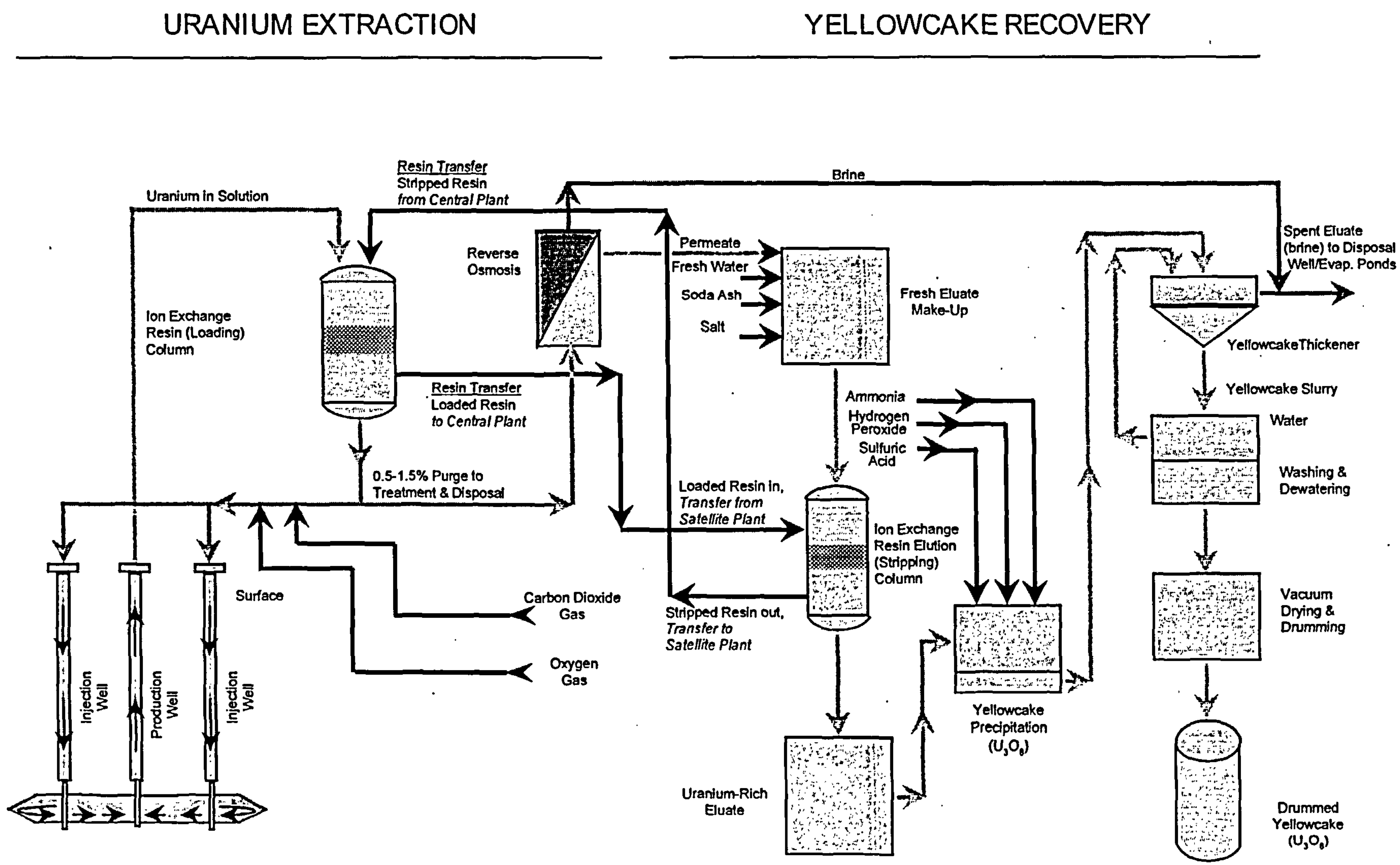
At normal pH and temperature associated with ISL mining, calcium remains in solution. However, changes in pressure and temperature may cause calcium carbonate precipitate to form as a scale.

Sulfate is created by the oxidation of pyrites associated with uranium roll front geochemistry.

$$2FeS_2(s) + 7.5O_2 + 7H_2O = 2Fe(OH)_3(s) + 4SO_4^{2-} + 8H^+ \qquad \text{(eq. 5)}$$

The ferric hydroxide will precipitate when formed. Excess calcium developed in eq. 4 coupled with excess sulfate in eq. 5 may develop $CaSO_4$ as a precipitate under the proper temperature and pressure.

FIGURE 3-2
FLOW PROCESS SCHEMATIC



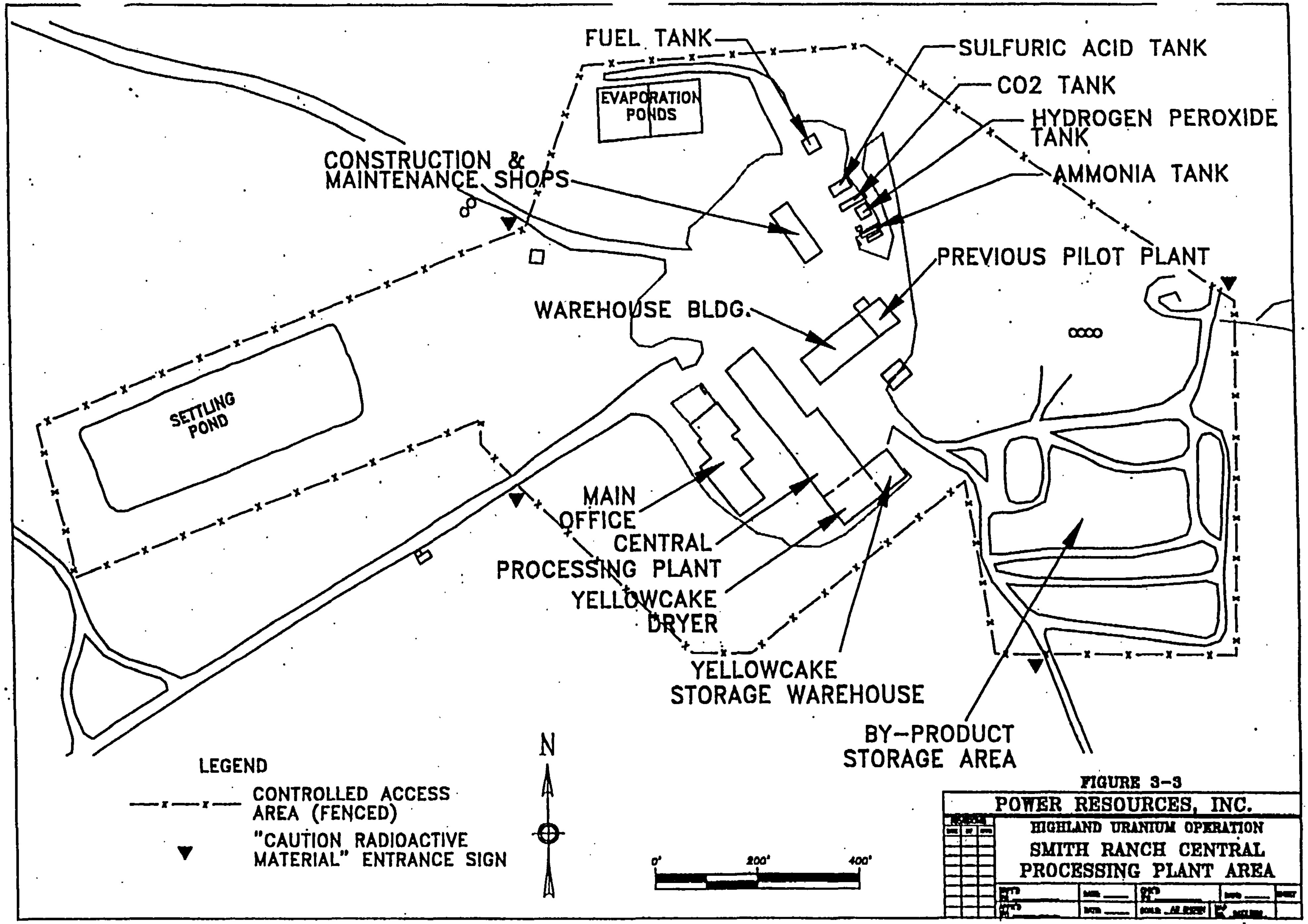


FIGURE 3-3

POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SMITH RANCH CENTRAL PROCESSING PLANT AREA

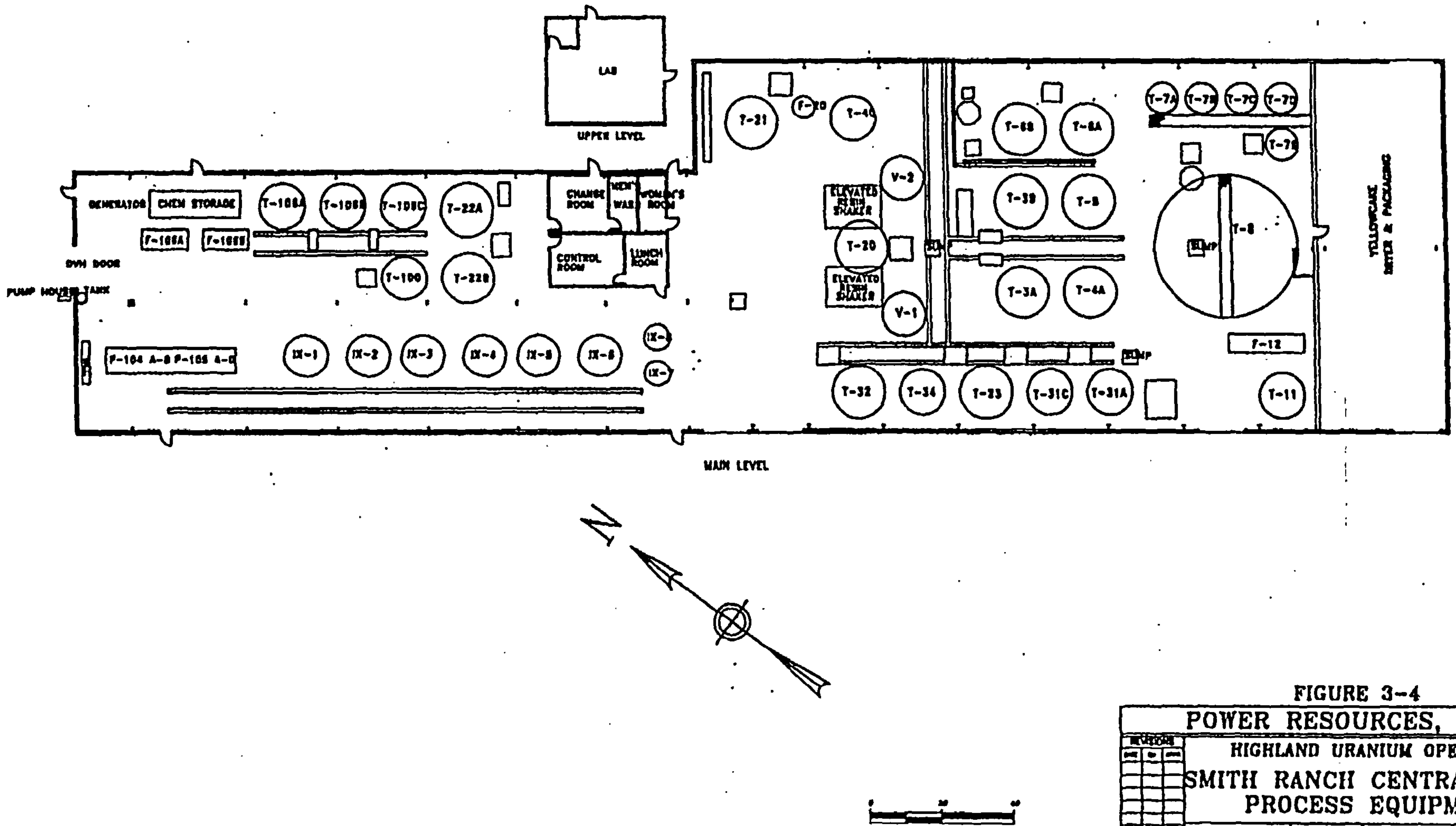


FIGURE 3-4

POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SMITH RANCH CENTRAL PLANT PROCESS EQUIPMENT

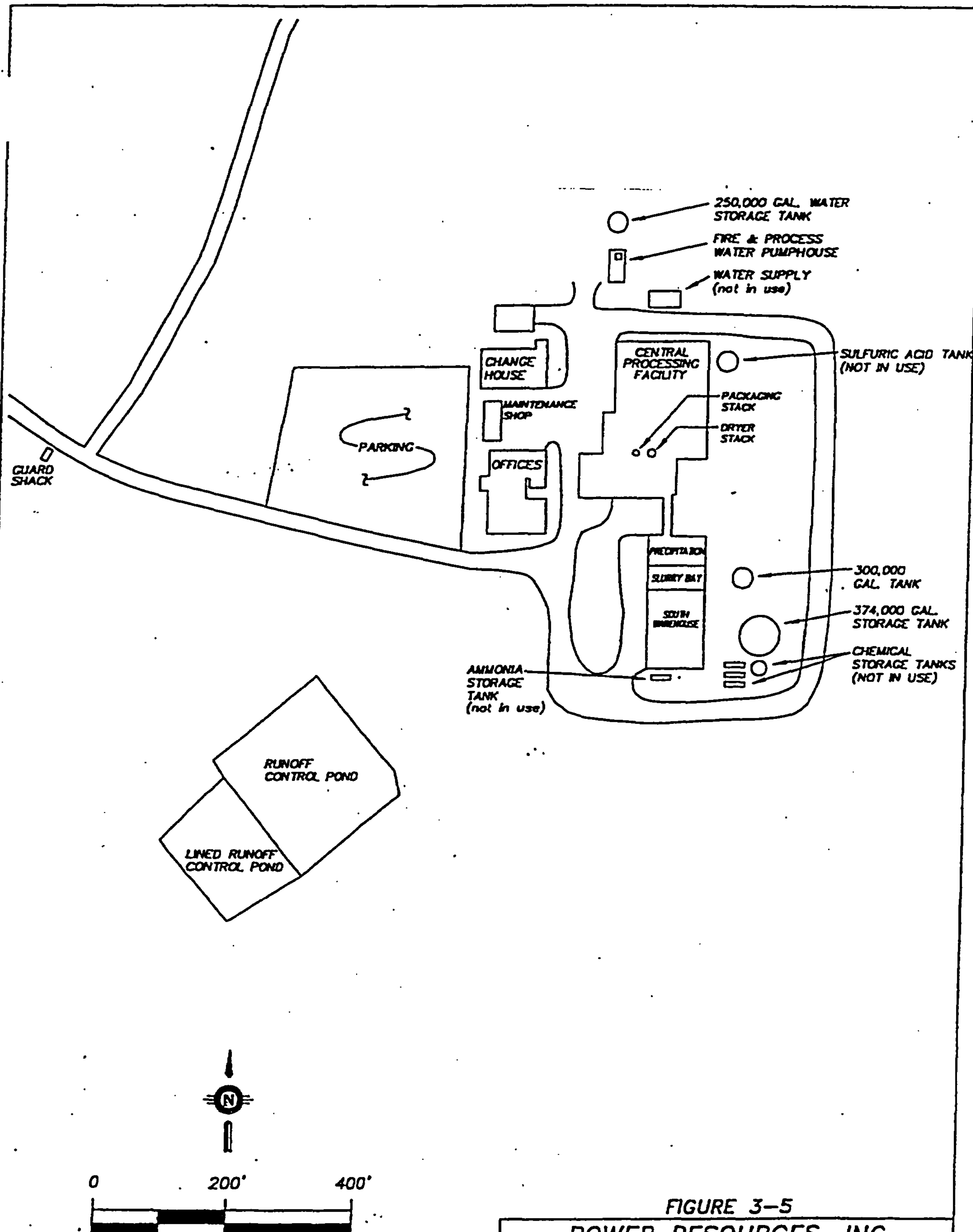


FIGURE 3-5

POWER RESOURCES, INC.

HIGHLAND URANIUM PROJECT
HIGHLAND CENTRAL PROCESSING FACILITY
CONVERSE COUNTY, WYOMING

REVISIONS

SCALE: AS SHOWN

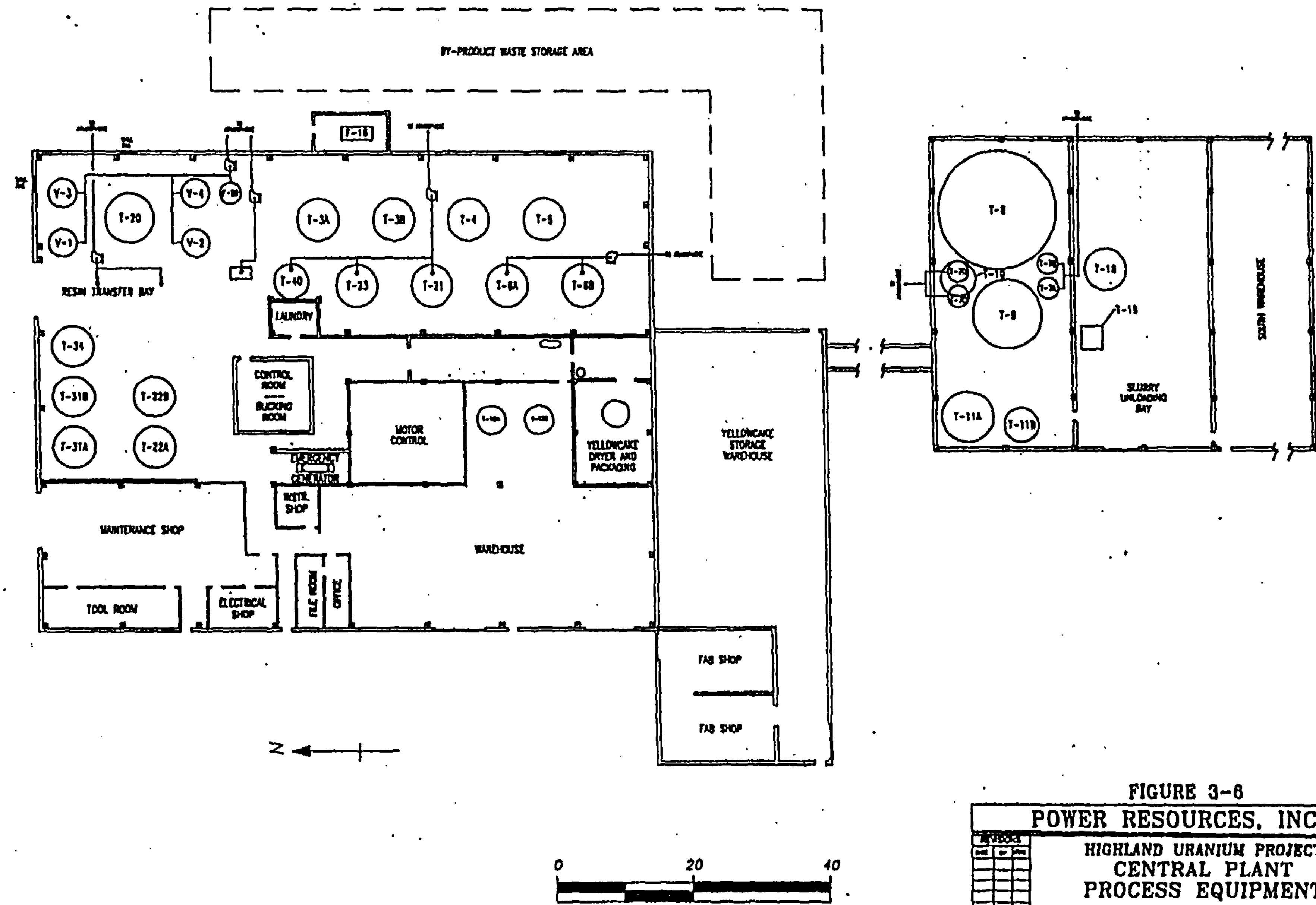


FIGURE 3-6

POWER RESOURCES, INC.

HIGHLAND URANIUM PROJECT
CENTRAL PLANT
PROCESS EQUIPMENT

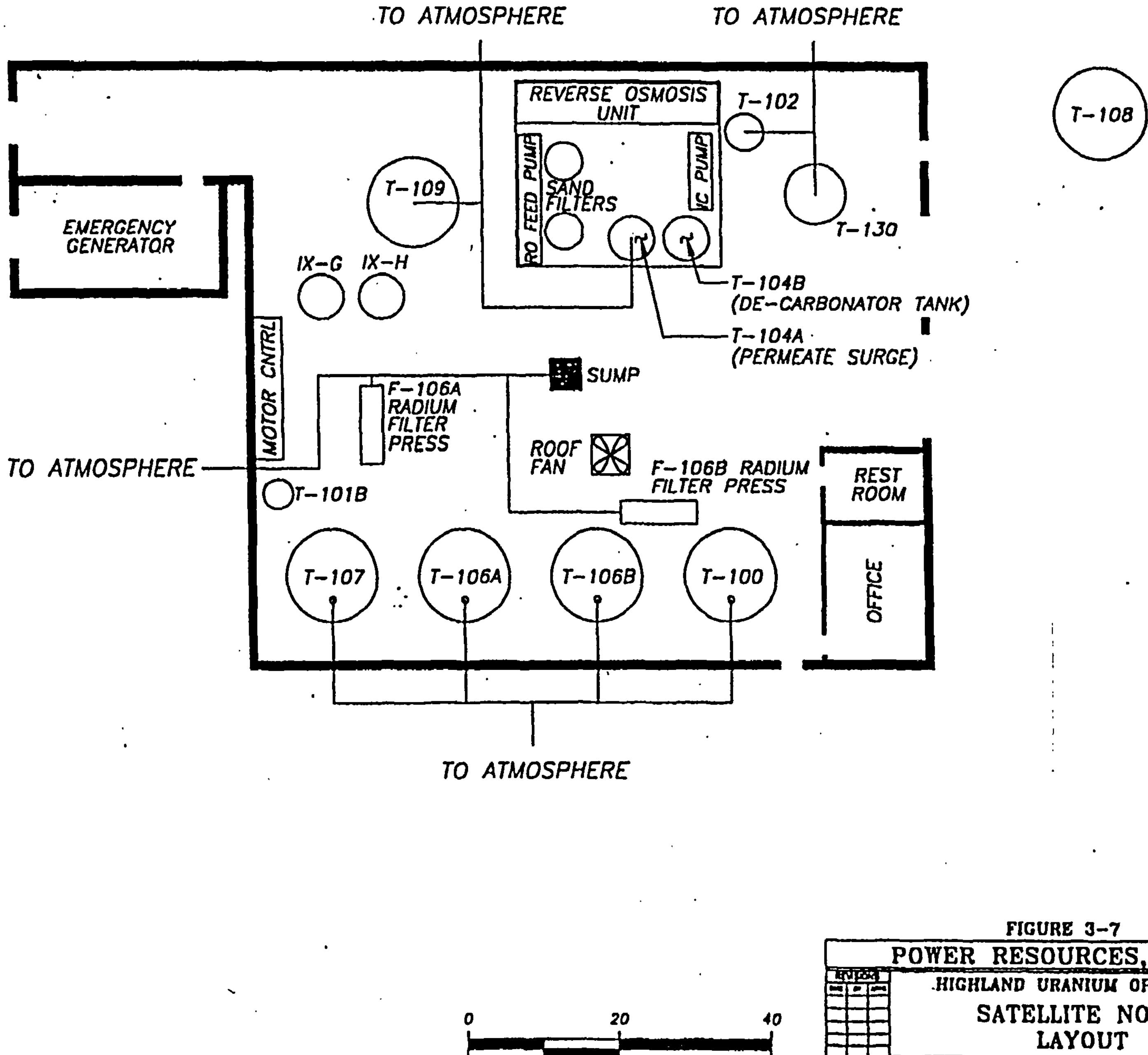


FIGURE 3-7

POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SATELLITE NO. 1
LAYOUT

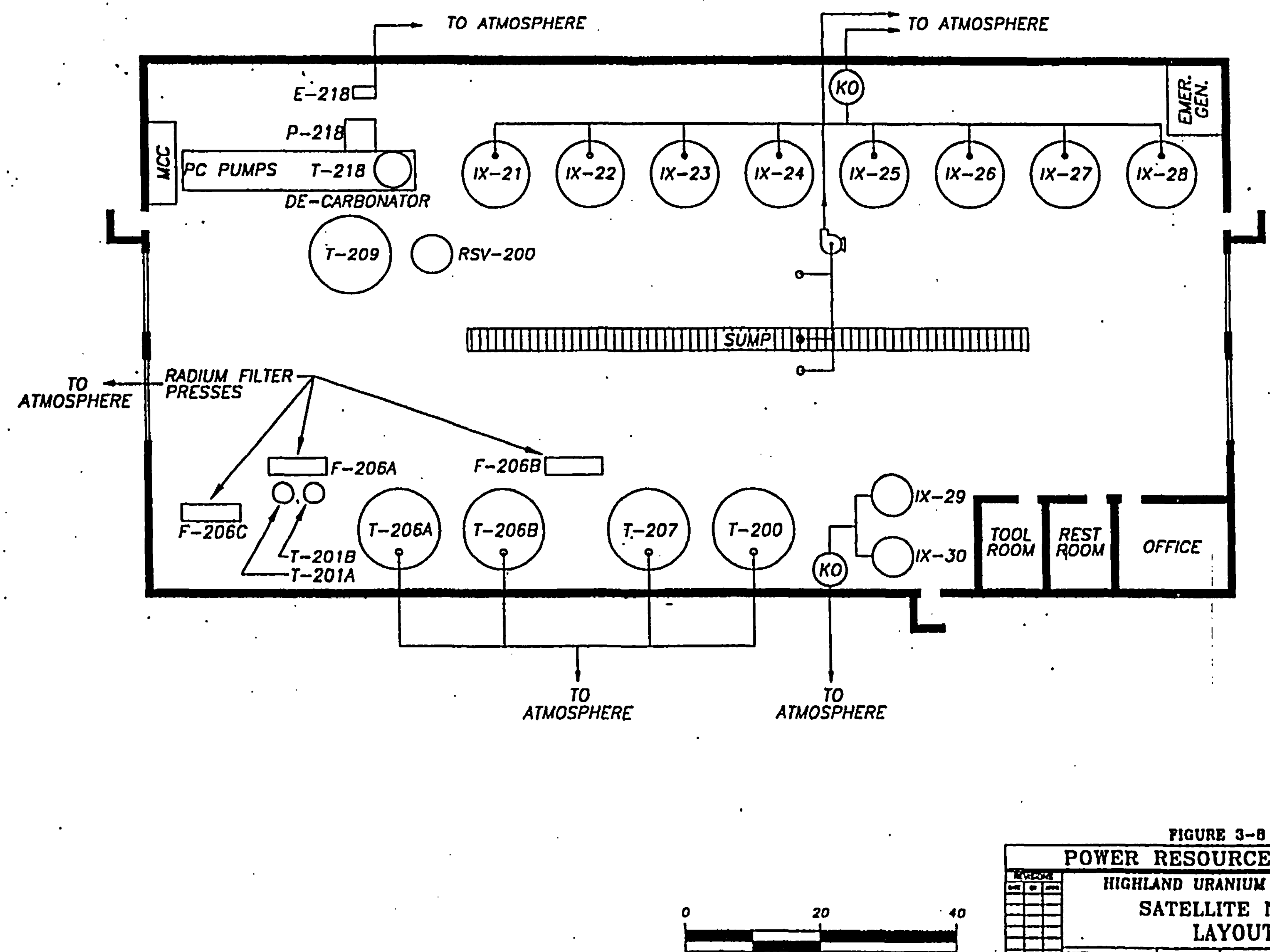


FIGURE 3-8

POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SATELLITE NO. 2

LAYOUT

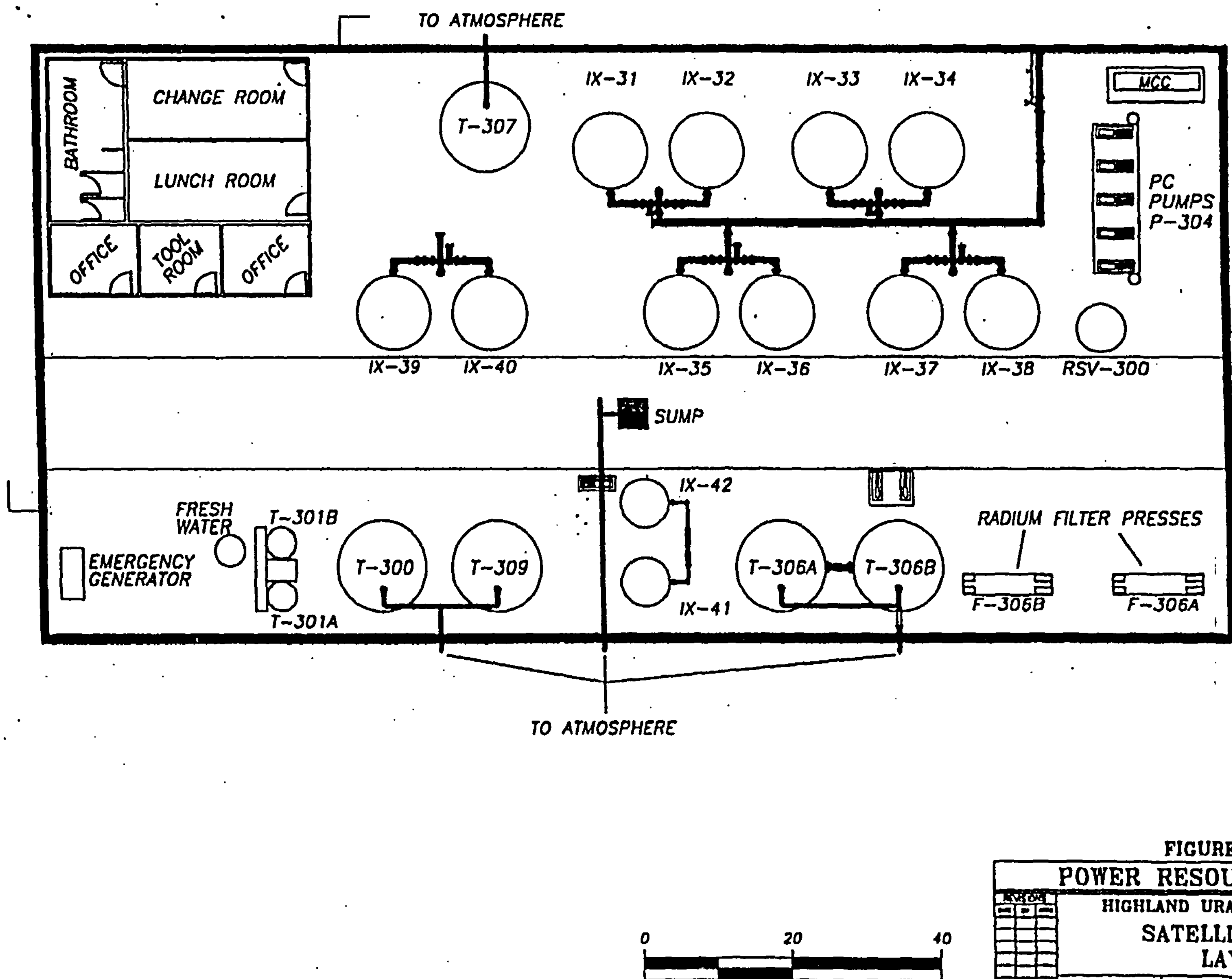


FIGURE 3-9

POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SATELLITE NO. 3
LAYOUT

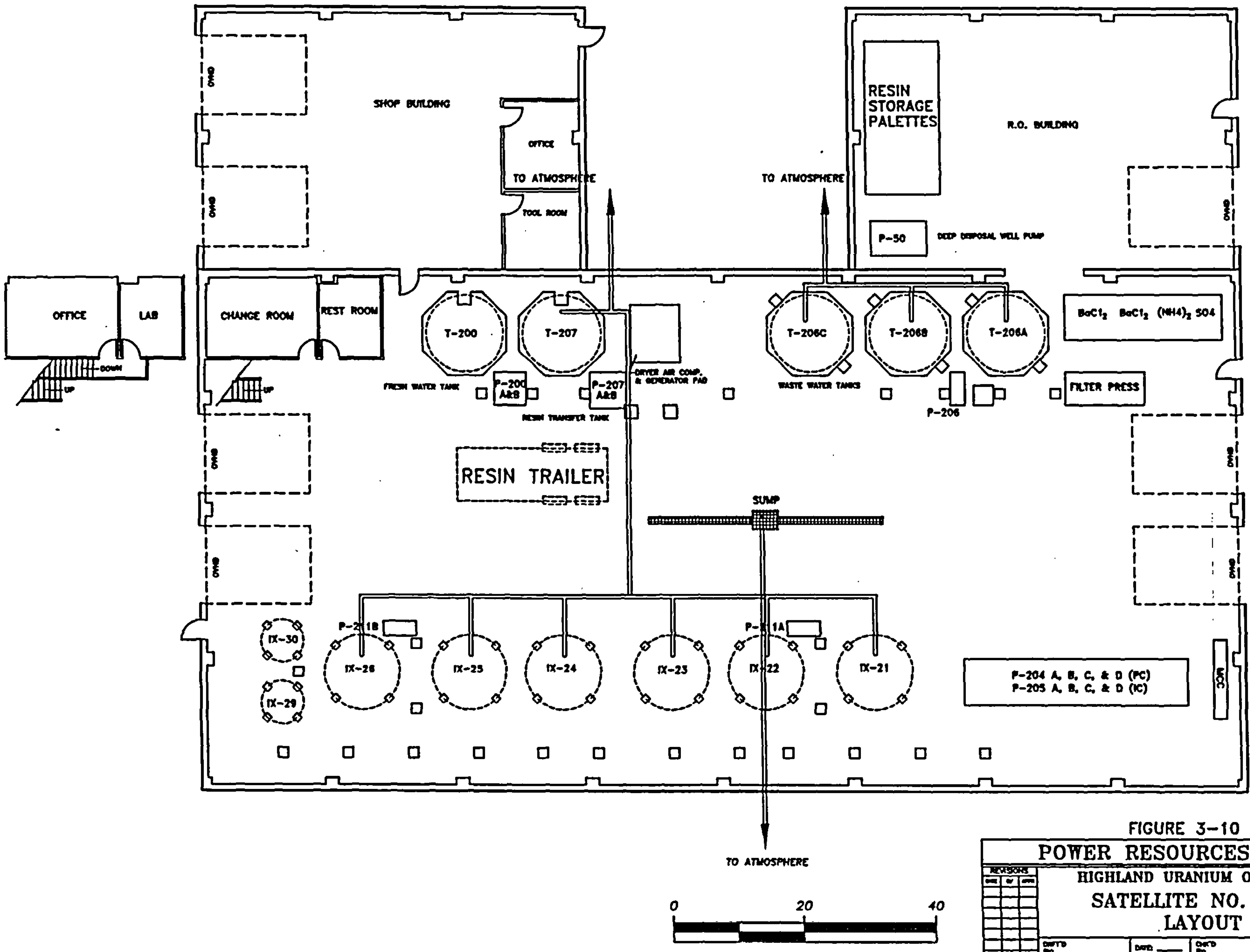


FIGURE 3-10

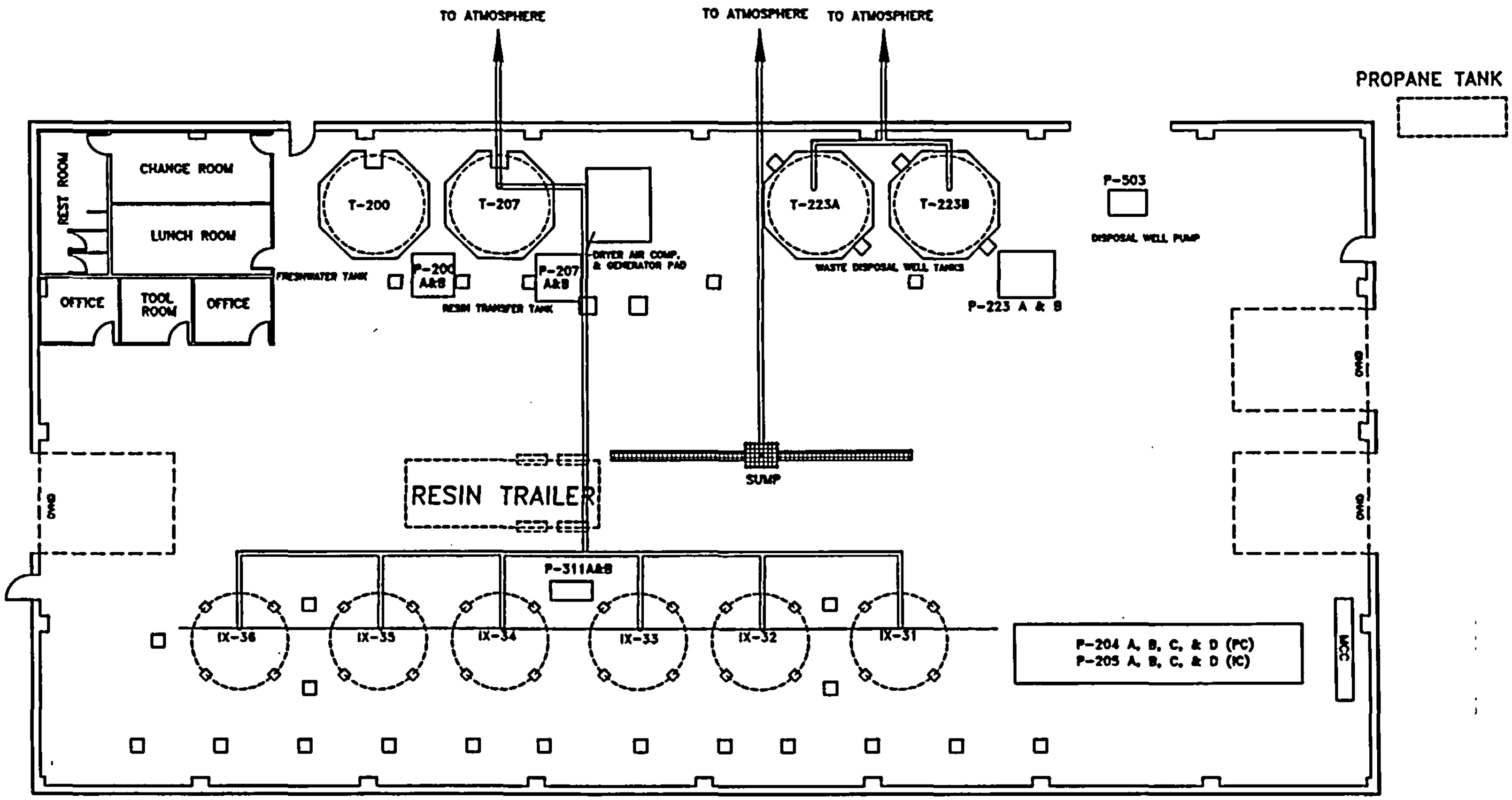
POWER RESOURCES, INC.

HIGHLAND URANIUM OPERATION

SATELLITE NO. SR-1

LAYOUT

REVISIONS	DRFT'D BY	DATE	CHK'D BY	DATE	SHEET
	APPR'D BY	DATE	SCALE AS SHOWN	MAP NO.	



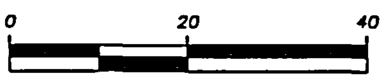


FIGURE 3-11

POWER RESOURCES, INC.

P.O. Box 1210 Glenrock, WY 82637 (307) 358-6541 (307) 235-1628

REVISIONS		
NO.	DATE	BY

REYNOLDS RANCH PROJECT

SATELLITE LAYOUT

CONVERSE COUNTY, WYOMING

Figure 3-12
Smith Ranch – Highland Uranium Project
Typical Wellfield Development Pattern

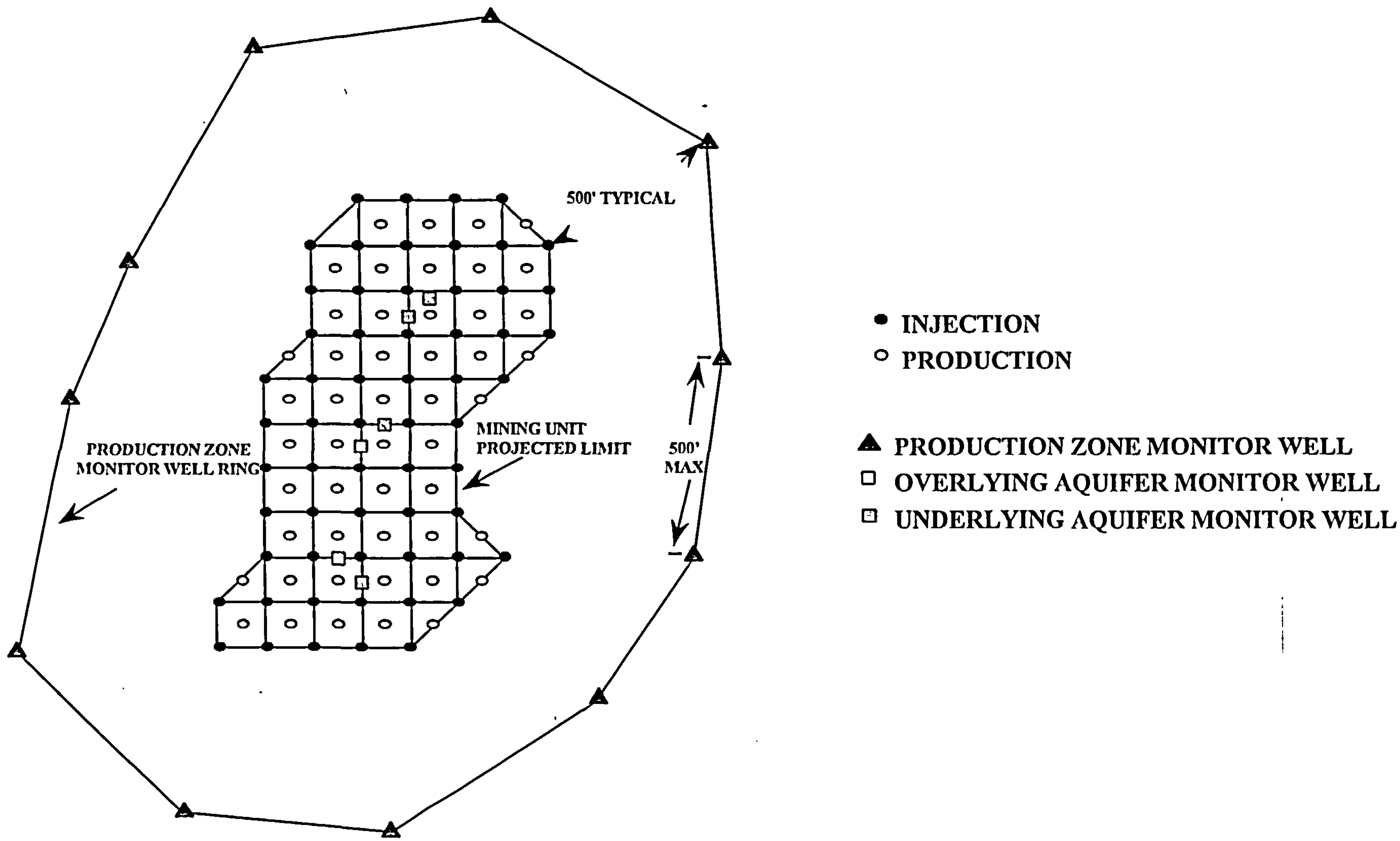
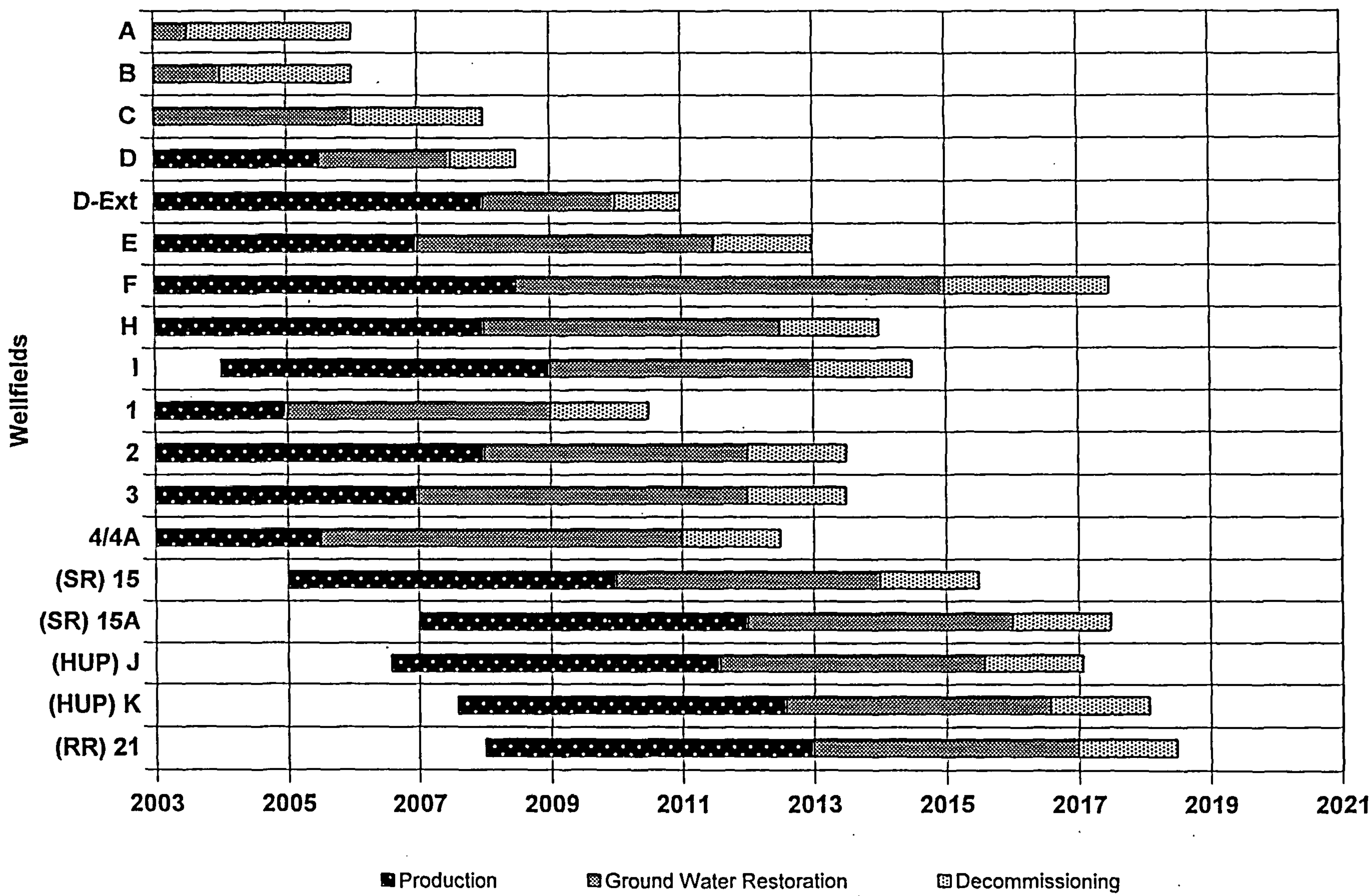


Figure 3-13
Smith Ranch-Highland Uranium Project - Estimated Time Table of Mining Related Activities



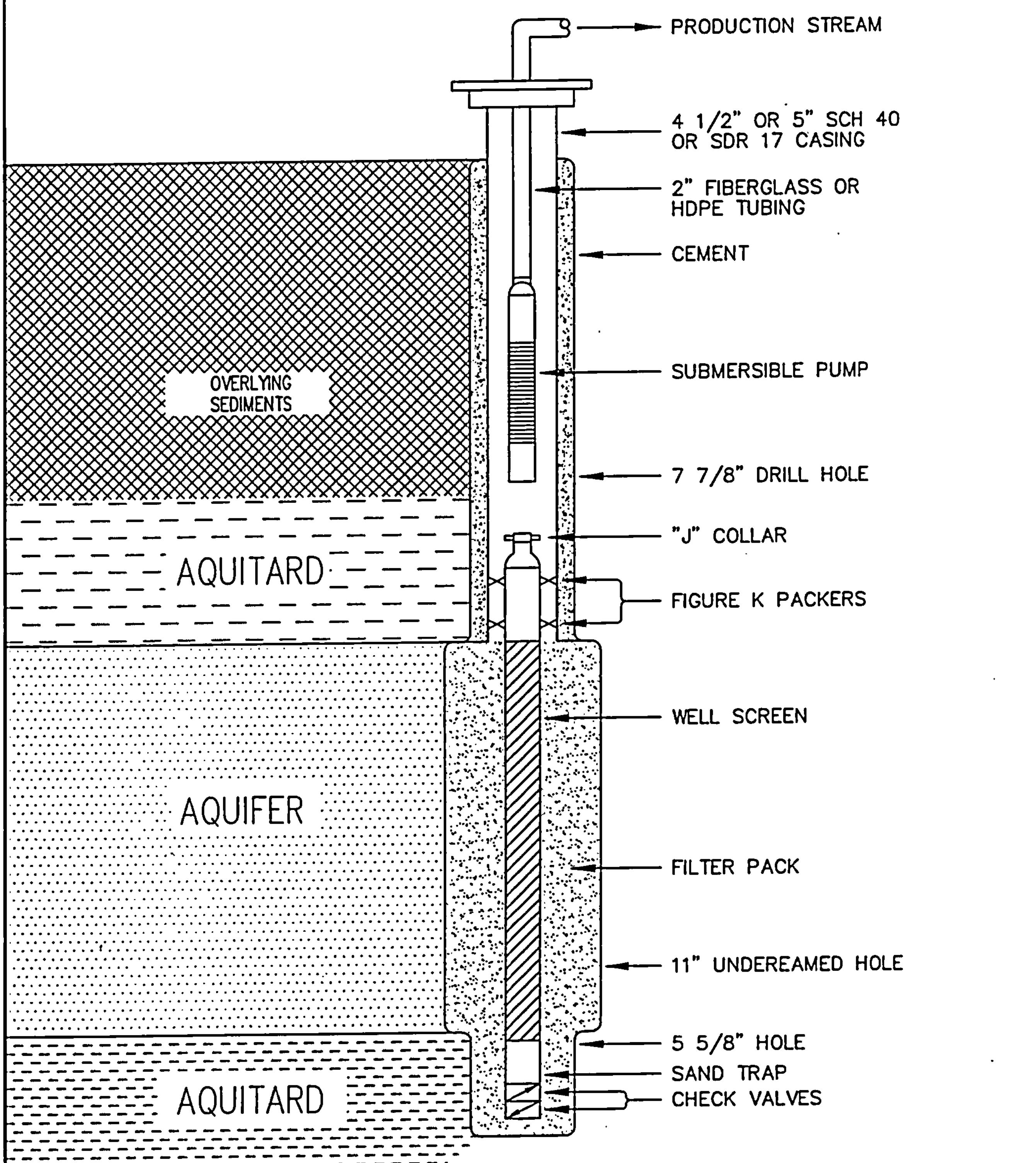


FIGURE 3-14

POWER RESOURCES, INC.

REVISIONS		
NO.	DATE	BY

REYNOLDS RANCH PROJECT

TYPICAL PRODUCTION WELL

CONVERSE COUNTY, WYOMING

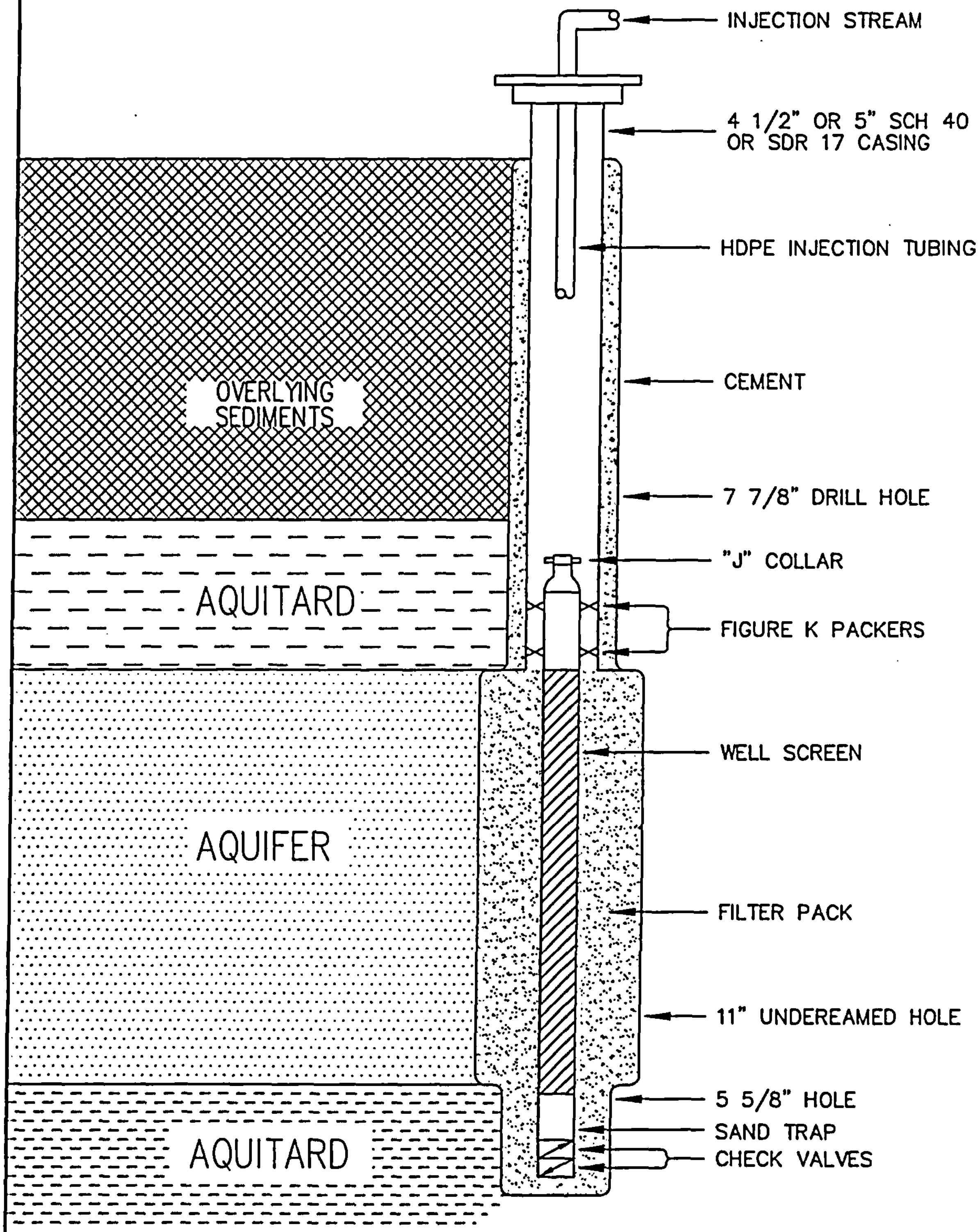


FIGURE 3-15

	POWER RESOURCES, INC.
REVISIONS (NO. / DATE / BY)	**REYNOLDS RANCH PROJECT**
	TYPICAL INJECTION WELL
	CONVERSE COUNTY, WYOMING

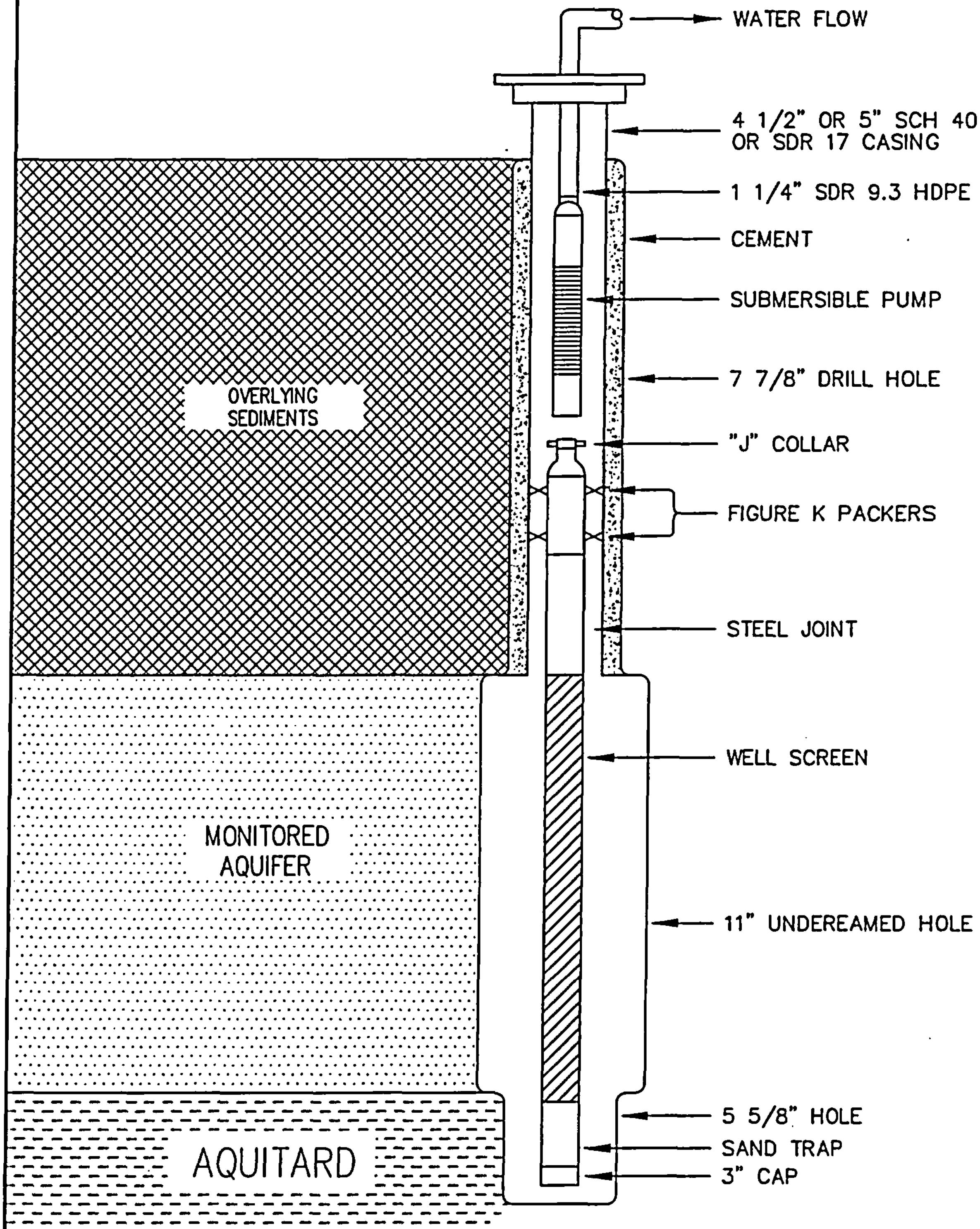


FIGURE 3-16

POWER RESOURCES, INC.

REVISIONS		
NO.	DATE	BY

REYNOLDS RANCH PROJECT

TYPICAL MONITOR WELL

CONVERSE COUNTY, WYOMING

CHAPTER 4
EFFLUENT CONTROL SYSTEM

This section describes the effluent control systems used at the SR-HUP and proposed Reynolds Ranch Satellite. The effluents of concern at ISL operations include the release or potential release of radon gas (radon-222) and dried yellowcake. Currently, yellowcake processing and drying operations are only conducted at the Smith Ranch CPP as the Highland Central Plant remains on standby status.

The yellowcake drying facilities at the Smith Ranch CPP are comprised of two vacuum dryers that have their own ventilation system. These vacuum dryers do not discharge any uranium when operating. Section 4.1.3 further discusses yellowcake drying at the Smith Ranch CPP. Yellowcake drying at the Highland Central Plant is conducted with a natural gas fired rotary hearth that utilizes a wet scrubber and vacuum system to limit the release of uranium during drying. Section 4.1.4 further discusses the effluent controls for this system.

Routine washdown procedures at both drying facilities keeps work areas clean of accumulating uranium as well as dirt and dust from outside sources.

4.1 GASEOUS AND AIRBORNE PARTICULATES

The principal radiological gas representing a potential radiological dose to man is radon-222 gas released to the atmosphere from the circulating leach solution and/or in the elution and precipitation circuit. Some carbon-dioxide gas and some acid fumes will evolve also from the elution/precipitation circuit, but these gases do not present a health problem at the anticipated concentrations. In order to alleviate potential discomfort or health problems due to the in-plant accumulation of gases and fumes, three ventilation systems have been installed. A ventilation system is connected to all process vessels where significant radon-222 or process fumes could reasonably be expected to be released. For the general work areas in the CPP building, a forced air ventilation system is installed for use when the buildings are normally closed due to weather or other factors. A third ventilation system is installed as a part of the yellowcake drying operation.

4.1.1 Tank and Process Vessel Ventilation Systems

A separate ventilation system is 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 to exhaust fumes to the outside atmosphere. Air flow through any openings in the vessel will be from the process area into the vessel and into the ventilation system controlling any releases that occur inside the vessel. Where needed, exhaust fans can pull the air from the top of the tanks and discharge the air with any gases and fumes to a vent placed on the outside of the building near the roof level. Separate ventilation systems are used as needed for the functional areas within the CPP.

A tank ventilation system of this type was utilized in the pilot process plant and in-plant monitoring for radon concentrations has proven it to be an effective system for minimizing employee exposure. Operational data collected during operation of the CPP has confirmed that the ventilation system is effective.

4.1.2 Work Area Ventilation System

The work area ventilation system is designed to force air to circulate within the separate CPP process areas. The systems for the ion exchange area and for the precipitation area include a minimum of two exhaust fans each. A third system is provided for yellowcake drying and packaging area. The ventilation system exhausts are located on the north or leeward side of the buildings. During favorable weather open doorways and the convection vents in the roof have provided satisfactory work area ventilation.

The maximum calculated annual radon release for the commercial ISL operations is based on NRC procedures used in NUREG-0925 Appendix C assuming all produced fluids are in equilibrium. Using these basis, radon is released at the maximum rate of 6738 Ci/year during the period of maximum production and restoration flows of 11,000 gpm and 3,000 gpm respectively (Table 4-1).

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic and small amounts of process chemicals such as ammonia, carbon dioxide, oxygen, hydrogen peroxide, sodium hydroxide, sulfuric acid and hydrochloric acid. There are no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.1.3 Yellowcake Drying at the Smith Ranch CPP

The wet yellowcake from the precipitation circuit is vacuum dried and packaged in fifty-five (55) gallon drums for shipment. The vacuum drying system is proven technology, which is being used successfully in several ISL sites where uranium oxide is being produced.

The vacuum drying system consists of the following:

1) Drying Chamber: A S.S. vessel is heated externally and is fitted with a mechanical agitator to stir the yellowcake.

The chamber has a top port for loading the wet cake and a bottom port unloading the dry powder. Additional ports are provided for venting of vapors during the drying procedure.

2) Bag House: This air and vapor filtration unit is 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.

3) Condenser: This 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. Dust passing through the bag filters is wetted and entrained in the condensing moisture within this unit.

4) Vacuum Producer: The vacuum producer is a 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 seals captures entrained particulate matter remaining in the gas streams.

5) Packaging: The 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 is used to determine when a drum is full. As noted in 4) above, ventilation is provided by the vacuum pump when the powder is being transferred.

6) Heating: The heat for drying is supplied by a heat transfer medium such as Dow-Therm or other suitable heat transfer materials. The yellowcake drying is accomplished under 325° F and at pressures less than atmospheric.

7) Effluent Monitoring: Because of the low, intermittent air flow exiting the vacuum pump, isokinetic sampling of the effluent is not possible. The air flow from the vacuum pump associated with the yellowcake dryer does not exit the building. The water that is collected from the condenser is recycled to the precipitation circuit or filtered and discharged with other process water. Room air will be monitored routinely for airborne dust and radionuclides as described in Chapter 9.

8) Controls: The system is 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 is 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.

4.1.4 Yellowcake Drying at the Highland Central Plant

When operating, the yellowcake drying and packaging facilities at the Highland Central Plant emit minor quantities of radioactive airborne particulates. To ensure adequate building ventilation, the following is utilized as required:

1) CPF building – Five 36 inch hooded axial fans providing a nominal ventilation capacity of 64,000 cfm and one 48 inch wall mounted axial fan providing an additional ventilation capacity of 20,900 cfm.

2) Precipitation area – Ventilation of this area is provided, when needed, by a 42 inch hooded axial roof fan, nominally rated at 15,000 cfm. Design criteria specifies that the system provides not less than 6 air exchanges per hour, approximately 12,900 cfm exhaust capability.

3) Yellowcake Dryer and Packaging Rooms – The exhaust air systems in these areas consist of two separate systems, each equipped with wet scrubbers for dust removal, and each discharging to the atmosphere via separate stacks.

   The Packaging Room scrubber system services the yellowcake drum filling hood, product drum lidding station and the product packaging enclosure. Collected air, fumes, particulates and gases are ducted to the Packaging Room exhaust system scrubber (a wet-baffled orifice unit), and discharged to the atmosphere via a 6 inch diameter stack extending 1 foot above the ridgeline of the building and 60 feet above the ground. The associated air-mover is a centrifugal blower. Design criteria provide for an inlet gas volume of 700 cfm, with a dust loading of 5 grains of yellowcake dust per cubic foot. Fresh water is supplied to the scrubber at about 1.5 gpm.

A second scrubber system services the Yellowcake Dryer. Collected air, fumes, particulates and gases are ducted to a wet scrubber, and discharged to the atmosphere via a 13.5 inch diameter stack extending one foot above the ridgeline of the building and 60 feet above the ground. The associated air-mover is a centrifugal blower. Design intake to the scrubber is 3,300 cfm of air containing 0.73 grains per cubic foot of minus 10 micron yellowcake dust. Water feed to the scrubber is approximately 5-10 gpm. The overall design efficiency of this system at design loading and operating conditions is greater than 99%.

Performance criteria for the Yellowcake Drying and Packaging scrubber systems are as follows:

1. Drafts of 10-15 inches of water are maintained at the intakes of both scrubbers.

2. Pressure drops of not less than 10 inches of water are maintained across both scrubbers.

3. Discharge volumes from 2,000 to 2,500 cfm and from 550 to 900 cfm are maintained from the Dryer and the Packaging exhaust stacks, respectively.

4. Total particulate concentrations of gaseous effluents from the Dryer and Packaging scrubbers normally do not exceed 0.03 grains per cubic foot of air discharged. This exceeds 99.9% scrubber efficiency at 750 pounds per hour throughput.

5. Continuous monitoring instruments are provided for the following at each scrubber system.

   - drafts at the fan intakes
   - pressure drops (differential) across the scrubbers
   - water flow rates

6. The Central Plant Process Computer continuously monitors the Yellowcake Dryer and Packaging scrubber drafts, differential pressures, and water flow rates. The computer records the drafts, differential pressures, and water flow rates every two hours. This data is printed in a daily report which is reviewed by the Central

Plant Superintendent, or designee. Any abnormal conditions are noted, and any needed repairs are initiated.

7. The Central Plant Process Computer also continuously controls the Dryer scrubber interlock system which prevents operation if an inadequate scrubber draft, differential pressure, or inadequate water flow to the system is detected. In the event of such a condition, the process computer also sounds an audible alarm in the CPF. The process computer also controls an audible alarm in the case that the Packaging scrubber draft, pressure differential, or water flow are determined to be inadequate.

8. Yellowcake drying and packaging operations are suspended if any of the equipment at the scrubber systems is not operating in accordance with design specifications.

9. As appropriate, specific operating parameter values presented above may be changed; however, they will be selected and used in a manner to maintain or improve the scrubber system efficiency. The appropriate Standard Operating Procedures (SOPs) will be revised to reflect these changes.

10. A stack emissions survey is performed semiannually on the Dryer and Packaging scrubber exhaust stacks to determine the emission rate of particulates, U-natural, radium-226 and thorium-230.

11. The Dryer and Packaging scrubber systems are inspected and cleaned on a routine basis (at least every 30 days of operation).

4.2 LIQUIDS AND SOLIDS

Liquid effluents from the operation include the production bleed stream, excess fluids from the elution and precipitation process, regeneration of the water softener system (calcium control), yellowcake rinse water, plant washdown water, restoration equipment (EDR/RO) waste, restoration bleed, analytical laboratory waste, and facility sanitary waste.

The net production bleed stream is approximately one half to one and one half percent of the production. The bleed is taken after the ion exchange units have removed the uranium. The bleed stream and washdown water from the Smith Ranch Satellite IX facilities is transferred to the CPP through a pipeline connecting the two facilities. The bleed is then commingled with the other liquid effluents and either discharged to one of the deep disposal injection wells or alternatively as shown in Figure 4-1 the water may be routed to a reverse osmosis unit. The resulting RO brine may be commingled with other plant water for disposal in a deep disposal injection well. The RO permeate effluent may be used as process water for chemical makeup or returned to the leaching circuit.

The production bleed stream, washdown water, and ground water restoration waste water generated at the Highland Satellites (Satellites Nos. 1, 2 and 3) is treated for removal of uranium and radium-226 and is then pumped to either Purge Storage Reservoir No. 1 or No. 2 prior to disposal via land application (irrigation) at one of the two pivot irrigators.

Excess liquids from the Smith Ranch CPP elution and precipitation circuit and water softener regeneration are expected to average about 60 gallons per minute and will be routed to lined evaporation ponds or to a disposal injection well. Less than 2 gallons per minute of water will result from plant wash water. This water will be commingled with other plant waste water or may be used as process make-up water if it is of satisfactory quality.

The production bleed stream, wash down water, and ground water restoration waste water generated at the proposed Reynolds Ranch Satellite will be disposed through a deep injection well. This deep injection well will be similar in design and depth to the current deep injection wells at Smith Ranch and located near the proposed Reynolds Ranch Satellite area. This deep injection well will be permitted through the WDEQ and operated according to permit requirements.

Excess liquids from the Highland Central Plant are disposed at Morton 1-20 deep disposal well located approximately one mile north of the plant. Currently, no liquids from the Highland Central Plant are disposed of as the facility remains on standby status.

During restoration two additional liquid waste streams are expected at Smith Ranch, Figure 4-2. The operation of electrodialysis (EDR) or reverse osmosis (RO) units will generate a stream in which most of the dissolved solids in the total EDR/RO stream are concentrated in 15% to 30% of the water volume. When operating at full capacity this concentrated stream may be about 250 gallons per minute per ion exchange facility. This stream will be routed to a lined evaporation pond or to a deep waste disposal well. When water quality from restoration areas improve to the point that after uranium and radium removal it is suitable for discharge under an NPDES permit, it may be routed from the separate radium removal settling system to a water treatment system. When the recovery plant is operating at normal capacity it is expected that this stream could be more than 1000 gallons per minute.

A projected water balance for Smith Ranch operating at 12,000 gpm with a one percent production bleed is shown in Figure 4-2. The water balance represents the highest production flowrate matched with the corresponding restoration flowrate from Table 4-1 (ad). These flowrates represent the total water balance with 3 ion exchange facilities and the Central Processing Plant. As capacity is added to the facility to meet these production and restoration levels, disposal capacity will be added in the form of additional deep disposal injection wells, (currently, there are two deep disposal wells at Smith Ranch and one at the HUP). Two more deep wells may be installed at Smith Ranch and one additional well at the HUP) or future evaporation ponds. Additional reductions in wastewater volumes may be obtained by increasing the efficiency of the reverse osmosis process. Figure 4-3, Recovery Plant Flow Rates, provides additional detail on the individual streams of the water going to the deep disposal injection wells.

The future lined evaporation ponds are expected to consist of several cells of five (5) to fifteen (15) acres each. Some waste streams may be routed to selected cells for additional treatment and/or processing. If treatment or processing can improve the water quality such that it meets Wyoming DEQ criteria for NPDES discharge or for irrigation and NRC radionuclide criteria for release to unrestricted areas, the water may be discharged through the water treatment plant or used for irrigation.

4.2.1 Deep Disposal Injection Wells

Currently, the SR-HUP utilizes three deep disposal injection wells to dispose of waste water generated by both wellfield and yellowcake processing operations. One well is associated with the Highland facilities and two wells are associated with the Smith Ranch facilities. The locations of the wells are shown on Plate 1. One deep disposal well is planned for the Reynolds Ranch Satellite Facility, which will be located near the Satellite.

The Smith Ranch Facility currently operates two Deep Disposal Injection wells, and these are currently permitted under the Underground Injection Control Program through the Wyoming Department of Environmental Quality – Water Quality Division (WDEQ-WQD). Both of these wells are approved to operate under UIC Permit 99-347 as Class I Non-Hazardous Waste Disposal Wells and authorized by U.S. NRC for the facility under Amendment 16 to Source Material License SUA-1548. PRI currently plans to construct additional deep disposal injection wells during the course of operations as water disposal needs are anticipated and with regulatory approval through WDEQ and U.S. NRC, including the Reynolds Ranch Satellite.

The two Smith Ranch operating disposal wells are designated as WDW #1 and WDW #2, and they are located in Township 36N and Range 74W. WDW #1 is located in the NE¼ Section 35 approximately ½ mile west of the CPP. WDW #2 is located in the NE¼ of Section 27 approximately 800 feet north of Satellite SR-1. The description of the construction and testing of these wells are found in submittals from the original licensee (Rio Algom Mining Corp.) to U.S. Nuclear

Regulatory Commission dated October 25, 1995 for WDW #1 and November 22, 1999 for WDW #2. Both wells are permitted to inject into the Parkman, Teapot and Teckla formations, and the permit authorizes injection of up to 432,000 gallons per day of process effluents, laboratory wastes, and production bleed at a maximum injection wellhead pressure of 1,566 psig.

The proposed deep disposal well at the Reynolds Ranch Satellite is very similar in design, depth, and operation to the deep disposal wells at Smith Ranch described above. The operating parameters and design information for the proposed Reynolds Ranch Disposal Well can be found in the permit application submitted to the WDEQ-WQD on October 6, 2004.

The Highland operating Morton 1-20 Disposal Well is also permitted with the WDEQ-WQD UIC Permit 99-347 as a Class I Non-Hazardous Waste Disposal Well. This permit also includes an additional deep disposal well (Vollman 33-27) located near the center of Section 27 T36N, R73W, approximately 1.5 miles east of Satellite No. 3. To date (December 2004) this well has not been constructed. The construction and operation of the Vollman 33-27 well was approved by NRC via License Amendment No. 9. (License SUA-1511), dated December 31, 1998. Similar to the two deep disposal wells associated with Smith Ranch operations, both the existing Morton 1-20 well and the planned Vollman 33-27 are, or will be, completed in a deep injection zone within intervals from 8,629 to 9,141 feet below the surface in the Teapot and Parkman formations.

4.2.2 Satellite No. 1 Radium Settling Basins

The Radium Settling Basins consist of two 3 acre feet (AF) clay lined ponds located east of Satellite No. 1. They are used to settle out residual radium-barium sulfate which remains after removal by the radium treatment system and filter presses located in Satellite No. 1. After treated wastewater passes through the Radium Settling Basins, it is transported to the Satellite No. 1 Purge Storage Reservoir where it is stored prior to periodic land application. The Radium Settling Basins are connected to Satellite No. 1 by a 3 inch HDPE pipeline and are connected to the Satellite No. 1 Purge Storage Reservoir by an 8-inch HDPE pipeline.

During early 1988 Everest Minerals Corporation (predecessor to Power Resources, Inc.) notified the NRC that very small quantities of water seepage had been detected in the underdrain system of the Radium Settling Basins. As discussed in the June 1, 1988 correspondence from Everest Minerals Corporation to the NRC, the seepage rates were much lower than the theoretical seepage rates through the clay liner which contained "as-built" permeabilities on the order of 1.0E-7 to 7.8E-7 cm/sec. Upon inspection of the clay liner during 1988 it was determined that erosion protection was needed to protect the sides of the clay liner from wave action. Therefore, a geotextile fabric was installed in September 1988 to protect against future erosion concerns.

The two radium settling basins continued to function as designed, with seepage rates and seepage water quality unchanged from previous periods. The small amount of seepage entering the underdrain system was periodically pumped back to the basins. The geotextile fabric installed to protect against erosion of the clay liner has proven to be very effective. The water quality data resulting from monitoring of the underdrain system was reported to the NRC in the 10 CFR 40.60 Semi-Annual Reports.

During August and September 2002 PRI made modifications to the filtering equipment at Satellite No. 1 in order that continued operation of the Radium Settling Basin was no longer needed. Therefore, they were drained in October 2002. Treated wastewater from Satellite No. 1 is now directly pumped to Purge Storage Reservoir No. 1. This operation is consistent with the treatment systems at Satellite Nos. 2 and 3.

PRI has begun the decommissioning and reclamation of the Radium Settling Basins. Most of the clay liner has been removed and disposed of as "by-product" waste. A small amount of clay liner remains with low levels of uranium and radium-226. PRI intends to dispose of the remaining clay liner in 2005.

The Radium Settling Basins were originally permitted by the WDEQ-WQD under Permit 93-178 and are currently permitted under the WDEQ/LQD Permit to Mine No. 603. The application package for this facility was submitted to the NRC on February 16, 1987.

4.2.3 Satellite No. 1 Purge Storage Reservoir and Irrigation Area

The Satellite No. 1 Purge Storage Reservoir (PSR-1) is located east of Satellite No. 1 and is used to store treated wellfield purge water and treated water from wellfield restoration activities. The reservoir contains 54 AF when at full capacity. Water stored in the reservoir is periodically land applied by sprinkler irrigation on a 58 acre irrigation area when weather conditions permit.

The reservoir is underlain by a natural clay soil that contains an average permeability of approximately 1.8E-8 cm/sec. Use of the reservoir began in January 1988 with the start of production from the Satellite No. 1 area. The reservoir performed as designed until August 1994 at which time a small amount of leakage was discovered seeping at the two ephemeral drainages located immediately east and south of the reservoir. A Corrective Action Plan (CAP), which addressed the conditions at the reservoir and corrective measures to be implemented, including the installation of two pumpback sumps (North and South Pumpback Sumps), was submitted to the NRC in correspondence dated October

3, 1994. It was determined that the seepage resulted from erosion of the natural clay liner along the eastern most portion of the reservoir. The erosion was caused mostly by wave action. Erosion of the clay liner exposed an underlying sandstone which allowed seepage to move out of the reservoir, to the south and east, where the sandstone outcropped in the ephemeral draws.

On November 9, 1994 all of the treated wastewater was diverted to the Satellite No. 2 Purge Storage Reservoir (PSR-2) in order that the PSR-1 could be dried out and repairs to the liner accomplished. Due to the abnormally wet spring of 1995, construction activities, which included repair of the clay liner and the addition of a geotextile fabric along the eastern side of the reservoir to protect against erosion, were not completed until August 1995. The CAP also included the construction of an 800 foot long Interceptor Trench approximately 300 feet south of PSR-1 in August 1996. The trench captures subsurface seepage from the south side of PSR-1 and pumps it back into the reservoir. The pumping system is fully automatic and continuously operates. To date (December 2004) the Interceptor Trench has been very effective in preventing seepage from PSR-1 from surfacing and entering the drainage south of the system. After the Interceptor Trench went into service, it was no longer necessary to operate the South Pumpback Sump.

As of December 2004, both the Interceptor Trench and North Pumpback Sump are fully operational. It is expected that the system will operate until PSR-1 is no longer used to store treated wastewater. The system is monitored in accordance with requirements of the WDEQ-LQD.

PSR-1 was originally permitted by the WDEQ-WQD under Permit No. 93-178. The PSR-1 and associated pumpback system are currently permitted under the WDEQ-LQD Permit to Mine No. 603. The original application package PSR-1 was submitted to the NRC on February 16, 1987.

The Satellite No. 1 Irrigation Area is located east of Satellite No. 1 near PSR-1. The area consists of a center pivot sprinkler irrigation system which covers 58 acres. Water from PSR-1 is periodically land applied by sprinkler irrigation on this area.

The Satellite No. 1 Irrigation Area was originally permitted by the WDEQ-WQD under Permit No. 92-077 and is currently permitted under the WDEQ-LQD Permit to Mine No. 603. The application package for this facility was submitted to the NRC on July 17, 1986 and approved with the original license approval in July 1987.

4.2.4 Satellite No. 2 Purge Storage Reservoir and Irrigation Area

An additional purge storage reservoir and irrigation area were constructed in 1994 northeast of Satellite No. 2. These facilities, known as the Satellite No. 2 Purge Storage Reservoir (PSR-2) and Irrigation Area are used for the storage and disposal of purge and ground water restoration fluids from wellfields served by Satellite Nos. 2 and 3.

The locations of the Satellite No. 2 PSR and Irrigation Area and the 4 inch HDPE pipeline which is used to transport treated wastewater from Satellite No. 3 to the Satellite No. 2 PSR are shown on Plate 1. The facilities are sized, constructed, and operated in a fashion similar to the existing Satellite No. 1 PSR and Irrigation Area. The facilities were originally permitted by the WDEQ-WQD under Permit No. 93-410 and are currently permitted under the WDEQ-LQD Permit to Mine No. 603. On June 10, 1994 the NRC approved Amendment No. 53 which approved the construction and use of these facilities. Similar to PSR-1, PSR-2 is underlain by several low permeability clay units which minimizes seepage to any potential useable aquifer. Use of the Irrigation Area started during September 1995.

4.2.5 Existing Lined Evaporation Ponds

Currently, two small, lined solar evaporation ponds are in operation at the Smith Ranch Facility. These ponds were initially constructed in 1981 and authorized under the Q-Sand Pilot Project License SUA-1387. These ponds are located just to the north of the CPP, and they are currently used for limited process effluent disposal and for solids retention prior to transfer to the deep disposal injection wells. The capacity of each pond is 0.78 acre feet of water. Each pond is 100 ft. x 100 ft. and 8 feet deep. During operations, a 3 feet freeboard is maintained in each pond to protect the berms from wave action due to winds.

Each pond is constructed with a compacted sandy clay base overlain by a 30 mil Hypalon liner. The bottom of each pond has a two way slope toward the center. A sand layer is placed over the bottom of the pond with the synthetic liner on top of the sand. For each pond, a perforated PVC pipe is installed in the sand layer parallel to the bottom slope. The perforated pipe is connected to a collection sump. The sumps will be monitored for leaks of process solutions, as described in Chapter 5.

4.2.6 Future Solar Evaporation Pond(s)

The future solar evaporation ponds for the SR-HUP will consist of five to fifteen acre cells typically ten to twenty feet deep for holding process waste waters containing high total dissolved solids. The design plan and method of construction for the individual cells will be similar to that used for the pilot plant lined evaporation ponds.

A preliminary subsurface study of potential evaporation pond sites was conducted by Chen & Associates of Casper, Wyoming. Eleven subsurface test holes drilled in the permit area encountered as much as 45 feet of clay and sandy clay material that would be suitable for use in constructing the pond embankments. No water was encountered in any of the test holes, which were 25 to 50 feet deep.

After all topsoil is removed and stockpiled from the area to be disturbed, the evaporation pond cells will be constructed from a combination of cuts and compacted subsoil embankments using the local clays and sandy clays. Embankment slopes will be on the order of 3 horizontal to 1 vertical and the cells will have an eight foot wide or greater crest on all embankments. The material in the bottom of the cell and interior sides of embankments will be compacted to 90 to 95% of maximum standard Proctor density. Material unsuitable for use in construction of soil liners will be identified and segregated. A leak detection system consisting of perforated pipes placed in a sand layer and designed to drain to a common sump will be installed in each cell. The cell will then be lined with an impervious membrane material such as hypalon or high density polyethylene.

The final design and location of each cell will depend on site-specific soils sampling and testing. The embankments will be designed to divert natural run-off away from the pond and the ponds will be located away from significant surface drainage systems. The ponds will be fenced individually to exclude livestock and wildlife such as antelope. The fences around the evaporation ponds will be posted with warning signs for personnel protection. A Permit to Construct will be obtained from the WDEQ prior to beginning construction.

There are no current plans for construction of solar evaporation ponds at the Reynolds Ranch amendment area.

4.2.7 Solid Waste

The non-radioactive wastes, such as packing material, are disposed in the site's existing solid waste disposal facility as authorized by the WDEQ. The on-site construction waste landfill site was originally permitted by the WDEQ in 1978 and continues to operate for disposal of construction, shipping, and demolition materials. Public access to the disposal site is prohibited by the facility's fencing. Only those materials generated by the facility or in association with its operation are allowed to be disposed at the site. No hazardous, sanitary, or radioactive contaminated wastes are disposed at this landfill. No impact to ground water is anticipated resulting from this landfill.

The disposal facility is located directly behind the Smith Ranch CPP near the top of a sandstone ridge to prevent run-on from snowmelt and precipitation (see Plate 1). Prior to its original use, topsoil from the site was removed and stockpiled for future use. The disposal site(s) consist of a constructed trench approximately 10-14 feet deep surrounded on either side by litter control fencing. Materials placed within the site are periodically buried in place with sand material originally excavated from the disposal pit. Construction materials, primarily including such items as waste lumber, pallets, or cable spools may be managed by controlled burns authorized by specific county burn permits. Any fugitive materials not managed by the litter fences periodically are collected and placed into the disposal site to assure the litter is appropriately controlled.

4.3 CONTAMINATED EQUIPMENT

Solid wastes generated by this project that are contaminated with uranium consist of materials such as rags, trash, packing material, worn or replaced parts from equipment, piping, sediments removed from process pumps and vessels, the solids remaining in the evaporation pond after the liquids have evaporated and sludge from the radium-226 treatment systems at Satellite Nos. 1, 2, and 3. Radioactive solid waste that has a contamination level requiring controlled disposal are isolated in drums or other suitable containers and disposed in a NRC licensed tailings facility or as otherwise approved by the NRC. The combined operations at the SR-HUP will generate between approximately 100 to 300 yd^3 of radioactive contaminated waste each year. During final decommissioning of the Central Processing facilities and Satellites, the volume will increase.

Table 4-1(a)
Calculations of Source Terms for the Smith Ranch Project

Wellfield 1. – Production

Operating Days = 360
Area = 1.05E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(1.05E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 8.5E7\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 28.6 gpm

(28.6 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.56E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(1.05E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(8.5E7\ L) + (2.65E4\ L/d) + (1.56E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.56E5 L/d) = 35 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)6.16E5 pCi/L)(8.5E7 L)(0.01/d) = 189 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2200 gpm/3000gpm) = 4.3 Ci/yr

Table 4-1 (b)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 2. – Production

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(1.9E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.54E8\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 52 gpm

(52 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.83E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$C_{RN} = \dfrac{[(1E6)\ (574\ pCi/cm^3)(1.9E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.54E8\ L) + (2.65E4\ L/d) + (2.83E5\ L/d)]}$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.83E5 L/d) = 63 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.54E8 L)(0.01/d) = 342 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(4000 gpm/3000gpm) = 7.8 Ci/yr

Table 4-1 (c)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 3. – Production

Operating Days = 360
Area = 1.71E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(1.71E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.39E8\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 46.8 gpm

(46.8 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.55E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(1.71E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.39E8\ L) + (2.65E4\ L/d) + (2.55E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.55E5 L/d) = 57 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.39E8 L)(0.01/d) = 308 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(3600 gpm/3000gpm) = 7.1 Ci/yr

Table 4-3 (d)

Calculations of Source Terms for Rio Algom Mining Corporation Smith Ranch Project (Cont.)

Wellfield 4. – Production

Operating Days = 360
Area = 1.14E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.14E5 m2)(3 m)(0.27)(1E3 L/m3) = 9.23E7 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 31.2 gpm

(31.2 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.70E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(1.14E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(9.23E7 L) + (2.65E4 L/d) + (1.70E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.70E5 L/d) = 38 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(9.23E7 L)(0.01/d) = 205 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2400 gpm/3000gpm) = 4.7 Ci/yr

Table 4-1 (e)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 5. – Production

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.43E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.16E8 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 39 gpm

(39 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.07E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(1.43E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.16E8 L) + (2.65E4 L/d) + (2.07E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.07E5 L/d) = 46 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.16E8 L)(0.01/d) = 257 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(3000 gpm/3000gpm) = 5.9 Ci/yr

Table 4-1 (f)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 6. – Production

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.9E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.54E8 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 52 gpm

(52 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.83E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(1.9E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.54E8 L) + (2.65E4 L/d) + (2.83E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.83E5 L/d) = 63 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.54E8 L)(0.01/d) = 342 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(4000 gpm/3000gpm) = 7.8 Ci/yr

Table 4-1 (g)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 7. – Production

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.7E7\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 26 gpm

(28.6 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.42E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(9.5E4\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.7E7\ L) + (2.65E4\ L/d) + (1.42E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.42E5 L/d) = 31 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(7.7E7 L)(0.01/d) = 169 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2000 gpm/3000gpm) = 3.9 Ci/yr

Table 4-1 (h)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 8. – Production

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.43E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.16E8 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 39 gpm

(39 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.07E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(1.43E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.16E8\ L) + (2.65E4\ L/d) + (2.07E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.07E5 L/d) = 46 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.16E8 L)(0.01/d) = 257 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(3000 gpm/3000gpm) = 5.9 Ci/yr

Table 4-1 (i)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 9. – Production

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.43E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.16E8 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 39 gpm

(39 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.07E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(1.43E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.16E8 L) + (2.65E4 L/d) + (2.07E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.07E5 L/d) = 46 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.16E8 L)(0.01/d) = 257 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(3000 gpm/3000gpm) = 5.9 Ci/yr

Table 4-1 (j)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 10. – Production

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(1.43E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.16E8\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 39 gpm

(39 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.07E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(1.43E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.16E8\ L) + (2.65E4\ L/d) + (2.07E5\ L/d)]}$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.07E5 L/d) = 46 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.16E8 L)(0.01/d) = 257 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(3000 gpm/3000gpm) = 5.9 Ci/yr

Table 4-1 (k)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 11. – Production

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(9.5E4 m^2)(3 m)(0.27)(1E3 L/m^3) = 7.6E7 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 26 gpm

(26 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.42E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(9.5E4 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(7.6E7 L) + (2.65E4 L/d) + (1.42E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.42E5 L/d) = 31 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(7.6E7 L)(0.01/d) = 169 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2000 gpm/3000gpm) = 3.9 Ci/yr

Table 4-1 (l)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 12. – Production

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.9E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.54E8 L

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 52 gpm

(52 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 2.83E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/cm^3)(1.9E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.54E8 L) + (2.65E4 L/d) + (2.83E5 L/d)]

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.83E5 L/d) = 63 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.54E8 L)(0.01/d) = 342 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(4000 gpm/3000gpm) = 7.8 Ci/yr

Table 4-1 (m)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 13. – Production

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.6E7\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 26 gpm

(26 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.42E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(9.5E4\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.6E7\ L) + (2.65E4\ L/d) + (1.42E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.42E5 L/d) = 31 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(7.6E7 L)(0.01/d) = 169 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2000 gpm/3000gpm) = 3.9 Ci/yr

Table 4-1 (n)
Calculations of Source Terms for the Smith Ranch Project

Wellfield 14. – Production

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.6E7\ L$

Capacity of Resin Column = 18903 gal. Fluid
Porosity 0.37
Unloading Rate = 1/d

IX Unloading Volume: based on 3000gpm

(18903 gal)(0.37)(3.785 L/gal) (1/d) = 2.65E4 L/d

Total Wastewater Purge Rate = 1.3% = 26 gpm

(26 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 1.42E5 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/cm^3)(9.5E4\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.6E7\ L) + (2.65E4\ L/d) + (1.42E5\ L/d)]}$$

= 6.16E5 pCi/L

Rn_W = (3.65E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(1.42E5 L/d) = 31 Ci/yr

Rn_V = (3.65E10 Ci/pCi,d/yr)(6.16E5 pCi/L)(7.6E7 L)(0.01/d) = 169 Ci/yr

Rn_{IX} = (3.6E-10 Ci/pCi,d/yr)(6.16E5 pCi/L)(2.65E4 L/d)(2000 gpm/3000gpm) = 3.9 Ci/yr

Table 4-1 (o)
Calculations of Source Terms for the Smith Ranch Project

Wellfield 1. – Restoration

Operating Days = 360
Area = 1.05E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.05E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 8.5E7\ L$$

Restoration Removal Rate Maximum = 913 gpm

$$(913\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d) = 4.98E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.05E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(8.5E7\ L) + (4.98E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E\text{-}10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(4.98E6\ L/d) = 853\ Ci/yr$$

Table 4-1 (p)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 2. – Restoration

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.9E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.54E8\ L$$

Restoration Removal Rate Maximum = 1660 gpm

$$(1660\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d) = 9.05E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.9E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.54E8\ L) + (9.05E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E\text{-}10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(9.05E6\ L/d) = 1551\ Ci/yr$$

Table 4-1 (q)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 3. – Restoration

Operating Days = 360
Area = 1.71E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.71E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.39E8\ L$$

Restoration Removal Rate Maximum = 1494 gpm

$$(1494\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d) = 8.14E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.71E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.39E8\ L) + (8.14E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E\text{-}10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(8.14E6\ L/d) = 1394\ Ci/yr$$

Table 4-1 (r)
Calculations of Source Terms for the Smith Ranch Project

Wellfield 4. – Restoration

Operating Days = 360
Area = 1.14E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.14E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 9.2E7\ L$$

Restoration Removal Rate Maximum = 996 gpm

(996 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 5.43E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.14E5\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(9.2E7\ L) + (45.43E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(5.43E6 L/d) = 931 Ci/yr

Table 4-1 (s)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 5. – Restoration

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.43E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.16E8 L

Restoration Removal Rate Maximum = 1245 gpm

(1245 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 6.79E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/g)(1.43E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.16E8 L) + (6.79E6 L/d)]

= 4.76E5 pCi/L

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(6.79E6 L/d) = 1164 Ci/yr

Table 4-1 (t)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 6. – Restoration

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.9E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.54E8\ L$$

Restoration Removal Rate Maximum = 1660 gpm

$$(1660\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d) = 9.05E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.9E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.54E8\ L) + (9.05E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(9.05E6 L/d) = 1551 Ci/yr

Table 4-1 (u)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 7. – Restoration

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.7E7\ L$$

Restoration Removal Rate Maximum = 830 gpm

$$(830\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d) = 4.5E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(9.5E4\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.7E7\ L) + (4.5E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E\text{-}10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(4.5E6\ L/d) = 771\ Ci/yr$$

Table 4-1 (v)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 8. – Restoration

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

(1.43E5 m^2)(3 m)(0.27)(1E3 L/m^3) = 1.16E8 L

Restoration Removal Rate Maximum = 1245 gpm

(1245 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 6.79E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

C_{RN} = [(1E6) (574 pCi/g)(1.43E5 m^2)(3 m)1.93 g/cm^3)(0.2)(0.181/d)0.8)]
[0.181/d + 0.01/d)(1.16E8 L) + (6.79E6 L/d)]

= 4.76E5 pCi/L

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(6.79E6 L/d) = 1164 Ci/yr

Table 4-1 (w)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 9. – Restoration

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.43E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.16E8\ L$$

Restoration Removal Rate Maximum = 1245 gpm

$$(1245\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d\ ) = 6.79E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.43E5\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.16E8\ L) + (6.79E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(6.79E6 L/d) = 1164 Ci/yr

Table 4-1 (x)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 10. – Restoration

Operating Days = 360
Area = 1.43E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(1.43E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.16E8\ L$$

Restoration Removal Rate Maximum = 1245 gpm

$$(1245\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d\ ) = 6.79E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(1.43E5\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.16E8\ L) + (6.79E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E-10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(6.79E6\ L/d) = 1164\ Ci/yr$$

Table 4-1 (y)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 11. – Restoration

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.7E7\ L$$

Restoration Removal Rate Maximum = 830 gpm

(830 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 4.5E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(9.5E4\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.7E7\ L) + (4.5E6\ L/d)]}$$

= 4.76E5 pCi/L

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(4.5E6 L/d) = 771 Ci/yr

Table 4-1 (z)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 12. – Restoration

Operating Days = 360
Area = 1.9E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$(1.9E5\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 1.54E8\ L$

Restoration Removal Rate Maximum = 1660 gpm

(1660 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 9.05E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$C_{RN} = \dfrac{[(1E6)\ (574\ pCi/g)(1.9E5\ m^2)(3\ m)1.93\ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(1.54E8\ L) + (9.05E6\ L/d)]}$

= 4.76E5 pCi/L

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(9.05E6 L/d) = 1551 Ci/yr

Table 4-1 (aa)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 13. – Restoration

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.7E7\ L$$

Restoration Removal Rate Maximum = 830 gpm

(830 gpm)(3.7 85 L/gal)(60 min/hr)(24 hr/d) = 4.5E6 L/d

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(9.5E4\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.7E7\ L) + (4.5E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

Rn_{Stack} = (3.65E-10 Ci/pCi,d/yr)(4.76E5 pCi/LL)(4.5E6 L/d) = 771 Ci/yr

Table 4-1 (ab)
Calculations of Source Terms for the Smith Ranch Project (Cont.)

Wellfield 14. – Restoration

Operating Days = 360
Area = 9.5E4 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d

Flow Volume in Circulation:

$$(9.5E4\ m^2)(3\ m)(0.27)(1E3\ L/m^3) = 7.7E7\ L$$

Restoration Removal Rate Maximum = 830 gpm

$$(830\ gpm)(3.7\ 85\ L/gal)(60\ min/hr)(24\ hr/d\ ) = 4.5E6\ L/d$$

Fraction of Radon Carried in Circulating Volume = 0.8
Rate of Venting and Other Loss to System from Leaks and Spills = 0.01/d

$$C_{RN} = \frac{[(1E6)\ (574\ pCi/g)(9.5E4\ m^2)(3\ \ m)1.93\ \ g/cm^3)(0.2)(0.181/d)0.8)]}{[0.181/d + 0.01/d)(7.7E7\ L) + (4.5E6\ L/d)]}$$

$$= 4.76E5\ pCi/L$$

$$Rn_{Stack} = (3.65E\text{-}10\ Ci/pCi,d/yr)(4.76E5\ pCi/LL)(4.5E6\ L/d) = 771\ Ci/yr$$

Table 4-1 (ac)
Calculations of Source Terms for the Smith Ranch Project

Wellfield 1. – New Wellfield Example

Operating Days = 360
Area = 1.05E5 m^2
Average Ore body Thickness = 3 m
Porosity = 0.27
Radium-226 in Ore = 574 pCi/g
Bulk Density of Ore = 1.93 g/cm^3
Radon Emanation Coefficient = 0.2
Radon Half-life = 0.181/d
110 Patterns Representing 330 Wells (3 unique wells per pattern)
1 mud pit per well
Drilled Well Diameter = 8"
Average Ore Material per Well in Grams:

$$(3.14)((8\ in/2)(2.54\ cm/in))^2(300\ cm)(1.93\ g/cm^3) = 1.88E5\ g/well$$

Total Ore in Mud Pit/yr = 1.88E5 g

Storage Time = 365 days/yr

Rnnw = 1E-12 Ci/pCi(0.2)(0.181/d)(574 pCi/g)(365 d/yr)(1.88E5 g/well)(330 wells/yr)

= 0.47 Ci/yr

Rn-222 flux = [(1E12 pCi/Ci)(0.47 Ci/yr)]/[1.05E5 m^2)(3.15E7 s/yr)]

= 0.14 $pCi/m^2/s$

Table 4-1 (Cont'd)
Calculations of Source Terms for the Smith Ranch Project

Irrigation:

Numerous calculations have been performed for soil loading from irrigating with treated mine wastewater. The final concentrations of uranium and radium in the top soils are small and the source terms associated with the irrigation are small compared to other project source terms.

Irrigation water derived from restoration will be treated with barium chloride to reduce Ra-226 to 5 pCi/L. this will leave approximately 2.58E-1 pCi/g above background in the upper 15 cm of soils of the 500 acre irrigation site over the life of the mine.

Ra-226 = 0.258 pCi/g or approximately 0.258 pCi/m^2/s of radon flux

Uranium, treated to 1ppm, will leave approximately 12 pCi/g U238 distributed over the top 45 cm of soil throughout the irrigation area.

Table 4-1 (ad)
Calculations of Cumulative Average Annual Source Terms for the Smith Ranch Project

Central Processing Plant IX (1997–2004)

ellfield		1997 1st half	1997 2nd half	1998 1st half	1998 2nd half	1999 1st half	1999 2nd half	2001 1st half	2001 2nd half	2002 1st half	2002 2nd half	2003 1st half	2003 2nd half	2004 1st half	2004 2nd half
1	Production		4000	4000	4000	4000	2000	2000							
	Restoration								1000	1000	1000	1000			
2	Production							2000	4000	4000	4000	4000	4000		
	Restoration													1000	1000
6	Production													4000	4000
	Restoration														
12	Production														
	Restoration														
13	Production														
	Restoration														
14	Production														
	Restoration														
Total IX Flow			4,000	4,000	4,000	4,000	2,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Total Restoration Flow			0	0	0	0	0	0	1,000	1,000	1,000	1,000	0	1,000	1,000

Central Processing Plant IX (2005–2013)

ellfield		2005 1st half	2005 2nd half	2006 1st half	2006 2nd half	2007 1st half	2007 2nd half	2008 1st half	2008 2nd half	2009 1st half	2009 2nd half	2010 1st half	2010 2nd half	2011 1st half	2011 2nd half	2012 1st half	2012 2nd half	2013 1st half	2013 2nd half
1	Production																		
	Restoration																		
2	Production																		
	Restoration	1000	1000																
6	Production	4000	4000																
	Restoration			1000	1000	1000													
12	Production			4000	4000	4000	4000	2000	2000										
	Restoration									1000	1000	1000	1000						
13	Production							2000	2000	2000	2000	2000	2000						
	Restoration													1000	500	500	500	500	
14	Production									2000	2000	2000	2000	2000					
	Restoration														500	500	500	500	1000
Total IX Flow		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	2,000	0	0	0	0	0
Total Restoration Flow		1,000	1,000	1,000	1,000	1,000	0	0	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Satellite IX #1 (1997–2004)

ellfield		1997 1st half	1997 2nd half	1998 1st half	1998 2nd half	1999 1st half	1999 2nd half	2001 1st half	2001 2nd half	2002 1st half	2002 2nd half	2003 1st half	2003 2nd half	2004 1st half	2004 2nd half
3	Production				3000	3000	2000	2000	2000	1000	1000	1000	1000		
	Restoration													500	500
4	Production						2000	2000	2000	2000	2000				
	Restoration											1000	1000	500	500
5	Production									1000	1000	3000	3000	2000	2000
	Restoration														
7	Production														
	Restoration														
8	Production													2000	2000
	Restoration														
	Production														
	Restoration														
Total IX Flow			0	0	3,000	3,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Total Restoration Flow			0	0	0	0	0	0	0	0	0	1,000	1,000	1,000	1,000

Satellite IX #1 (2005–2013)

ellfield		2005 1st half	2005 2nd half	2006 1st half	2006 2nd half	2007 1st half	2007 2nd half	2008 1st half	2008 2nd half	2009 1st half	2009 2nd half	2010 1st half	2010 2nd half	2011 1st half	2011 2nd half	2012 1st half	2012 2nd half	2013 1st half	2013 2nd half
3	Production																		
	Restoration	1000	500	500	500														
4	Production																		
	Restoration																		
5	Production	2000																	
	Restoration		500	500	500	1000	1000												
7	Production				1000	2000	2000	2000	2000	2000									
	Restoration										500	500	500	500					
8	Production	2000	3000	3000	3000	2000	2000	2000											
	Restoration								1000	1000	500	500	500	500	1000				
	Production																		
	Restoration																		
Total IX Flow		4,000	3,000	3,000	4,000	4,000	4,000	4,000	2,000	2,000	0	0	0	0	0	0	0	0	0
Total Restoration Flow		1,000	1,000	1,000	1,000	1,000	1,000	0	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	0	0

Satellite IX #2 (1997–2004)

ellfield		1997 1st half	1997 2nd half	1998 1st half	1998 2nd half	1999 1st half	1999 2nd half	2001 1st half	2001 2nd half	2002 1st half	2002 2nd half	2003 1st half	2003 2nd half	2004 1st half	2004 2nd half
9	Production														
	Restoration														
10	Production									3000	3000	3000	3000	2000	2000
	Restoration														
11	Production													2000	2000
	Restoration														
	Production														
	Restoration														
	Production														
	Restoration														
	Production														
	Restoration														
Total IX Flow			0	0	0	0	0	0	0	3,000	3,000	3,000	3,000	4,000	4,000
Total Restoration Flow			0	0	0	0	0	0	0	0	0	0	0	0	0
Cummulative Flow			2,000	2,000	5,000	7,000	6,000	8,000	8,000	11,000	11,000	11,000	11,000	12,000	12,000
Cummulative Restoration			0	0	0	0	0	0	1,000	1,000	1,000	2,000	1,000	2,000	2,000
Avg. Annual Flux Source Term Ci/				228.3		600.4			1573.25		2503.1		2759.9		5419.1

Satellite IX #2 (2005–2013)

ellfield		2005 1st half	2005 2nd half	2006 1st half	2006 2nd half	2007 1st half	2007 2nd half	2008 1st half	2008 2nd half	2009 1st half	2009 2nd half	2010 1st half	2010 2nd half	2011 1st half	2011 2nd half	2012 1st half	2012 2nd half	2013 1st half	2013 2nd half
9	Production				3000	3000	3000	3000	3000										
	Restoration									1000	1000	1000	1000						
10	Production	2000																	
	Restoration		1000	1000	500	500	500												
11	Production	2000	2000	2000															
	Restoration				500	500	500	1000											
	Production																		
	Restoration																		
	Production																		
	Restoration																		
	Production																		
	Restoration																		
Total IX Flow		4,000	2,000	2,000	3,000	3,000	3,000	3,000	3,000	0	0	0	0	0	0	0	0	0	0
Total Restoration Flow		0	1,000	1,000	1,000	1,000	1,000	1,000	0	1,000	1,000	1,000	1,000	0	0	0	0	0	0
Cummulative Flow		12,000	9,000	9,000	11,000	11,000	11,000	11,000	9,000	6,000	4,000	4,000	4,000	2,000	0	0	0	0	0
Cummulative Restoration		2,000	3,000	3,000	3,000	3,000	2,000	1,000	1,000	3,000	3,000	3,000	3,000	2,000	2,000	1,000	1,000	1,000	1,000
Avg. Annual Flux Source Term Ci/			5343.4		6738.6		5109		2251		4774.3		5057.8		2808		1542		1156.5

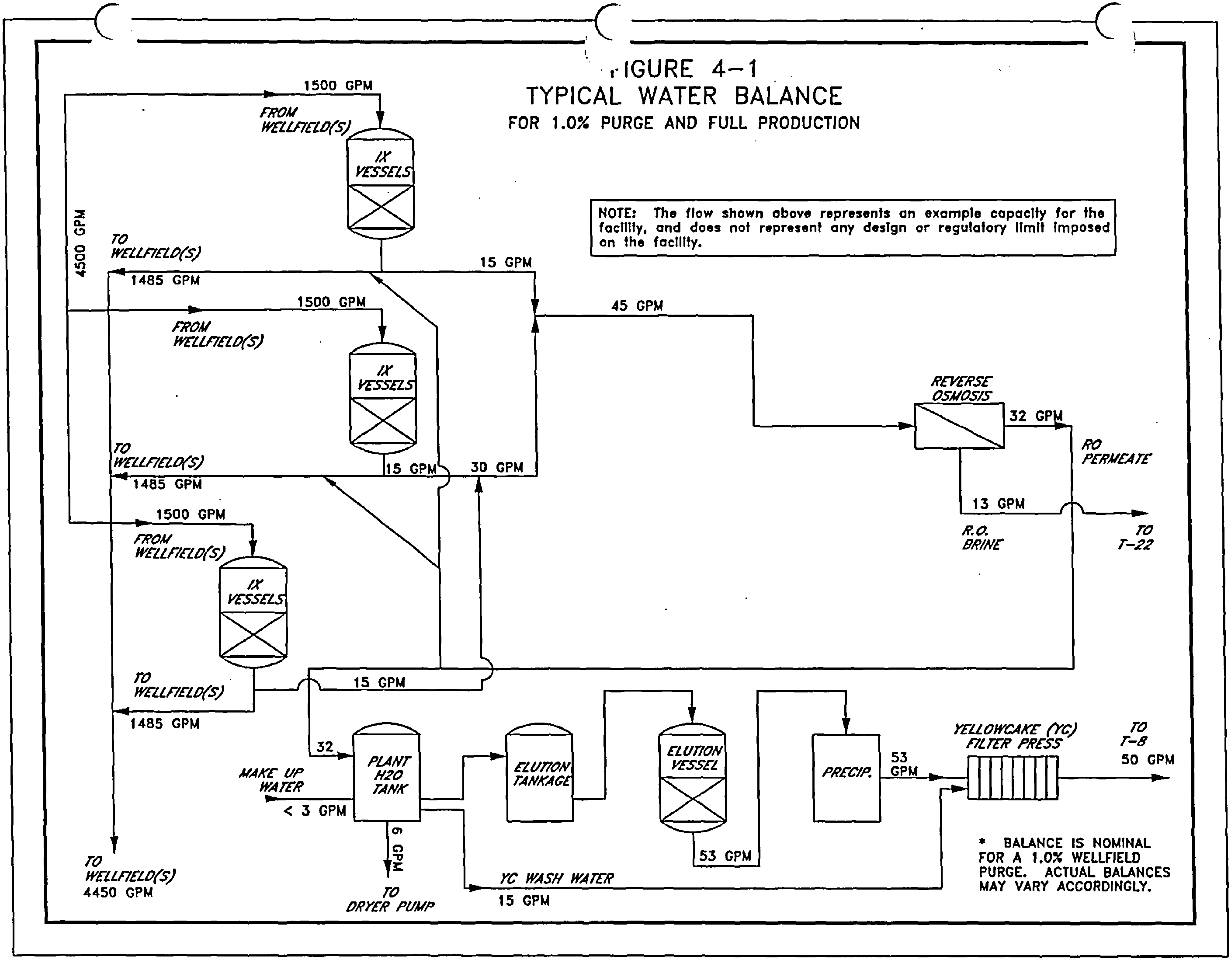
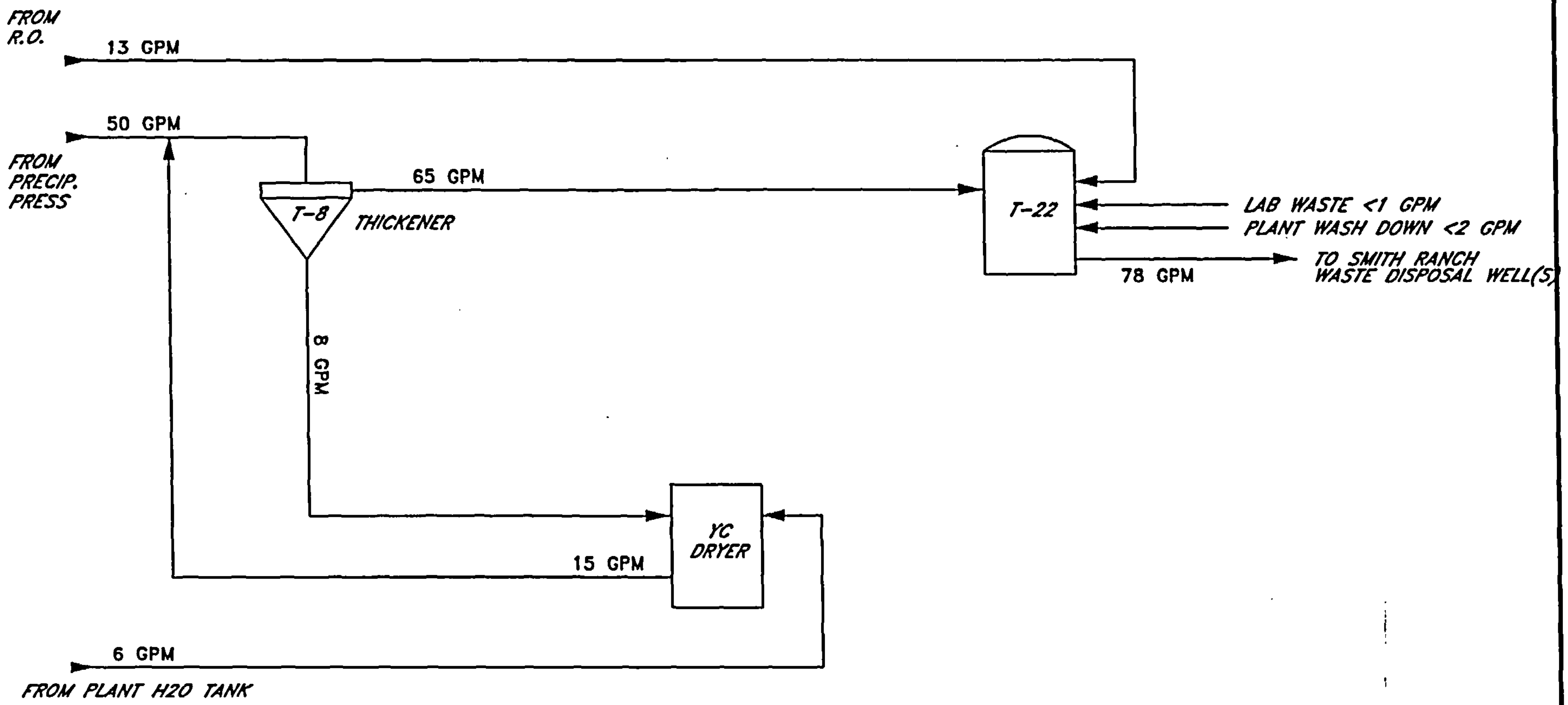


FIGURE 4-1
TYPICAL WATER BALANCE
FOR 1.0% PURGE AND FULL PRODUCTION

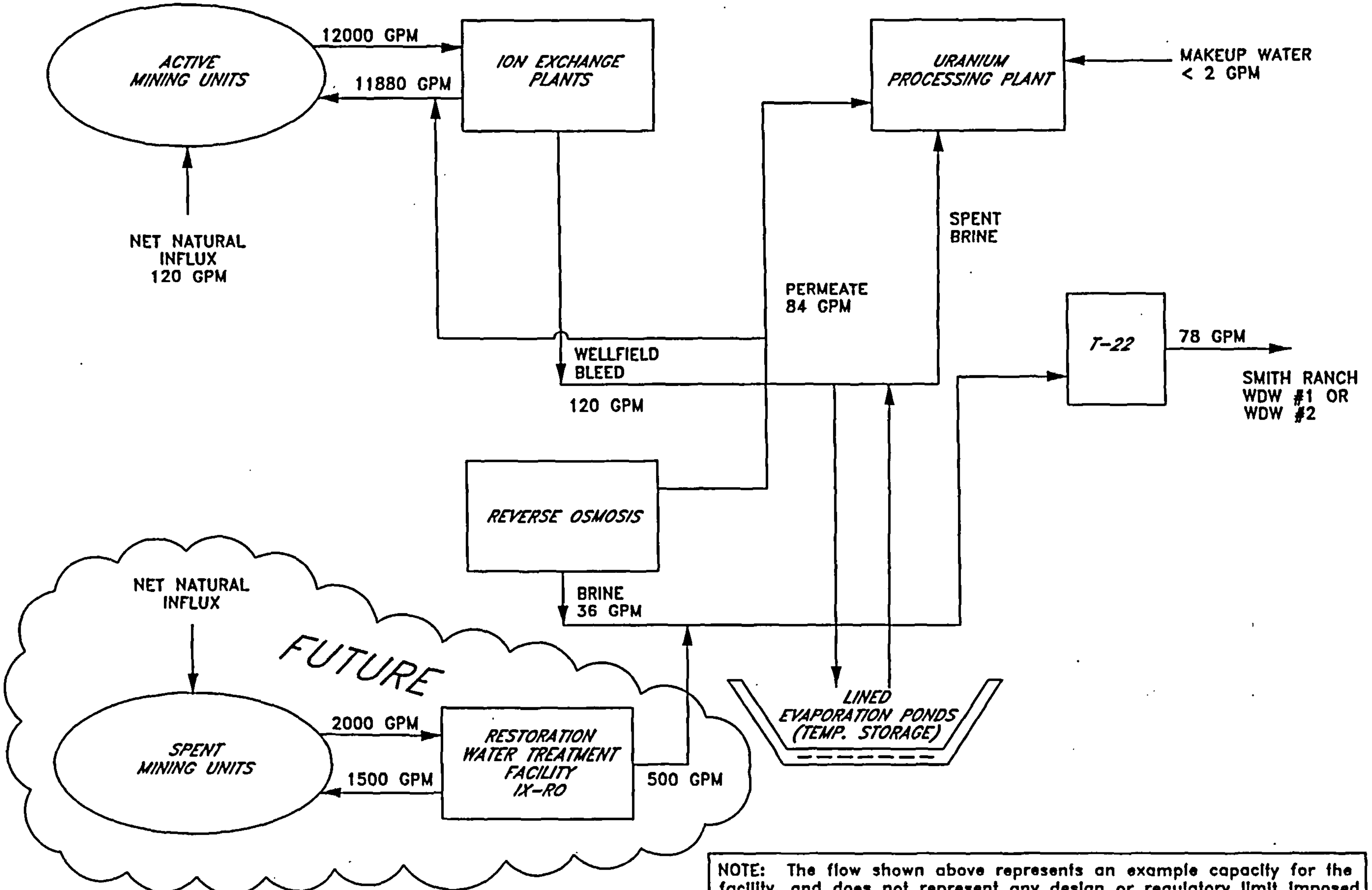
FIGURE 4-1 (CONT.)



NOTE: The flow shown above represents an example capacity for the facility, and does not represent any design or regulatory limit imposed on the facility.

FIGURE 4-2
WATER BALANCE FOR SMITH RANCH PROJECT

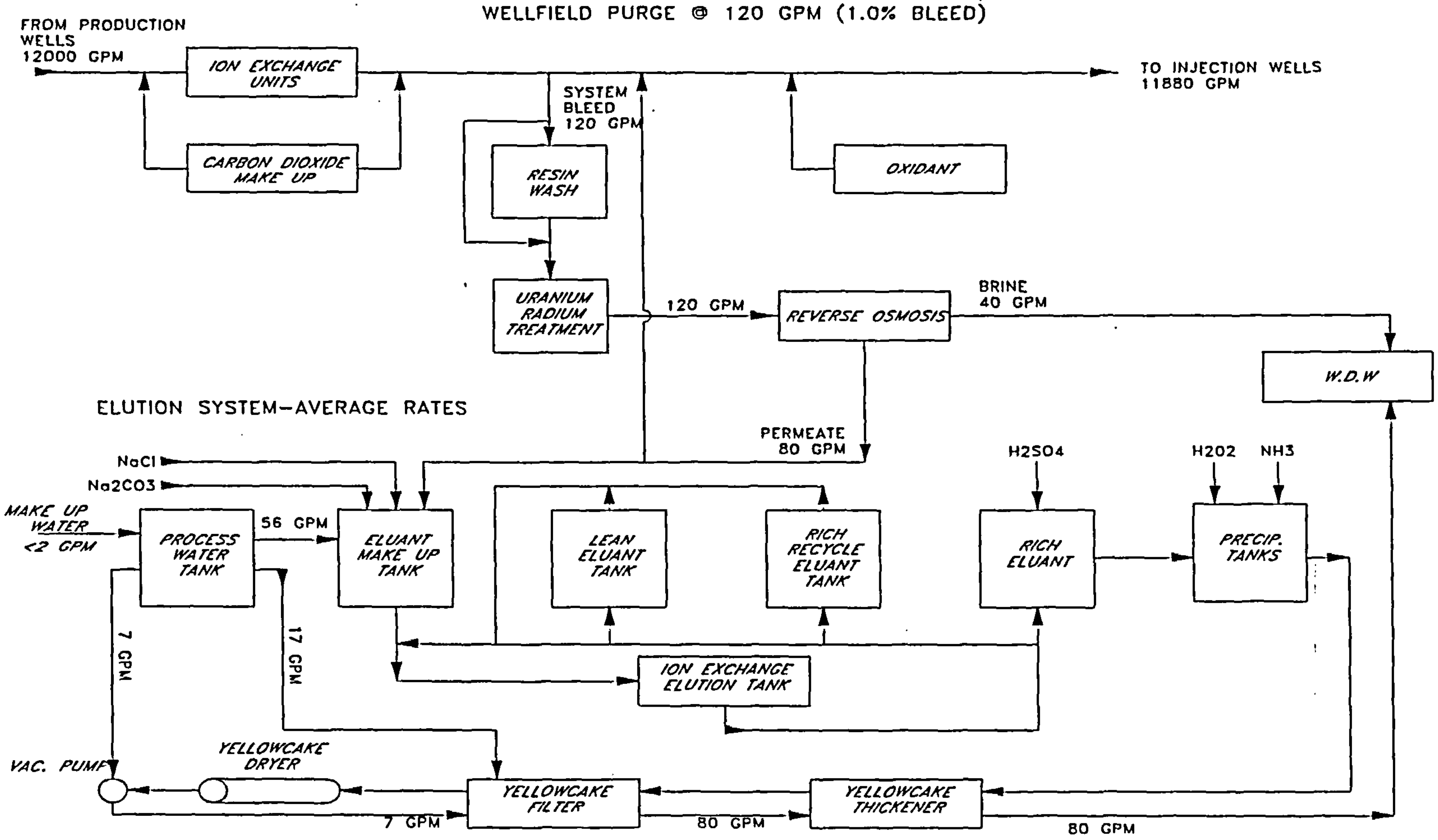
WELLFIELD OPERATIONS AT 12000 GPM
WITH 120 GPM PURGE (1.0% BLEED)



NOTE: The flow shown above represents an example capacity for the facility, and does not represent any design or regulatory limit imposed on the facility.

FIGURE 4-3
RECOVERY PLANT FLOW RATES

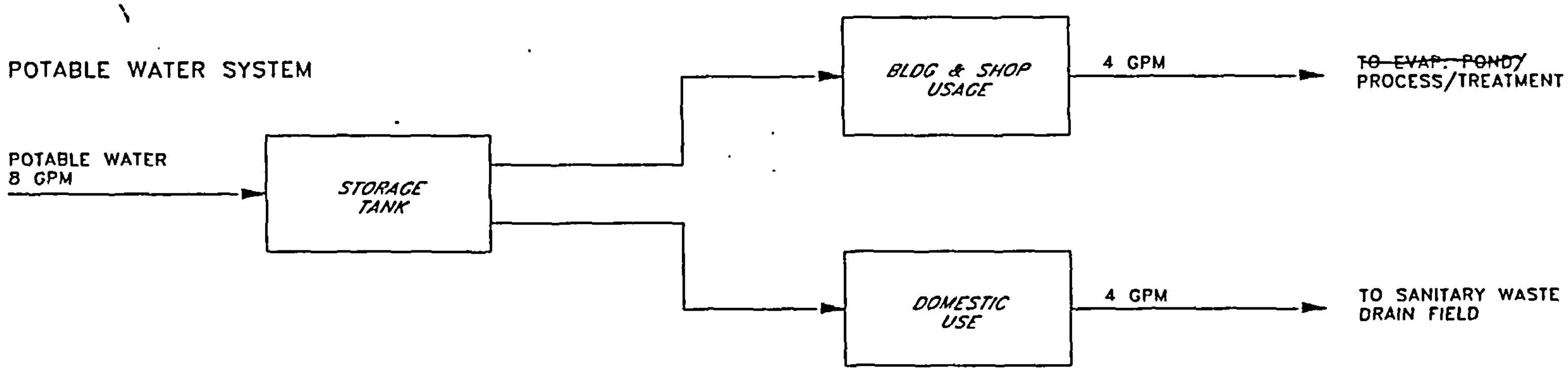
MAIN FLOW THROUGH ION EXCHANGE SYSTEMS @ 12,000 GPM
WELLFIELD PURGE @ 120 GPM (1.0% BLEED)



Note: The flow shown above represents an example capacity for the facility, and does not represent any design or regulatory limit imposed on the facility.

FIGURE 4-3 (CONT'D)

POTABLE WATER SYSTEM



Note: The flow shown above represents an example capacity for the facility, and does not represent any design or regulatory limit imposed on the facility.

CHAPTER 5
PRE-OPERATIONAL ASSESSMENT OF WELLFIELDS AND ENVIRONMENTAL MONITORING

The primary objectives for an in situ leaching project monitoring program are protection of existing ground water supplies, keeping employee and public exposure to ALARA, and preventing and/or mitigating the impact of any surface contamination that could result due to a leak or spill of process solutions. The program to keep employee and public exposure to ALARA is discussed in Chapter 9. The remaining pre-operation and operational monitoring programs are discussed in this chapter.

5.1 PRE-OPERATIONAL ASSESSMENT OF WELLFIELDS

5.1.1 General

Appendix D5 and Appendix D6 of this amendment application contain general baseline geologic and hydrologic information pertaining to the Reynolds Ranch amdendment area. General baseline geologic and hydrologic information pertaining to SR-HUP operations has been previously submitted. Prior to wellfield development it is necessary to collect and assemble very detailed information on geologic and hydrologic conditions in order that ore zones can be defined, geologic and hydrologic parameters quantified, wellfields planned, hydrologic monitoring programs developed, and baseline ground water quality sufficiently determined. To accomplish the above, the operator must conduct a very capital intensive multi-step program which includes interaction with the WDEQ.

Sections 5.1.2 through 5.16 contain a detailed description of the types of geologic and hydrologic data which have been collected for operating wellfields and will be collected for proposed wellfields. Section 5.1.7 contains a description of the baseline gamma surveys that will be conducted at all proposed wellfields.

5.1.2 Monitor Well Spacing

The density and spacing of monitor wells are determined during the detailed geologic and hydrologic assessment of a proposed wellfield. Monitor wells are installed in the mineralized area (production pattern area) at a density of one well per three acres of area under the production patterns. A minimum of five of these wells are installed per mine unit. These wells are used to obtain baseline water quality data to characterize the Production Zone and to determine ground water Restoration Target Values (RTVs).

Monitor 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 (Section 5.1.5). The distance between these monitor wells is typically between 300 and 800 feet. The distance between these monitor wells and the production patterns is typically 250 to 600 feet. The acceptable distance between the monitor wells and the production patterns is determined using a ground water flow model and estimated hydraulic properties for the proposed production area. The acceptable distance between monitor wells and the production patterns also takes into account the demonstration that if an excursion were to occur, production fluids can be controlled within 60 days, as required by WDEQ requirements.

Monitor wells are installed within the overlying and underlying aquifers at a density of one of each type of well per every three acres of pattern area. These wells are used to obtain baseline water quality data and are used in the development of UCL's for these zones. In the case that no potentially affected overlying and/or underlying aquifer exists, or the confining unit (aquitard) between the production zone and/or the overlying or underlying aquifer is thin (less than 5 feet in thickness), within a part, or entire wellfield, the density and location of such wells will be determined in consultation with the regulatory agencies. In the event that the mineralized area and corresponding production pattern area is very narrow and continuous (i.e. "line drive"), wells monitoring the overlying and underlying aquifers (if present) will not be more than approximately 1,000 ft apart from one another.

5.1.3 Hydrologic Testing Proposal

Once an area has been adequately assessed from a geologic and mineability standpoint and the operator determines that it is both feasible and desirable to ISL the area, the limits of the mine area are determined and it becomes a proposed mine unit. A Hydrologic Testing Proposal is then developed to determine the following:

1. Hydrologic characteristics of the Production Zone aquifer.

2. Presence or absence of hydrologic boundaries within the Production Zone aquifer.

3. The degree of hydrologic communication, if any, between the Production Zone and the overlying and underlying aquifers.

4. The vertical permeability of the overlying and underlying confining units which have not already been tested.

5. The degree of hydrologic communication between the Production Zone and the surrounding monitor well ring.

The Hydrologic Testing Proposal is submitted to the WDEQ for review and comment. PRI has a Standard Operating Procedure (SOP) in place which details the contents of the Hydrologic Testing Proposal.

5.1.4 Mine Unit Hydrologic Test Document

Following completion of the field data collection, the Mine Unit Hydrologic Test Document is assembled and submitted to the WDEQ for review. In accordance with NRC requirements, the Mine Unit Hydrologic Test Document 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 the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements. The written SERP evaluation will be maintained at the site.

The Mine Unit Hydrologic Test Document 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. Any other information pertinent to the area tested will be included and discussed.

5.1.5 Baseline Water Quality Determination

5.1.5.1 General

The collection of baseline water quality data and determination of baseline water quality conditions is very important as the Upper Control Limits (UCL's) and ground water restoration objectives are based on this data. PRI has Standard Operating Procedures (SOPs) in place that detail acceptable water quality sampling and handling procedures, as well as the statistical assessment of the data.

5.1.5.2 Data Collection

Water quality samples are obtained and analyzed from the above monitor wells to establish baseline (background) ground water quality conditions in each zone. Sampling, preservation and analysis procedures are performed in accordance with accepted procedures. The number of samples collected and the parameters analyzed are as follows:

1) Mineralized Zone (Production Pattern) MP-Wells - Two separate samples, collected at least two weeks apart, are collected for the parameters listed in Table 5-1 The regulatory authorities are contacted in order that they can, if desired, collect split samples from the second field sampling for comparative purposes.

   Two separate samples, collected at least two weeks apart, are analyzed for the following parameters:

   - Total alkalinity
   - Chloride
   - Conductivity
   - Sulfate
   - TDS
   - Fluoride*
   - pH
   - Selenium
   - Uranium
   - Radium-226
   - Arsenic*

   * Arsenic and fluoride are deleted from the above list of parameters if the previous two analyses (conducted for the list of parameters included in Table 5-1) show that arsenic and fluoride are below detection limits.

2) Ore Zone (Monitor Well Ring), M and Trend (T) Wells (if installed) - One sample for the parameters in Table 5-1 and three samples for the UCL parameters chloride, total alkalinity, and conductivity. All samples are collected at least two weeks apart.

3) Overlying and Underlying Zones, MO and MU Wells - Two samples for the parameters in Table 5-1 and two samples for the UCL parameters chloride, total alkalinity, and conductivity. All samples are collected at least two weeks apart.

5.1.5.3 Statistical Assessment of Baseline Water Quality Data

Baseline water quality is determined by averaging the data collected for each parameter, for each zone that is monitored. The variability of the data is also calculated. Outliers are determined in accordance with methods presented in WDEQ-LQD Guideline 4, or other accepted methods. Values determined to be outliers are not used in the baseline calculations. Where wells are not uniformly distributed, the average may be determined by weighting the data according to the fraction of area, or water volume, represented by the data. Baseline conditions are determined as follows:

Mineralized Zone (Production Pattern) Wells - 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.

Ore Zone (Monitor Well Ring) Wells - Data for each parameter are averaged. As with the mineralized zone wells, if sub-zones are present which differ in underground water classes, data within the specific sub-zones is averaged separately.

Overlying Aquifer - Data for each parameter are averaged.

Underlying Aquifer - Data for each parameter are averaged.

5.1.5.4 Restoration Target Values

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 (i.e. MP-Wells), constitute the RTV's. If the data indicate that waters of significantly different quality exist within the same mine unit, the data will be divided into sub-zones and averaged to determine the RTV's for each subzone.

5.1.6 Upper Control Limits

5.1.6.1 General

Monitor wells are installed within the Production Zone outside and around the pattern area (i.e. monitor well ring) and within overlying and underlying aquifers to document that the lixiviant and production fluids are not leaving the defined Production Zone. The process bleed (wellfield purge), in combination with production activities (pumping and injection rates), assist in keeping production fluids within the Production Zone.

Should production fluids reach a monitor well and its UCLs are exceeded, an "excursion" occurs. If an excursion is determined to have occurred, operational changes are implemented until such time that production fluids are retrieved to the Production Zone and the affected monitor well(s) is no longer on excursion status. As part of the detailed hydrologic assessment, UCLs are determined based on the baseline water quality data. The UCL parameters are chloride, total alkalinity, and conductivity.

It should be noted that the UCLs for Highland wellfields historically used bicarbonate instead of total alkalinity. Given the pH of the ground water UCLs for bicarbonate and total alkalinity are synonymous, except that total alkalinity is expressed as mg/L $CaCO_3$ equivalent instead of mg/L of bicarbonate. As of July 2004 PRI converted all UCLs to total alkalinity using the SERP process for all of Highland wellfields. Such a conversion is necessary to assist laboratory operations and provide consistent reporting requirements throughout the project.

5.1.6.2 Determination of Upper Control Limits

The UCLs are based on the baseline water quality data and determined as follows:

- Chloride UCL - baseline mean plus five standard deviations, or the baseline mean plus 15 mg/L, whichever is greater. Expressed as mg/L chloride.

- Total Alkalinity UCL - baseline mean plus five standard deviations. Expressed as mg/L as $CaCO_3$.

- Conductivity UCL - baseline mean plus five standard deviations. Expressed in μmhos/cm at 25°C.

5.2 OPERATIONAL HYDROLOGIC MONITORING PROGRAM

5.2.1 General

During operation, the primary purpose of the wellfield monitoring program is to detect and correct any condition which could lead to an excursion of leaching solution or detect such an excursion should one occur. To achieve this objective, flow rates and operating pressures are monitored at individual operating wells and along the main pipelines to and from the recovery plant. Water quality and water levels in the wellfield monitor wells are tested to ensure compliance.

5.2.2 Monitoring Frequency and Reporting

The Production Zone, overlying aquifer, and underlying aquifer monitor wells are sampled semi-monthly at approximately two week intervals (but not less than 10 days apart) and the samples are analyzed for and compared against the excursion parameter UCL values. The excursion parameters shall be chloride, conductivity and total alkalinity. In addition, the water level in each monitor well is measured and recorded prior to each sampling event. Water levels are not used as an excursion indicator. 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.

5.2.3 Water Quality Sampling and Analysis Procedures

Water quality samples are obtained by pumping the monitor wells with permanently installed submersible pumps. To assure that water within the well casing has been adequately displaced and formation water is sampled, wells are pumped a certain amount of time, based on the particular well's performance. A minimum of one (1) casing volume of water is removed from the well prior to sampling. Prior to sampling, the electrical conductivity and pH are measured at periodic intervals and recorded on field data sheets to demonstrate that water quality conditions have stabilized and ensure that formation water is sampled. All data for each well are periodically reviewed to ensure that both sampling and analytical procedures are adequate.

Water quality samples from monitor wells are analyzed for chloride, total alkalinity, and conductivity usually within 48 hours of sampling, at the on-site laboratory. All analyses are performed in accordance with accepted methods. PRI has Standard Operating Procedures (SOPs) in place that detail water sampling and laboratory analysis procedures.

5.2.4 Excursions

An excursion is considered to have occurred at a well if any two of the three UCL parameters (chloride, alkalinity, and conductivity) are exceeded. A verification sample is taken within 24 hours of the determination that a sample has exceeded two of the three UCL values. The verification sample is split and analyzed in duplicate to assess analytical error. During an excursion all monitoring wells on excursion status are sampled at least every seven days for the UCL parameters and uranium.

Upon verification of an excursion, the WDEQ-LQD will be verbally notified within 24 hours and the NRC Project Manager will be verbally notified within 48 hours. The WDEQ will be notified in writing within seven days. The NRC Project Manager will be notified in writing within 30 days. Corrective actions, such as changes in pumping or injection rates are implemented as soon as possible. Corrective actions continue until the excursion is mitigated.

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.

5.3 EFFLUENT AND ENVIRONMENTAL MONITORING

5.3.1 General

PRI maintains a detailed environmental and radiological program to monitor any releases from the SR-HUP and Reynolds Ranch operations to the environment. The program scope encompasses monitoring of air, ground water, surface water, and direct radiation. Soils and vegetation are also monitored at the irrigation facilities. The program is designed to meet the requirements of NRC's 10 CFR 40.65. Monitoring results are reported semi-annually to the NRC in the 40.65 Semi-Annual Reports. PRI has SOPs in place that detail the various monitoring programs. Many years of monitoring data collected at both the Smith Ranch and HUP operations have shown no significant adverse impacts to the environment or any increased health risks to the public.

5.3.2 Continuous Air Particulate Monitoring

To ensure compliance with 10 CFR 20.1301, 20.1302 and 20.1501, PRI maintains a continuous air monitoring program at five separate locations. These monitoring locations contain high flow air pumps which continuously collect particulate matter on paper filters. The filters are exchanged weekly, composited for analysis on a quarterly basis, and are analyzed for uranium, radium-226, and thorium-230 and lead-210. Results of the analyses are reported to the NRC in the Semi-Annual Report. The locations of the Air Monitoring Stations are shown on Plate 1 and are as follows:

1. Air Station No. 1 (Dave's Water Well): This station monitors background conditions, upwind of both the Smith Ranch and HUP wellfields and yellowcake processing facilities. The site is located adjacent to Dave's Water Well in the SW¼ NW¼ Section 8, T35N, R74W.

2. Air Station No. 2 (Smith Ranch Restricted Area): This station monitors conditions downwind of the Smith Ranch CPP Restricted Area boundary. The site is located 500 feet northeast of the Smith Ranch CPP in the NW¼ NE¼ Section 36 T36N, R74W.

3. Air Station No. 3 (Vollman Ranch): This station monitors the nearest downwind resident to the Smith Ranch CPP Restricted Area as well as background conditions for the Highland Central Plant Restricted Area. The site is located adjacent to the ranch house in the NW¼ NE¼ Section 27, T36N, R73W.

4. Air Station No. 4 (Overlook): This station monitors conditions downwind of the Highland Central Plant at the Restricted Area boundary. The site is located approximately 400 feet northeast of the Central Plant Facility in the NE¼ NE¼ Section 29, T36N, R72W. This monitoring station is only operated when yellowcake processing operations are active at the Highland Central Plant.

5. Air Station No. 5 (Fowler Ranch): This station monitors conditions at the nearest downwind residence to the Highland Central Plant. The site is located approximately 1200 feet west of the Fowler Ranch house in the SE¼ SE¼ Section 9, T36N, R72W. The ranch house is only occupied for a few months each year. This station is only operated when yellowcake processing operations are active at the Highland Central Plant.

6. Air Station No. 6 (Reynolds Ranch Satellite Area): This station monitors conditions downwind of the Reynolds Ranch Satellite Facility. The site is located approximately 1,100 feet northeast of the Satellite building in the NE¼ SE¼ Section 35 T37N, R74W.

Table 5-2 summarizes the U-Nat, Th-230, and Ra-226 monitoring data collected at the Smith Ranch Air Monitoring Stations for the period 1996 through 2002. Review of the air particulate data shows that all radionuclide concentrations have averaged less than 5% of the respective Effluent Concentration Limits. The data also shows that no significant difference has been determined between background radionuclide concentrations and those determined at the Restricted Area Boundary of the Smith Ranch CPP, or the nearest downwind residence (Vollman Ranch).

Table 5-3 summarizes the U-Nat, Th-230, and Ra-226 monitoring data collected at the Air Monitoring Stations used to monitor the impact of the Highland Central Plant, for the period 1995 through 1999. Review of this data shows that all radionuclide concentrations have averaged less than 5% of the respective Effluent Concentration Limit. A review of this data also shows that no significant difference has been determined between background radionuclide concentrations and those determined at the Restricted Area Boundary at the HUP Central Plant, or the nearest downwind residence (Fowler Ranch). Comparison of historic radionuclide particulate data from the Smith Ranch and Highland Air Monitoring Stations shows no significant variations.

Since drying operations will not be conducted at the Reynolds Ranch Satellite Facility, continuous air particulate monitoring is not planned. It is anticipated that the Satellite operations at Reynolds Ranch will not have a significant impact on radiological constituents of air particulates, which is supported by the results of air particulate monitoring results for SR-HUP discussed above.

5.3.3 Passive Radon Gas Monitoring

Passive radon gas (radon-222) is monitored at the site to assess background conditions and releases from the facilities to the environment. Radon is monitored using Track-Etch type radon cups (detectors) provided by a contractor specializing in radon detection. The radon cups were historically exchanged on a quarterly basis. The frequency of exchange of the cups has been changed to semi-annually (every 6 months) in order that the 0.2 pCi/L sensitivity level recommended in NRC Regulatory Guide 4.14 can be potentially met. Results of the monitoring are reported to the NRC in the Semi-Annual Report. Radon is monitored at the five Air Monitoring Stations described above. Radon is monitored at Air Station Nos. 4 and 5 only when the stations are active in response to yellowcake processing at the Highland Central Plant. Passive radon-222 will be monitored at the Reynolds Ranch Satellite at a background station (Air Station No. 1) and at a station just downwind of the Satellite Facility (Air Station No. 6).

Radon-222 monitoring data collected at the Smith Ranch Air Monitoring Stations for the period 1996 through 2002 is summarized in Table 5-2. Table 5-4 summarizes the radon-222 monitoring data collected at the Highland Air

Monitoring Stations and the three Passive Air Stations. A review of these data shows that radon-222 at all sites has averaged less than 20% of the Effluent Concentration Limit. Review of this data also shows that no significant difference has been determined between background radon-222 concentrations and those determined at the Restricted Area Boundary or nearest downwind residence sites. The data from the Highland Passive Air Stations also show that increases in radon-222 adjacent to Satellite No. 2, where radon is routinely vented during operations, has had a minimal impact on ambient air quality. As the monitoring data shows, any increases in radon-222 have been minimal and well below the Effluent Concentration Limit.

Similar radon-222 conditions to that described above for SR-HUP are expected to exist from the Reynolds Ranch Satellite operation.

5.3.4 Passive Gamma Radiation Monitoring

Passive gamma radiation is monitored at the five Air Monitoring Stations described above. Passive gamma radiation is monitored using spherical TLD's which are exchanged on a quarterly basis. Results of the monitoring are reported to the NRC in the Semi-Annual Report. Gamma radiation is monitored at Air Station Nos. 4 and 5 only when the stations are active in response to yellowcake processing at the Highland Central Plant. Gamma radiation will be monitored at the Reynolds Ranch Satellite at a background station (Air Station No. 1) and at a station just downwind of the Satellite Facility (Air Station No. 6).

Passive gamma radiation monitoring data collected at the Smith Ranch Air Monitoring Stations for the period 1996 through 2002 is summarized in Table 5-2. Table 5-5 summarizes the passive gamma radiation monitoring at the Higland Air Stations and the three Passive Air Stations. Review of these data show that background gamma radiation levels at the respective upwind and downwind sites for each project range from 33 to 36 mRem per quarter. It should be noted that the downwind sites also represent background due to their distance from any processing areas or gamma radiation sources. In comparison to the background sites, data obtained at the Restricted Area Boundaries of the Smith Ranch CPP and Highland CPF show apparent minimal increases in gamma radiation of only 2 to 5 mRem per quarter.

Similar gamma radiation conditions to that described above for SR-HUP are expected to exist from the Reynolds Ranch Satellite operation.

5.3.5 Environmental Ground Water Monitoring Program

The project wide environmental ground water monitoring program includes the quarterly monitoring of operating domestic and stock wells located within 1 km of operating wellfields. Water samples are obtained from these wells for the analysis of uranium and radium-226. The ground water monitoring stations for current operating wellfields are described in Table 5-6 and shown on Plate 1. Plate 1 also shows the locations of other potential ground water monitoring sites near proposed SR-HUP and Reynolds Ranch wellfields that will be added to the monitoring program once wellfield operations commence in those areas.

5.3.6 Environmental Surface Water Monitoring Program

The project wide environmental surface water monitoring program includes the quarterly monitoring of Sage Creek when stream flow is present as well as numerous stock ponds that are located down stream of operating wellfields. The surface water monitoring sites are described in Table 5-7 and shown on Plate 1. Water samples are obtained from these sites for the analysis of uranium and radium-226 when adequate water exists to permit sampling.

Surface water sampling for locations for the Reynolds Ranch amendment area will be determined and added to the monitoring plan as wellfield operations commence.

5.3.7 Wastewater Land Application Facilities Monitoring Program

5.3.7.1 General

To assist in assessing impacts of irrigating treated wastewater at the Satellite No. 1 and Satellite No. 2 Wastewater Land Application Facilities (Irrigation Areas) the irrigation water, soil, and vegetation are monitored for various constituents including natural uranium and radium-226. This monitoring program has been in place since the start of each facility. Results of the monitoring program are reported to the NRC in the Semi-Annual Report and to the WDEQ-LQD in the Annual Report. The monitoring programs for the Satellite No. 1 and Satellite No. 2 Wastewater Land Application Facilities are shown in Tables 5-8 and 5-9, respectively.

5.3.7.2 Radium Treatment Sampling

Monthly Grab samples are collected from the radium treatment system at each Satellite to assure that the barium chloride treatment system is reducing radium-226 to acceptable concentrations (less than the Effluent Concentration Limit of 60 pCi/L (6.0E-8μCi/mL)). Monitoring data collected throughout the life of the project shows that the treatment system is very effective in reducing radium-226 concentrations to levels below the Effluent Concentration Limit (ECL).

The result of monitoring data for the radium treatment system at Satellite No. 1 for the period 1995 through 1999 shows a mean radium-226 concentration of

9.25 E-9 μCi/mL which is 15% of the ECL. The results of monitoring data for the radium treatment system at Satellite No. 2 for the period 1995 through 1999 shows a mean radium-226 concentration of 2.51 E-8 μCi/mL, which is 42% of the ECL. Monitoring data for the Satellite No. 3 treatment system, which has only been operational since January 1999, shows a mean radium-226 concentration of 2.12 E-8 μCi/mL (35% of the ECL) for the period January 1999 through December 1999.

5.3.7.3 Irrigation Fluid Sampling

The irrigation fluid quality has been monitored at both irrigation facilities since irrigation operations started. Review of the irrigation fluid monitoring results at the Satellite No. 1 facility, for the period 1989 through 1999, shows the following mean concentrations of natural uranium and radium-226 (weighted by volume of water applied):

U-Nat 1.32 mg/L or 9.0 E-7 μCi/mL
Radium-226 5.59 pCi/L or 5.6 E-9 μCi/mL

Results of this monitoring program at the Satellite No. 2 facility for the period 1995 through 1999 show the following mean concentrations of natural uranium and radium-226 (weighted by volume of water applied):

U-Nat 0.79 mg/L or 5.3 E-7 μCi/mL
Radium-226 7.33 pCi/L or 7.3 E-9 μCi/mL

The concentrations of uranium and radium-226 within the treated wastewater applied at both irrigation facilities are within the range of concentrations predicted in the information submitted to the NRC for use of these facilities.

5.3.7.4 Soil Sampling

The monitoring programs for the Satellite No. 1 and Satellite No. 2 Wastewater Land Application Facilities also require that soil samples be collected annually in August at depths of 0-6 inches and 6-12 inches to assess impacts of irrigation on the irrigated soil. Results of the soil monitoring for natural uranium and radium-226 at the Satellite No. 1 and Satellite No. 2 facilities are summarized in Tables 5-10 and 5-11, respectively.

A review of the soils data for the Satellite No. 1 facility shows an increasing trend in natural uranium concentrations within the 0-6 inch soil depth, compared to a background range of 4.4 E-7 to 1.7 E-6 μCi/g (0.7 to 2.5 mg/kg). The most recent data obtained in August 1999 shows a mean natural uranium concentration of 1.1 E-5 μCi/g (16.5 mg/kg) for the 0-6 inch soil depth. Since no discernable increase in radium-226 concentrations have been observed at this same depth, no problems are anticipated in meeting soil radionuclide release criteria.

A review of the natural uranium concentration data for the 6-12 inch soil depth at the Satellite No. 1 facility shows only a minimal increase above background. Since no discernable increase in radium-226 concentrations have been observed at this same depth, no problems are anticipated in meeting soil radionuclide release criteria.

The higher concentrations of uranium in the near surface soil (0-6 inch depth) is attributed to the uranium attaching to soil particles and being more concentrated due to evaporation of soil water towards the surface. If deemed necessary at decommissioning, it would be possible to reduce the near surface concentrations by deep plowing and mixing the soil.

A review of the data for the Satellite No. 2 facility, which has not been in operation as long as the Satellite No. 1 facility, shows that uranium is also increasing slightly in the near surface soil (0-6 inch depth). The most recent data obtained in August 1999 shows a natural uranium concentration of 4.6 E-6 μCi/g (6.9 mg/kg) which is minimally above the background range of 1.8 E-6 to 3.4 E-6 μCi/g (2.7 to 5.0 mg/kg). Data for the 6-12 inch depth shows that soil uranium concentrations are still within the background range.

A review of the radium-226 data for both soil depths at the Satellite No. 2 facility shows that concentrations have not exceeded the background range of radium-226 concentrations. Because no discernable increase in radium-226 has been determined, or is it expected, no problems are anticipated in meeting soil radionuclide release limits.

5.3.7.5 Vegetation Sampling

The vegetation (grass) at both irrigation facilities is also monitored on an annual basis, in August of each year, to determine the potential accumulation of radionuclides in the vegetation. Monitoring of the vegetation started at the Satellite No. 1 facility in 1991 while monitoring of the Satellite No. 2 facility commenced in 1996. The mean natural uranium and radium-226 concentrations in vegetation for the Satellite No. 1 and Satellite No. 2 irrigation facilities are included in Tables 5-12 and 5-13, respectively.

A review of the data for the Satellite No. 1 irrigation facility shows a relatively small increase in uranium concentrations within the vegetation during the period 1991 through 1997. The apparent abrupt increase in uranium in the vegetation in 1998 and 1999 is attributed to a change in sample analysis procedures. At the request of the WDEQ-LQD, starting in 1998, the radionuclide and other parameters were analyzed on a dry weight basis, instead of a wet weight basis. The highest uranium concentrations in the vegetation, which were observed in the 1999 data, are also suspect as the "background" sample also showed anomalously higher uranium concentrations. Monitoring data obtained in August 2000 should help explain this apparent anomally.

A review of the radium-226 data obtained for the vegetation at the Satellite No. 1 facility shows that radium-226 concentrations remain very close to the range of background concentrations.

A review of the data for the Satellite No. 2 irrigation facility shows only minor increases in uranium concentrations within the vegetation. The mean concentration determined for the samples collected in August 1999 was 6.8 E-4 mg/kg (1.00 mg/kg). Radium-226 concentrations in the vegetation showed no discernable increase compared to background concentrations.

5.3.8 Waste Disposal Well Monitoring

The SR-HUP currently utilizes three Class I Non-Hazardous Waste Disposal Wells to dispose of waste water generated by wellfield and yellowcake processing operations. Wells WDW #1 and WDW #2 are associated with the Smith Ranch facilities and Well Morton 1-20 is associated with the Highland facility (see Plate 1). In accordance with the UIC permits issued by the WDEQ-WQD for the disposal wells at each facility, the quality of the injected water is monitored on a quarterly basis. Samples are composited from the waste stream each quarter and analyzed for total dissolved solids, total alkalinity, ammonia, natural uranium, radium-226, and pH.

The quality of waste water injected into the Smith Ranch waste disposal wells and Highland Morton 1-20 Well for the period 1997 through 2002 is summarized in Tables 5-14 and 5-15. The permit limit for uranium is 65 mg/L while pH must be maintained between 2 and 11. Permit limits have not been established for any of the other sample parameters. Review of the data in Tables 5-14 and 5-15 shows that the permit limit for uranium was exceeded at Smith Ranch during the 3rd Quarter 2002 report period and at Highland during the 4th Quarter 2002 report period. The permit limits for uranium and pH were not exceeded during any other report period.

The elevated uranium concentration in the Smith Ranch 3rd Quarter 2002 sample resulted from an upset condition in the CPP Precipitation Circuit during the period August 13 to 26, 2002. Since the 3rd Quarter 2002 composite sample was also collected during this two week period, the sample contained an elevated concentration of uranium. Samples of the waste water obtained on a daily basis and analyzed at the CPP Process Lab showed an average uranium concentration for the three month period of 43.9 mg/L, which is less than the permit limit of 65 mg/L. As evidenced by the results of the 4th Quarter 2002 sample, corrective actions have been implemented to ensure that an upset condition such as that which occurred in August 2002 does not happen again.

For the Highland Morton 1-20 Well, the elevated uranium concentration in the 4th Quarter 2002 sample was a result of tank cleanout procedures that did not allow for normal operation of the uranium removal circuit during preparation of the Highland Central Plant for standby status. Currently, the Morton 1-20 well is also on standby status.

The planned Deep Disposal Well for Reynolds Ranch will be monitored in accordance with the UIC permit issued by the WDEQ-WQD. However, it is anticipated that monitoring of the Reynolds Ranch Deep Disposal Well will be conducted in a similar manner to the Smith Ranch disposal wells. Monitoring information for the proposed Reynolds Ranch Disposal Well can be found in the permit application submitted to the WDEQ-WQD on October 6, 2004.

5.3.9 Evaporation Ponds

5.3.9.1 Evaporation Pond Sampling

The evaporation ponds are sampled on a semi-annual basis. Each pond sample is analyzed for bicarbonate, calcium, chloride, sodium, sulfate, TDS, uranium, radium-226 and thorium-230. PRI has SOPs in place that detail the monitoring programs for these ponds.

5.3.9.2 Leak Detection Monitoring

Each lined evaporation or treatment pond at the Smith Ranch CPP is constructed with a leak detection system consisting of a network of perforated pipes in a sand layer beneath the liner with the pipes draining to a collection sump. Should a leak in the liner occur, the water will flow through the sand, enter a perforated pipe, then flow to the sump. PRI has SOPs in place that detail the monitoring program for the leak detection system. The monitoring program for the lined ponds includes either a fluid level sensor in each pond sump with an alarm displayed at the CPP or a daily inspection of each sump by an operator. The evaporation ponds are inspected daily for visual indications of leaks or embankment deterioration by an individual instructed in proper inspection procedures. The pond inspections are recorded and initialed by the inspector.

If six inches or more of fluid is detected in any leak detection system sump, it will be sampled and analyzed for chloride and conductivity. If analyses indicate a pond leak, and the analyses are confirmed, the appropriate agencies will be notified by telephone within 48 hours after receiving the confirming analyses and the water level in the pond with the indicated leak will be lowered by transferring the contents to another cell. If water continues to flow to the sump, samples will be collected every seven days and analyzed for chloride and conductivity. Once per month a sample will be analyzed for bicarbonate, uranium, and sulfate. A written report will be filed with the appropriate agencies within 30 days after the notification of the suspected leak and every 30 days thereafter until the leak is repaired. The reports will include the available analytical data, the corrective actions taken, and results of the actions.

A freeboard of at least three (3) feet will be maintained in each pond to prevent loss of solutions by wave action and to allow for holding the contents of another pond on a temporary basis in the event of a leak.

5.3.10 Wildlife Monitoring

5.3.10.1 General

In accordance with WDEQ mine permit requirements, PRI takes various precautions to limit potential adverse impacts to wildlife from in situ mining operations.

Impacts to wildlife as a result of current and proposed operations are insignificant for the following reasons:

1. No unique or critical habitats are present within the permit area.

2. No important wildlife migration routes are contained within the permit area.

3. ISL activities disturb relatively minor amounts of land surface compared to conventional open pit mining methods.

4. Areas disturbed by wellfield activities are quickly revegetated after wellfield construction and are used by wildlife throughout production activities.

5. Restrictive fencing is limited to isolated areas which do not significantly impede wildlife movements.

6. Vehicular traffic is limited and reduced speed limits are utilized for safety purposes and to decrease the potential for vehicle-wildlife collisions.

7. Power lines are constructed using standard practices to minimize the potential electrocution of raptors.

Observations over the 13+ years of operation show that wildlife are not impacted, and both deer and pronghorn readily utilize the fenced operating areas. It is likely that wildlife are attracted to the fenced wellfield areas due to the lack of livestock and the abundant vegetative growth which offers food and cover.

During the initial permitting of both the Smith Ranch Project and the HUP, commitments were made to the WDEQ-LQD and Wyoming Game & Fish Department to monitor for a 3-year period the effects of ISL mine development and operation activities on Pronghorn Antelope and Mule Deer, the big game species of concern in the area. These 3-year monitoring commitments were complete at both operations and the required reports submitted to the WDEQ-LQD. Based on the results of these monitoring programs it was determined that the ISL operations were having no significant negative impact on Pronghorn or Mule Deer. The regulatory agencies agreed that it was not necessary to prolong this monitoring. As a result, this monitoring will not be conducted for the Reynolds Ranch amendment area.

5.3.10.2 Threatened and Endangered Species

The baseline studies of the project site identified the three species that were "Threatened" or "Endangered Species" and could possibly be present at the site. These species included the Blackfooted Ferret (Endangered), the Bald Eagle (Threatened) and the Peregrine Falcon (Threatened). In May 2000 the U.S. Fish and Wildlife Service (USFWS) was contacted to assess the status of these species. It was determined that only the Blackfooted Ferret is still an Endangered Species.

Relative to Blackfooted Ferrets, none have ever been observed on, or near, the project site and the lack of prairie dog colonies anywhere near the site precludes the habitat required by them.

Current (January 2003) information suggests that the Mountain Plover is proposed by the USFWS for listing as a Threatened Species. Although the project site is located in the very broad geographic region where this specie is known to exist, the site does not contain the habitat preferred by them. Field observations throughout the life of the project have resulted in no observations of the Mountain Plover.

In the case that a Threatened or Endangered Species begins to use the license area or adjacent areas, the USFWS Wyoming Field Office, Cheyenne will be notified.

5.3.10.3 Raptor Nest Surveys

It is not anticipated that mining related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the permit area due to the lack of trees and other nesting sites. Additionally, mining related activities are limited to relatively small areas for limited periods of time. Known active nest sites are not located within active or proposed wellfield areas.

In accordance with WDEQ-LQD requirements a raptor nest survey is conducted in late April or early May each year to identify any new nests and assess whether known nests are being utilized. The survey covers all areas of planned activity for the life of mine (wellfields, Satellites, CPF, etc.) and a one mile area around the activity. Status and production at known nests will be determined, if possible. This survey program is primarily intended to protect against unforeseen conditions such as the construction of a new nest in an area where operations may take place.

Raptor nest surveys since 1992 has shown that known nest sites are used by Redtailed Hawks, Swainsons Hawks, and great Horned Owls on a seasonal basis. The only Golden Eagles nesting on the project site have nested approximately 2 miles from any project activity.

Activities at the project site have not resulted in the need to disturb or relocate any raptor nest. Due to the location of proposed wellfields, it is very unlikely that any raptor nests will be disturbed in the future. In the very unlikely event that it is necessary to disturb a raptor nest, a permit for a mitigation plan will be acquired from the U.S. Fish and Wildlife Service, Wyoming Field Office, in Cheyenne, Wyoming.

5.3.11 Cultural Resources Mitigation

In accordance with WDEQ-LQD and Wyoming State Historic Preservation Office (WSHPO) requirements, cultural resource surveys have been conducted on lands comprising the project area (see Section 2.4 of Chapter 2). These surveys have been approved by the USBLM, WDEQ-LQD, and WSHPO.

In the Smith Ranch area, it was determined that only two sites of significant historical or archaeological value could be potentially affected by the project. These sites included 48C01289 and 48C0352, both of which were considered eligible for the National Register of Historic Places (NRHP) at the time of the initial surveys. Due to the potential for impacts to site 48C01289 during future wellfield operations, additional evaluative testing was conducted in July 1999. As a result of this additional testing, the cultural resource evaluation of 48C01289 has been changed to "ineligible". Currently, no additional evaluative testing has been conducted on site 48C0352. However, no surface disturbing activities will take place within 100 feet of the boundaries of this site until the adverse effects of such disturbance have been mitigated under a plan approved by the USBLM, WDEQ-LQD, and WSHPO.

In the Highland area, it has been concluded in all previous cultural resource surveys that the sites mapped are of no significant historical or archaeological value.

Baseline studies in the Reynolds Ranch amendment area determined that one area, the Holdup Hollow segment of the Bozeman Trail, was listed in the NRHP. As a result of the study, the proposed boundaries for the Reynolds Ranch amendment area were modified to exclude the Holdup Hollow segment. Therefore, no surface disturbing activities will take place within 100 ft of the boundaries of this area.

If any significant cultural materials are discovered during the development and construction of new mining areas, they will be protected and the appropriate federal (USBLM) or state (WSHPO) office notified.

5.3.12 Spill Reporting Requirements

Any liquid spill which enters a water of the state, any liquid spill in excess of 420 gallons or any spill that threatens to enter a water of the state, comprised of lixiviant, pregnant liquor, acid, solvent, process waste water or any similar stream, must be reported to the WDEQ/LQD within 24 hours of the incident. A written report is required to be submitted within 7 days. For purposes of this document, a water of the state includes dry draws, playas, and wetlands, as well as streams, rivers and lakes.

All reportable spills are recorded in a spill log or file located at the facility. The NRC Project Manager will be notified within 48 hours for any spill that may have a radiological impact on the environment or is required to be reported to any other State or Federal agency.

This notification will be followed within 30 days by a written report to the NRC Project Manager.

TABLE 5-1

BASELINE WATER QUALITY PARAMETERS

Parameter	Lower Detection Limit *
Alkalinity	0.1
Ammonium	0.05
Arsenic	0.001
Barium	0.1
Bicarbonate	0.1
Boron	0.1
Cadmium	0.01
Calcium	0.05
Carbonate	0.1
Chloride	0.1
Chromium	0.05
Copper	0.01
Electrical Conductivity @ 25 degrees C	1 micromho/cm
Fluoride	0.1
Iron	0.05
Lead	0.05
Magnesium	0.01
Manganese	0.01
Mercury	0.0005
Molybdenum	0.05
Nickel	0.05
Nitrate	0.01
pH	0-14 s.u.
Potassium	0.1
Radium-226	0.1 pCi/L
Selenium	0.001
Sodium	0.05
Sulfate	0.5
Total Dissolved Solids	1
Uranium	0.001
Vanadium	0.1

* mg/L unless specified otherwise

Table 5-2

Mean Concentrations of U-nat, Thorium-230, Radium-226, Radon-222, and Gamma Radiation Air Monitoring Data at the Smith Ranch Air Monitoring Stations for the Period 1996 through 2002

Parameter	Air Station No. 1 Dave's Water Well (Upwind)	Air Station No. 2 CPP Fence Line (Restricted Area Boundary)	Air Station No. 3 Vollman Ranch (Downwind)
Air Particulate Monitoring			
U-nat (µCi/mL)	1.60E-15	1.85E-14	1.40E-15
ECL (µCi/mL)	3.00E-12	3.00E-12	3.00E-12
% ECL	0.05%	0.6%	0.05%
Th-230 (µCi/mL)	5.40E-16	6.30E-16	4.90E-16
ECL (µCi/mL)	2.00E-14	2.00E-14	2.00E-14
% ECL	3%	3%	2%
Ra-226 (µCi/mL)	5.30E-16	1.90E-15	6.00E-16
ECL (µCi/mL)	9.00E-13	9.00E-13	9.00E-13
% ECL	0.06%	0.2%	0.07%
Radon-222 Monitoring			
Radon-222 (µCi/mL)	1.30E-09	1.10E-09	1.10E-09
ECL (µCi/mL)	1.00E-08	1.00E-08	1.00E-08
% ECL	13%	11%	11%
Gamma Radiation			
Gamma (mRem/Qtr)	33	38	34

Notes: ECL, Effluent Concentration Limit

Table 3

Summary of U-Nat, Thorium-230 and Radium-226 Air Monitoring Data at the Highland Air Monitoring Stations for The Period 1995 through 1999

	U-Nat (µCi/mL)			Th-230 (µCi/mL)			Ra-226 (µCi/mL)		
Yr/Qtr	Air Station No. 1 Vollman Ranch (Upwind)	Air Station No. 2 CPF Overlook (Restricted Area Boundary)	Air Station No. 3 Fowler Ranch (Downwind)	Air Station No. 1 Vollman Ranch (Upwind)	Air Station No. 2 CPF Overlook (Restricted Area Boundary)	Air Station No. 3 Fowler Ranch (Downwind)	Air Station No. 1 Vollman Ranch (Upwind)	Air Station No. 2 CPF Overlook (Restricted Area Boundary)	Air Station No. 3 Fowler Ranch (Downwind)
1995-1st	3.85E-16	7.46E-15	3.46E-15	<1.00E-16	<1.00E-16	<1.00E-16	2.10E-16	9.50E-16	2.24E-15
2nd	5.43E-16	2.55E-15	3.31E-16	<1.00E-16	<1.00E-16	3.31E-16	<1.00E-16	<1.00E-16	2.65E-16
3rd	3.77E-16	5.71E-15	3.59E-15	<1.00E-16	<1.00E-16	6.76E-16	<1.00E-16	1.56E-16	1.18E-15
4th	2.68E-16	3.12E-15	3.42E-15	1.10E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	1.22E-16
1996-1st	3.40E-16	1.60E-14	2.34E-15	<1.00E-16	1.42E-16	1.13E-16	<1.00E-16	<1.00E-16	<1.00E-16
2nd	3.03E-16	1.10E-14	2.77E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
3rd	4.35E-16	6.28E-15	1.35E-15	<1.00E-16	<1.00E-16	<1.00E-16	1.32E-16	3.17E-16	<1.00E-16
4th	9.01E-16	5.19E-15	2.57E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
1997-1st	1.22E-15	2.29E-15	1.47E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
2nd	1.14E-15	2.11E-15	1.56E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	1.94E-16
3rd	5.61E-16	2.85E-15	4.68E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
4th	7.71E-15	6.50E-15	1.56E-15	<1.00E-16	<1.00E-16	1.67E-16	<1.00E-16	<1.00E-16	<1.00E-16
1998-1st	1.60E-14	2.39E-15	1.36E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	1.70E-16	<1.00E-16
2nd	2.17E-15	2.57E-15	3.57E-15	<1.00E-16	<1.00E-16	3.23E-16	2.08E-16	2.50E-16	4.77E-16
3rd	6.43E-16	1.93E-15	1.21E-15	<1.00E-16	<1.00E-16	<1.00E-16	1.06E-16	<1.00E-16	<1.00E-16
4th	1.02E-14	4.09E-15	2.50E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	1.36E-16	<1.00E-16
1999-1st	2.62E-15	7.06E-16	5.26E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	2.51E-16
2nd	9.33E-15	1.70E-15	1.25E-15	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
3rd	7.17E-15	2.73E-15	6.75E-16	1.86E-16	1.05E-16	1.58E-16	<1.00E-16	5.25E-16	<1.00E-16
4th	4.38E-15	7.66E-16	8.04E-16	1.58E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16	<1.00E-16
Minimum	**2.68E-16**	**7.06E-16**	**3.31E-16**	**<1.00E-16**	**<1.00E-16**	**<1.00E-16**	**<1.00E-16**	**<1.00E-16**	**<1.00E-16**
% ECL	**0.3**	**0.8**	**0.4**	**0.5**	**0.5**	**0.5**	**0.01**	**0.01**	**0.01**
Maximum	**1.60E-14**	**1.60E-14**	**4.68E-15**	**1.86E-16**	**1.42E-16**	**6.76E-16**	**2.10E-16**	**9.50E-16**	**2.24E-15**
% ECL	**17.8**	**17.8**	**5.2**	**0.9**	**0.7**	**3.4**	**0.02**	**0.11**	**0.25**
Mean	**3.33E-15**	**4.40E-15**	**2.05E-15**	**1.08E-16**	**1.02E-16**	**1.58E-16**	**1.13E-16**	**1.90E-16**	**3.01E-16**
% ECL	**3.7**	**4.9**	**2.3**	**0.5**	**0.5**	**0.8**	**0.01**	**0.02**	**0.03**

Notes:
1. Lower limit of detection used to determine mean values.
2. % Effluent Concentration Limit (ECL) based on the following ECL's:

U-Nat = 9.00 E-14 µCi/mL   Th-230 = 2.00 E-14 µCi/mL

Ra-226 = 9.00 E-13 µCi/mL

Table 5-4

Summary of Radon-222 Monitoring Data at the Highland Air Monitoring Stations for the Period 1995 through 1999

Yr/Qtr	Air Station No. 1	Air Station No. 2	Air Station No. 3	Passive Air Station No. 1	Passive Air Station No. 2	Passive Air Station No. 3
	Vollman Ranch (Upwind)	CPF Overlook (Restricted Area Boundary)	Fowler Ranch (Downwind)	SAT20-SW	SAT2-NE	SAT3 (Background)
1995-1st	6.0E-10	1.5E-09	9.0E-10	1.1E-09	1.1E-09	NA
2nd	8.0E-10	7.0E-10	1.1E-09	1.7E-09	1.7E-09	NA
3rd	1.2E-09	1.3E-09	1.8E-09	3.7E-09	2.5E-09	NA
4th	1.0E-09	1.7E-09	1.1E-09	1.7E-09	1.9E-09	NA
1996-1st	<3.0E-10	9.0E-10	5.0E-10	1.0E-09	1.1E-09	NA
2nd	9.0E-10	8.0E-10	9.0E-10	1.7E-09	1.2E-09	1.0E-09
3rd	1.9E-09	1.7E-09	1.9E-09	3.8E-09	2.4E-09	1.9E-09
4th	9.0E-10	1.3E-09	9.0E-10	1.6E-09	1.4E-09	7.0E-10
1997-1st	1.5E-09	1.3E-09	1.1E-09	1.4E-09	1.2E-09	1.0E-09
2nd	9.0E-10	1.9E-09	NA	1.4E-09	1.3E-09	1.1E-09
3rd	1.1E-09	1.2E-09	1.2E-09	2.4E-09	1.9E-09	1.7E-09
4th	1.7E-09	9.0E-10	1.8E-09	2.4E-09	1.8E-09	9.0E-10
1998-1st	<3.0E-10	<3.0E-10	3.0E-10	5.0E-10	<3.0E-10	3.0E-10
2nd	7.0E-10	7.0E-10	9.0E-10	1.7E-09	1.5E-09	1.3E-09
3rd	1.0E-09	5.0E-10	9.0E-10	2.7E-09	1.3E-09	1.0E-09
4th	7.0E-10	7.0E-10	9.0E-10	1.4E-09	1.5E-09	8.0E-10
1999-1st	8.0E-10	1.3E-09	1.6E-09	1.8E-09	1.7E-09	9.0E-10
2nd	<3.0E-10	8.0E-10	9.0E-10	1.6E-09	5.0E-10	8.0E-10
3rd	1.0E-09	1.4E-09	1.1E-09	2.5E-09	1.5E-09	3.3E-09
4th	1.2E-09	1.2E-09	1.4E-09	2.6E-09	2.1E-09	1.2E-09
Minimum	**<3.00E-10**	**<3.00E-10**	**3.00E-10**	**<5.00E-10**	**<3.00E-10**	**3.00E-10**
% ECL	**3.0**	**3.0**	**3.0**	**5.0**	**3.0**	**3.0**
Maximum	**1.90E-09**	**1.90E-09**	**1.90E-09**	**3.80E-09**	**2.50E-09**	**3.30E-09**
% ECL	**19.0**	**19.0**	**19.0**	**38.0**	**25.0**	**33.0**
Mean	**9.40E-10**	**1.11E-09**	**1.12E-09**	**1.89E-09**	**1.50E-09**	**1.19E-09**
% ECL	**9.4**	**11.1**	**11.2**	**18.9**	**15.0**	**11.9**

Notes:
1. NA, data not available
2. Lower Limit of Detection used to determine mean values.
3. Concentrations expressed in μCi/mL.
4. % Effluent Concentration Limit (ECL) based on ECL of 1.00 E-8 μCi/mL.

Table 5-5

Summary of Gamma Radiation Monitoring Data At the Highland Air Monitoring Stations for the Period 1995 through 1999

Yr/Qtr	Air Station No. 1 Vollman Ranch (Upwind)	Air Station No. 2 CPF Overlook (Restricted Area Boundary)	Air Station No. 3 Fowler Ranch (Downwind)	Passive Air Station No. 1 SAT2-SW	Passive Air Station No. 2 SAT2-NE	Passive Air Station No. 3 SAT3 (Background)
1995-1st	34.8	40.0	35.4	46.8	30.6	NA
2nd	24.6	31.0	26.4	22.8	32.0	NA
3rd	27.8	42.0	33.8	40.8	39.2	NA
4th	24.6	23.4	31.6	34.6	24.6	NA
1996-1st	37.4	45.4	41.0	52.6	38.8	NA
2nd	28.6	34.6	32.0	42.2	33.4	35.2
3rd	41.8	45.0	38.4	38.0	48.8	41.0
4th	37.4	44.0	43.2	41.2	41.4	37.4
1997-1st	29.0	33.4	30.8	35.8	33.0	31.8
2nd	29.4	34.6	30.4	34.4	29.8	29.0
3rd	32.0	33.8	33.4	35.2	30.0	30.4
4th	30.6	36.8	30.8	39.2	30.2	34.6
1998-1st	32.0	37.0	36.0	35.8	31.8	35.6
2nd	30.6	37.4	32.2	37.6	30.4	33.6
3rd	43.4	49.8	42.8	57.4	48.0	46.6
4th	36.4	40.6	41.0	46.6	42.8	40.4
1999-1st	35.2	32.0	44.0	38.8	32.4	33.4
2nd	37.4	42.8	40.2	53.4	36.4	40.6
3rd	36.0	39.6	35.2	42.8	33.8	NA
4th	38.4	NA	40.4	43.8	37.4	41.6
Minimum	**24.6**	**23.4**	**26.4**	**22.8**	**24.6**	**29.0**
Maximum	**43.4**	**49.8**	**44.0**	**57.4**	**48.8**	**46.6**
Mean	**33.4**	**38.1**	**36.0**	**41.0**	**35.2**	**36.5**

Notes: 1. NA, Data not available.
2. Gamma radiation levels expressed in mRem/Quarter.

Table 5-6

Ground Water Monitoring Program

Site	Location	Source	Use	Analyses
GW-1	NW¼, NW¼, SEC 1, T35N, R74W	Windmill	Livestock	Uranium, Radium-226
GW-2	NE¼, NW¼, SEC 35, T36N, R74W	Water Well	Livestock	Uranium, Radium-226
GW-3	SE¼, NW¼, SEC 27, T36N, R74W	Windmill	Livestock	Uranium, Radium-226
GW-4	SE¼, SW¼, SEC 23, T36N, R74W	Windmill	Livestock	Uranium, Radium-226
GW-5	NE¼, NE¼, SEC 30, T36N, R73W	Windmill	Livestock	Uranium, Radium-226
GW-6	SW¼, SE¼, SEC 21, T36N, R73W	Windmill	Livestock	Uranium, Radium-226
GW-7	NE¼, NW¼, SEC 27, T36N, R73W	Water Well	Domestic	Uranium, Radium-226
GW-8	SW¼, NW¼, SEC 23, T36N, R73W	Windmill	Livestock	Uranium, Radium-226
GW-9	SE¼, SE¼, SEC 14, T36N, R73W	Windmill	Livestock	Uranium, Radium-226
GW-10	SE¼, NE¼, SEC 14, T36N, R73W	Water Well	Livestock	Uranium, Radium-226
GW-11	NE¼, SE¼, SEC 11, T36N, R73W	Water Well	Livestock	Uranium, Radium-226
GW-12	SE¼, SW¼, SEC 7, T36N, R72W	Water Well	Livestock	Uranium, Radium-226

Table 5-7

Surface Water Monitoring Program

Site	Location	Source	Analyses
SW-1	NW¼, NW¼, SEC 3, T35N, R74W	Stock Pond	Uranium, Radium-226
SW-2	NE¼, SE¼, SEC 2, T35N, R74W	Stock Pond	Uranium, Radium-226
SW-3	NE¼, NW¼, SEC 35, T36N, R74W	Stock Pond	Uranium, Radium-226
SW-4	NW¼, SE¼, SEC 36, T36N, R74W	Stock Pond	Uranium, Radium-226
SW-5	SW¼, SE¼, SEC 21, T36N, R73W	Stock Pond	Uranium, Radium-226
SW-6	SE¼, SW¼, SEC 22, T36N, R73W	Stock Pond	Uranium, Radium-226
SW-7	SE¼, NW¼, SEC 22, T36N, R73W	Stock Pond	Uranium, Radium-226
SW-8	NE¼, SW¼, SEC 18, T36N, R72W	Stock Pond	Uranium, Radium-226
SW-9	NW¼, NW¼, SEC 18, T36N, R72W	Stock Pond	Uranium, Radium-226
SW-10*	SW¼, SW¼, SEC 19, T36N, R72W	Stock Pond	Uranium, Radium-226

Note: *, Site SW-10 will be monitored once mining commences in drainage area of pond.

TABLE 5-8

Satellite No. 1 Wastewater Land Application Facility Monitoring Program

Sample Type	Location	Frequency	Analyses
Treated Waste Water	At radium settling ponds or discharge from Satellite No. 1 radium treatment system	Monthly; grab	Ra226
Irrigation Fluid	At irrigation pivot during irrigation	Grab sample during each calendar month of operation	Na, Ca, Mg, Cl, SO_4, As, Se, U, Ra226, HCO_3, TDS, K, Ba, B, SAR, pH
Soil Water	24, 48, 72 inch depth	June	pH, Electrical Cond., Cl, SO_4, HCO_3, B, U, Ra226
Irrigated soil thoroughly blended composite 6-12 inch depth	One sample per four (4) irrigated acres	August	Na, Ca, Mg, K, As, Se, B, Ba, Ra226, U, Electrical Cond., SAR, pH
Irrigated Vegetation	One sample at each soil sample location, composited	August; if harvested as hay, one sample per cutting	As, Se, B, Ra226, U, Ba
Visual Inspection	Irrigation Perimeter	Daily during irrigation	Check for runoff

NOTE: Heavy metal analyses in soils will be performed on plant available or ADPTA extractable fraction.

Table 5-9

Satellite No. 2 Wastewater Land Application Facility Monitoring Program

Sample Type	Location	Frequency	Analyses
Treated Waste Water	At discharge from radium treatment system at Satellite Nos. 2 and 3	Monthly; grab	Ra226
Irrigation Fluid	At Irrigation pivot during irrigation	Grab sample each calendar month of operation	Na, Ca, Mg, Cl, SO_4, As, Se, U, Ra226, HCO_3, TDS, K, Ba, B, SAR, pH
Soil Water	At two 4 ft lysimeters	June	pH, Electrical Cond., Cl, SO_4, HCO_3, Se, B, U, Ra226
Water	At shallow wells 1 and 2 adjacent to reservoir	Water level quarterly, semi-annual grab water quality	pH, Electrical Cond., Cl, SO_4, HCO_3, Se, B, U, Ra226
Irrigated Soil	4 sample sites per quarter of irrigated area, obtained at depths of 0-6 inches, 6-12 inches	August	Na, Ca, Mg, K, As, Se, B, Ba, Ra226, U, Electrical Cond., SAR, pH
Irrigated Vegetation	One sample at each soil sample location, composited by quarter	August	As, Se, B, Ra226, U, Ba
Visual Inspection	Irrigation Perimeter	Daily during irrigation	Check for runoff

NOTE: Heavy metal analyses in soils will be performed on plant available or ADPTA extractable fraction.

Table 5-10

Mean U-Nat and Radium-226 Concentrations in Soil at the Satellite No. 1 Irrigation Area for the Period 1990 through 1999

Year	0-6 Inches				6-12 Inches			
	U-Nat		Ra-226		U-Nat		Ra-226	
	µCi/g	mg/kg	µCi/g	pCi/g	µCi/g	mg/kg	µCi/g	pCi/g
1990	8.8E-7	1.3	1.6E-6	1.6	6.1E-7	0.9	1.6E-6	1.6
1991	2.1E-6	3.1	9.1E-7	0.9	6.8E-7	1.0	1.1E-6	1.1
1992	3.6E-6	5.3	9.2E-7	0.9	1.6E-6	2.4	1.0E-6	1.0
1993	2.5E-6	3.7	2.4E-6	2.4	1.8E-6	2.7	2.6E-6	2.6
1994	2.6E-6	8.3	1.1E-6	1.1	1.8E-6	2.7	1.4E-6	1.4
1995	6.5E-6	9.6	1.3E-6	1.3	1.1E-6	1.6	1.3E-6	1.3
1996	9.1E-6	13.4	1.0E-6	1.0	2.9E-6	4.3	1.0E-6	1.0
1997	8.0E-6	11.8	1.0E-6	1.0	1.8E-6	2.7	1.1E-6	1.1
1998	1.8E-5	26.1	1.3E-6	1.3	3.8E-6	5.6	1.2E-6	1.2
1999	1.1E-5	16.5	1.1E-6	1.1	2.0E-6	2.9	1.1E-6	1.1

Background Range:

U-Nat	0-6 inches	4.4E-7 to 1.7E-6 µCi/g (0.7 to 2.5 mg/kg)
U-Nat	6-12 inches	6.4E-7 to 1.6E-6 µCi/g (0.9 to 2.4 mg/kg)
Ra-226	0-6 inches	9.9E-7 to 1.4E-6 µCi/g (0.5 to 1.4 pCi/g)
Ra-226	6-12 inches	7.0E-7 to 1.3E-6 µCi/g (0.7 to 1.3 pCi/g)

Table 5-11

Mean U-Nat and Radium-226 Concentrations in Soil at the Satellite No. 2 Irrigation Area for the Period 1996 through 1999

Year	0-6 Inches				6-12 Inches			
	U-Nat		Ra-226		U-Nat		Ra-226	
	µCi/g	mg/kg	µCi/g	pCi/g	µCi/g	mg/kg	µCi/g	pCi/g
1996	5.9E-6	8.8	1.1E-6	1.1	2.0E-6	3.0	1.2E-6	1.2
1997	5.0E-6	7.4	1.3E-6	1.3	2.4E-6	3.5	1.4E-6	1.4
1998	8.7E-6	12.9	1.2E-6	1.2	2.3E-6	3.4	1.3E-6	1.3
1999	4.6E-6	6.9	1.4E-6	1.4	2.2E-6	3.3	1.4E-6	1.4

Background Range:

U-Nat	0-6 inches	1.8E-6 to 3.4E-6 µCi/g (2.7 to 5.0 mg/kg)
U-Nat	6-12 inches	8.8E-7 to 3.3E-6 µCi/g (1.3 to 4.9 mg/kg)
Ra-226	0-6 inches	7.0E-7 to 1.9E-6 µCi/g (0.7 to 1.9 pCi/g)
Ra-226	0-12 inches	8.0E-7 to 2.2E-6 µCi/g (0.8 to 2.2 pCi/g)

Table 5-12

Mean U-Nat and Radium-226 Concentrations in Vegetation at the Satellite No. 1 Irrigation Area for the Period 1991 through 1999

Year	U-Nat		Ra-226
	µCi/kg	mg/kg	µCi/kg
1991	1.4E-3	2.03	1.1E-5
1992	7.8E-4	1.16	3.7E-5
1993	9.2E-4	1.36	1.7E-7
1994	3.9E-7	5.70	9.6E-5
1995	1.1E-4	0.16	1.8E-5
1996	5.8E-3	8.60	2.3E-5
1997	5.0E-4	0.73	1.4E-5
1998	3.6E-3	12.75	1.5E-5
1999	2.1E-2	30.82	1.5E-5

Background Range:

U-Nat 3.4E-3 to 5.3E-5 µCi/kg (0.08 to 5.00 mg/kg)
Ra-226 2.6E-5 to 6.4E-6 µCi/kg

Table 5-13

Mean U-Nat and Radium-226 Concentrations in Vegetation at the Satellite No. 2 Irrigation Area for the Period 1996 through 1999

Year	U-Nat		Ra-226
	µCi/kg	mg/kg	µCi/kg
1996	1.3E-4	0.19	4.4E-6
1997	1.5E-4	0.22	2.4E-5
1998	1.1E-3	1.62	1.3E-5
1999	6.8E-4	1.00	1.4E-5

Background Range:

U-Nat 1.7E-5 to 2.8E-5 µCi/kg (0.03 to 0.04 mg/kg)
Ra-226 1.0E-5 to 1.5E-5 µCi/k

CHAPTER 6
RECLAMATION PLAN

The objective of the Reclamation Plan is to return the affected ground water and land surface to conditions such that they are suitable for uses for which they were suitable prior to mining. The methods to achieve this objective for both the affected ground water and the surface are described in the following sections.

6.1 GROUND WATER RESTORATION

6.1.1 Water Quality Criteria

The primary goal of the ground water restoration efforts will be to return the ground water quality of the Production Zone, on a mine unit average, to the pre-injection baseline condition as defined by the baseline water quality sampling program which is performed for each mine unit. Should baseline conditions not be achieved after diligent application of the best practicable technology (BPT) available, PRI commits, in accordance with the Wyoming Environmental Quality Act and WDEQ regulations, to a secondary goal of returning the ground water to a quality consistent with the use, or uses, for which the water was suitable prior to ISL mining.

For the purposes of this application, the use categories are those established by the WDEQ, Water Quality Division. The final level of water quality attained during restoration is related to criteria based on the pre-mining baseline data from that wellfield, the applicable Use Suitability Category and the available technology and economics. Baseline, as defined for this project, shall be the mean of the pre-mining baseline data, taking into account the variability between sample results (baseline mean plus two standard deviations).

6.1.2 Restoration Criteria

The restoration criteria for the ground water in a mining unit is based on the baseline water quality data collected for each mine unit from the wells completed in the planned Production Zone (i.e., MP-Wells), on a parameter by parameter basis. All parameters are to be returned to as close to baseline as is reasonably achievable. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the mining units shall be the mean plus two standard deviations of the pre-mining values. Table 5-1 of Chapter 5 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 ground water, 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.

Restoration success will be determined after completion of the stability monitoring period. At the end of stability, all constituent concentrations will meet approved standards and will not show strong trends in groundwater deterioration as a result of ISL activities. Upon regulatory approval of the stability monitoring results, the decommissioning of the wellfield will be started.

6.1.3 Ground Water Restoration Method

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

1) ground water transfer;
2) ground water sweep;
3) ground water treatment.

These phases are designed to optimize restoration equipment used in treating ground water and to minimize the volume of ground water consumed during the restoration stage. PRI will monitor the quality of ground water 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 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 PRI based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by PRI.

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 reduce the mobilized species. However, PRI will 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 by such reductants include those of arsenic, molybdenum, selenium, uranium and vanadium.

Once restoration activities have returned the average concentration of restoration parameters to acceptable levels and following concurrence from the WDEQ that restoration has been achieved in the mining area, the stability monitoring stage will begin. This stage consists of monitoring the restored wellfield for six months following successful completion of the restoration stage. Following the stability monitoring stage, PRI will make a request to the regulatory agencies that the wellfield is restored.

6.1.3.1 Ground Water Transfer

During the ground water transfer phase, water will 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.

6.1.3.2 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.

6.1.3.3 Ground Water Treatment

Either following or in conjunction with the ground water 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.

Ground water recovered from the restoration wellfield will be passed through the 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 ground water may be passed through a de-carbonation unit to remove residual carbon dioxide that remains in the ground water after mining.

At any time during the process, an amount of reductant sufficient to reduce any oxidized minerals may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone ground water reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements through reduction of these 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 contaminated ground water, 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, stored for use in the mining process, or sent to the waste water disposal system. 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 ground water 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 ground water treatment phase to return the ground water 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 ground water 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.

6.1.3.4 Restoration Monitoring

During restoration, lixiviant injection is discontinued and the quality of the ground water is constantly being improved back to near baseline quality, 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 underling 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.

6.1.4 Restoration Stability Monitoring Stage

Following concurrence from the WDEQ that restoration has been achieved in the mining area, a six month stability period is assessed to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program is performed during the stability period:

1. The monitor ring wells (M-Wells) are sampled once every two months and analyzed for the UCL parameters, chloride, total alkalinity and conductivity; and

2. At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 5-1 of Chapter 5.

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 cannot be monitored within 65 days of the last sampling event.

6.1.5 Well Plugging

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

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

1. When practicable, all pumps and tubing are removed from the well.
2. All wells are plugged from total depth to within 5 feet of the collar with a nonorganic well abandonment plugging gel formulated for well abandonment and mixed in the recommended proportion of 10 to 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.
3. The casing is cut off at least two feet below the ground surface. Abandonment fluid is topped off to the top of the cut-off casing.
4. A cement plug is placed at the top of the casing, 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.

6.2 SURFACE RECLAMATION AND DECOMMISSIONING

6.2.1 Introduction

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 landowner, i.e. the rancher desires to retain roads or buildings. 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.

Following regulatory approval of ground water restoration in any given wellfield, and at least 12 months prior to the planned commencement of facility decommissioning or surface reclamation in a wellfield area, PRI will submit a final (detailed) decommissioning plan to the NRC for review and approval. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the SR-HUP and Reynolds Ranch Projects.

6.2.2 Surface Disturbance

The primary surface disturbances associated with solution mining are the sites containing the Central Processing Plants, Satellite Facilities, and evaporation ponds. Surface disturbances also occur during the well drilling program, pipeline installations, and road construction. These more superficial disturbances, however, involve relatively small areas or have very short-term impacts.

The Smith Ranch Central Plant and Main Office Complex is located within the historic Bill Smith Mine Site. Therefore, construction of the facilities for ISL mining did not create any new disturbance areas. Disturbances associated with the evaporation ponds, ion exchange Satellites, 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 are limited, and are reclaimed and reseeded as soon as weather conditions permit. Vegetation will normally be reestablished over these areas within two years. Disturbance for access roads at the SR-HUP is also limited as a network of roads is already in place to most wellfield areas and throughout the project area. However, access roads at the Reynolds Ranch amendment area will be constructed, and for new wellfield areas at the SR-HUP.

6.2.3 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil is salvaged from building sites (including Satellite buildings), permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which are determined during final wellfield construction activities. It is estimated that a maximum of 250 acres of topsoil will be salvaged, stockpiled, and reapplied throughout the life of the SR-HUP and Reynolds Ranch projects.

As described in Appendix D-7 SOILS previously submitted for SR-HUP and Appendix D-7 of this amendment application for Reynolds Ranch, topsoil thickness varies within the permit area from non-existent to several feet in depth. Topsoil thickness is usually greatest in, and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil stripping depths may vary from 0 to up to several feet in depth, depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, the field mapping and SCS Soil Surveys will be utilized to determine approximate topsoil depths. The extent of topsoil stripping and stockpiling for the remainder of the project's life will be very limited as no new major facilities or roads will require construction.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles are generally located on the leeward side of hills to minimize wind erosion. Stockpiles are not located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles are seeded as soon as possible after construction with the permanent seed mix. In accordance with WDEQ-LQD requirements, all topsoil stockpiles are 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. When use of the mud pit is complete, all subsoil is replaced and topsoil is applied. Mud pits only remain open a short time, usually less than 30 days. Similarly, during pipeline construction, topsoil is stored separate from subsoil and is replaced on top of the subsoil after the pipeline ditch is backfilled. The success of revegetation efforts at the Smith Ranch and Highland sites show that these procedures adequately protect topsoil and result in vigorous vegetation growth.

6.2.4 Revegetation Practices

Revegetation practices are 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 and pond areas will be seeded with vegetation to minimize wind and water erosion. After topsoiling for the final reclamation, an area will normally be seeded with oats to establish a stubble crop, then reseeded with grasses the next growing season. 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. The long term seed mix consists of one or more of the native wheatgrasses (i.e. Western Wheatgrass, Thickspike Wheatgrass). Typical seeding rates are 12-14 lbs of pure live seed per acre.

Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent mix typically contains native wheatgrasses, fescues, and clovers. Typical seeding rates are 12-14 lbs of pure live seed per acre.

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 Areas 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.

6.2.5 Site Decontamination and Decommissioning

When ground water restoration in the final mining unit is completed, decommissioning of the Central Processing/Office areas at both Smith Ranch and Highland and the remaining facilities (evaporation ponds, purge storage reservoirs, radium ponds) will be initiated. In decommissioning the Satellite plant, the process equipment will be dismantled and sold to another licensed facility, or decontaminated in accordance with Regulatory Guide 1.86 "Termination of Operating Licenses for Nuclear Reactors" and "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material". Materials that cannot be decontaminated to an acceptable level will be disposed in an NRC approved facility. After decontamination, materials that will not be reused or that have no resale value, such as building foundations, will be buried on-site.

The Central Processing/Office Areas will be contoured to blend with the natural terrain, surveyed to ensure gamma radiation levels are within acceptable limits, topsoiled, and reseeded per the approved Reclamation Plan.

After all liquids in the evaporation ponds, purge storage reservoirs, and/or radium ponds have evaporated or been disposed via deep disposal well, or irrigation, the precipitated solids and pond liners will be removed and disposed of in a licensed facility. The area will then be contoured to blend with the natural terrain, surveyed to ensure gamma levels are nor exceeded, topsoiled, and reseeded per the approved plan.

Gamma surveys are also conducted during the decommissioning of each wellfield. Material identified during the gamma surveys as having contamination levels requiring disposal in a licensed facility will be removed, packaged (if applicable), and shipped to an NRC approved facility for disposal.

In the event that soil cleanup is required during decommissioning of facilities and wellfield areas, the cleanup criteria for radium and other radionuclides (uranium and thorium) will be based on the radium benchmark dose approach of 10 CFR 40, Appendix A, Criterion 6(6).

6.2.6 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.

6.2.7 Financial Assurance

In accordance with existing NRC license conditions and WDEQ permit requirements, PRI will maintain surety instruments to cover the costs of reclamation of each operation, including the costs of ground water restoration, the decommissioning, dismantling and disposal of all buildings, waste water ponds and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision is submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, PRI revises the surety instrument to reflect the revised amount.

PRI maintains several approved Irrevocable Letters of Credit in favor of the State of Wyoming for the various operations. Costs for the reclamation of the Reynolds Ranch Operation will be included in the surety estimate for the Smith Ranch Uranium Project once construction commences. Currently (December 2004), the amounts of the surety estimates are as follows:

Smith Ranch-Highland Uranium Project	
- Smith Ranch Facilities	$15,695,700
- Highland Uranium Project Facilities	$22,402,000
North Butte/Ruth Facilities	$183,400
Gas Hills Facilities	$803,600

CHAPTER 7
ENVIRONMENTAL EFFECTS

The objective of the mining and environmental monitoring program is to conduct a mining operation that is viable and environmentally responsible. The environmental monitoring programs used to ensure that potential sources of pollution are controlled and monitored are presented in Chapter 5. Chapter 7 also discusses and describes the degree of unavoidable environmental change, the short-term and long-term impacts due to the operation and discusses potential impacts of possible accidents associated with the project.

7.1 SITE PREPARATION AND CONSTRUCTION

Impacts from site preparation and construction are limited to the local soils and vegetation. The Central Processing/Office complexes at both Smith Ranch and Highland are located within previously constructed uranium mine/mill sites. Therefore, the use or construction of these facilities did not result in new surface disturbance. Implementation of the ISL mining project has extended the operating life of the site and deferred final reclamation. During this period, livestock grazing will continue to be excluded from limited areas where mining related activities are occurring.

Drilling wells and installation of pipelines result in temporary disturbance to the soils and vegetation in those areas; however, as demonstrated by current practices, the impact is minimal. Topsoil is bladed to one side, then re-spread as soon as construction is complete and the area seeded. Vegetation in these areas is normally re-established within two years of disturbance. Implementation of the project resulted in livestock being excluded from some of the wellfield areas, however, this will vary with the grazing level and the landowner's desires.

Surface disturbances associated with the evaporation ponds and access roads is for the life of these activities as the topsoil will be removed from these areas and stockpiled prior to construction. When these facilities are no longer needed for the operation, the areas will be re-contoured, top-soiled and re-seeded. The primary impact of these activities will be the exclusion of livestock and wildlife from the evaporation pond areas for the life of the ponds. It is expected that grazing will be excluded from as much as 1200 to 1400 acres over the life of the project. After the project is complete, all areas will be reclaimed and the pre-mining use restored. Therefore, there will be no long-term surface impact from the operation.

There will be no subsidence as a result of the operation. The proposed in-situ leach process removes uranium minerals from the surfaces of the host formation along with trace quantities of other elements similarly deposited on the host sandstone and clays. The demonstrated nature of this process is that the physical structure of the host matrix is unaffected. For this reason, subsidence does not result from in situ leaching, nor does in situ leaching of uranium alter the potential for subsidence. Because there is no potential for subsidence as a result of the in situ mining process, no subsidence mitigation or control plan has been included with this application.

7.2 EFFECTS OF OPERATIONS

As shown by numerous years of monitoring data collected at both the Smith Ranch and Highland operations, no significant or measurable impacts to air or surface water quality are anticipated as a result of the operation.

7.2.1 Impact to Ephemeral Drainages

Within the current SR-HUP permit area, the main drainages collect surface precipitation and snowmelt in a roughly northwest to southeast direction along Sage Creek. Within the Reynolds Ranch amendment area, the main drainages collect surface precipitation and snowmelt in a roughly southwest to northeast direction along Duck Creek, Willow Creek, and Brown Springs Creek. All flow within both areas is ephemeral with no intermittent or perennial stream flows. The volume of flow from these ephemeral drainages is seasonal and directly related to local climatic conditions. The climate is semi-arid with an overall precipitation averaging 13 inches per year. Snow accumulations are generally light and overall contribute little to the total annual precipitation. Most of the precipitation comes in the form of local potentially high intensity thunderstorms.

Mining activities may sometimes come in contact with ephemeral drainages as a result of roads or wellfield operations. The travel roads include two track and/or established roadways. To the extent possible, existing travel roads are utilized when travelling within the permit area. In instances where ephemeral drainages may be impacted by mining operations, whether by road or wellfield operations, the appropriate protection measures will be afforded to minimize impact to the drainage including prevention of erosion.

The primary surface disturbances associated with in-situ leaching occur with well drilling, pipeline installations, road and wellfield construction. These disturbances involve relatively small areas and/or have a very short-term impact. Continuing efforts are made to keep short-term disturbances caused by these operations to a minimum.

Activities associated with drilling include construction of drill pits and preparation of drill sites. Once a drill site has been selected, the appropriate topsoil protection methodology is employed. Erosion protection measures which may be taken, based on the site specific requirements, include the placement of hay bales, sedimentation breaks, placement of water contour bars, grading and contouring both before and/or after drilling operations to minimize erosion.

Road construction is kept to a minimum by utilizing existing roads when possible. When designing and constructing new roads, weather, elevation contours, land rights, and drainages are considered. When constructing new roads, efforts are made to cross ephemeral drainages or channels at right angles to enhance erosion protection measures. However, given that each specific site is different, it may not always be feasible or warranted to construct roads or crossings at right angles or along elevation contours. In such cases, appropriate erosional measures are considered, examined, and utilized to minimize erosion.

During the construction of wellfields, many activities are on-going including drilling, casing of wells, well development, pipeline construction, header house construction, lateral pipeline placement, and access road construction. These activities may have a short term or temporary effect on erosion. To reduce the potential impact of these activities, erosion protection measures are employed based on site specific conditions. These measures may include; the placement of hay bales, sedimentation breaks, placement of water contour bars, installing culverts, grading and contouring to help minimize erosion.

In steep grade areas, in addition to the previously noted erosion protection measures, the disturbed areas are re-seeded as soon as possible after construction is completed. This seeding commences at the appropriate time for optimum growth, whether the next spring or fall planting, and weather permitting.

In areas where wells may be constructed in drainage areas, impacts are minimized through the use of necessary erosion protection structures including but not limited to; placement of hay bales; construction of water contour bars; installing culverts; flow diversion structures; grading and contouring; application of rip rap; and designated traffic routes. Traffic within the drainage bottoms is limited to work activities necessary to construct and service wells. Wells that are constructed in significant drainages where runoff has the potential to impact the wellhead will have added wellhead protection. This protection will vary depending on the drainage and its potential for runoff. Protection measures may include barriers surrounding the wellhead, protective steel casing, and cement blocks or other means to protect the wellhead from damage that may be caused by runoff.

7.2.2 Surface Water Impacts

The potential impacts to surface waters as a result of operations at the Smith Ranch-Highland Uranium Project and Reynolds Ranch amendment area are considered to be minimal and temporary. There is, however, the potential for impacts to occur during wellfield construction and reclamation activities. During leaching, restoration, and after reclamation, the surface will be vegetated and contoured to minimize temporary effects to surface water quality.

The physical presence of the surface facilities including wellfields and associated structures, access and haul roads, Satellite IX buildings, office buildings, pipelines, Central Processing Plant facilities and other structures associated with the ISL 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 sites, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage are within and adjacent to the permit area. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts are 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.

During wellfield construction and reclamation, the potential loss of vegetation to those activities may cause increased opportunities for erosion and potential movements of sediments into drainages. Where possible, contouring is used to minimize the potential effects of erosion. Upon completion of construction and reclamation, and as soon as feasible considering growing seasons, re-vegetation work is started using either cover crops or a native seed mix to stabilize the soil and minimize erosion due to runoff.

7.2.3 Ground Water Impacts

Over the long-term, the groundwater concentration of some parameters in the ore zone may slightly vary compared with the initial condition; however, any changes are minimal and will not alter the potential use category of these waters as defined by the Wyoming Department of Environmental Quality. The most significant water impact will be the withdrawal and beneficial use of about 20,000 acre feet of groundwater over the life of the project; approximately the same volume as was produced from the Bill Smith Mine between 1974 and 1982. Most of the water removed will be returned to the environment after treatment and discharge or used for irrigation, etc. The remaining water removed from the formation will be evaporated or disposed through authorized deep well injection.

7.2.4 Air Quality Impacts

The potential impacts to air quality as a result of ISL mining and processing of uranium are minimal and temporary. During wellfield and plant construction, the principal emissions to air are suspended particulates and gaseous pollutants from vehicle and drill rig exhausts, dust from vehicular traffic on unpaved roads, and dust from disturbed and unprotected soils. Throughout the life of the project, drill rigs and associated mobile equipment will be used during wellfield construction. Diesel powered drill rigs and water trucks associated with wellfield delineation and development, act as non-stationary sources of air pollutants. The drilling activities will proceed through the various wellfields with each drill hole location requiring one to four days of work. Most other equipment associated with wellfield development and construction will experience intermittent use, and its impact on air quality will be negligible. Other mobile vehicles will either be gasoline or diesel powered on-road cars and trucks typically equipped with required emission control devices.

Dust emissions from wind erosion is minimized by promptly reclaiming disturbed soil and establishing vegetative cover to wellfields and soil stockpiles.

Air quality impacts related to operations are largely limited to airborne effluents generated from processing. Air pollution consisting of dust suspended and exhaust emissions by vehicle traffic associated with routine wellfield maintenance is minimal.

Dissolved radon gas, generated by its dissolution from processing solutions, may escape to the atmosphere and potentially adversely impact air quality in the wellfields and immediate vicinity of processing buildings. Radon can be vented to the atmosphere from the wellfields at each wellhead or from the process equipment in the IX facility or the processing plant. PRI is using pressurized downflow IX columns, and therefore radon releases occur only when individual IX columns are disconnected from the circuit and opened to remove the resin for elution. Additionally, the yellowcake dryers could potentially release airborne particulate emissions, including natural uranium and radon daughters, to the environment. Previous modeling of the radiological effects of these emissions upon the local population was completed using the MILDOS-AREA computer code developed by NRC. A more detailed discussion of this model can be found in Section 7.3.

7.2.5 Wildlife Impacts

7.2.5.1 Endangered Species

There are no known endangered species or endangered species habitat within the project area. Therefore, there is no impact to endangered species from the proposed project.

7.2.5.2 Wildlife

The species observed on the permit area are common throughout eastern Wyoming and many other areas of the Rocky Mountain region. Many individuals of the small animal species such as the small burrowing mammals, snakes, lizards, and arthropods that now live in areas that will be disturbed by the proposed project will be destroyed when the vegetation is removed. Since a relatively small number of reptiles inhabit the disturbed portion of the permit area, the impact on these animals is relatively minor. Vegetation removal also has a relatively minor effect on insects and other arthropods because of their ability to quickly re-establish populations on reclaimed area. However, the loss of arthropods does decrease the amount of food available to insectivorous animals, including many species of birds. More small mammals (mice, rats, and ground squirrels) are lost as a result of vegetation removal than any other group of vertebrates. The number of animals lost in any area will generally be proportional to the number of acres disturbed. The short average life cycle of small mammals means that the loss in potential biomass accumulates during each year of project operation and rebounds proportionally once project areas are revegetated and released. It is estimated that as much as 8.4 to 120 lbs/yr of rodent biomass may be lost throughout the life of the recovery plant and associated facilities. A total of 84 to 1200 lbs/yr of rodent biomass may be lost as a result of wellfield installation and operation. Construction and operation of the additional Satellite facilities may result in a loss of 4.2 to 60 lb/yr of rodent biomass. While this does not significantly affect the long-term maintenance of small mammal populations in the area, it does reduce the amount of food available to predatory animals such as raptors, coyotes, and badgers. Whittaker (1970) states that the efficiency of food utilization by primary carnivores may be as high as 15 percent. If this figure is used as a rough estimate, then project operations may result in the loss of a maximum of 14 to 198 lbs/yr of carnivore biomass. Construction of the future additional facilities could result in a loss of 1 to 9 lbs/yr of carnivore biomass.

Highly mobile species, such as the larger mammals (Pronghorn Antelope and Mule Deer) and most birds, will be able to escape the disturbed area. However, the movement of those animals into adjacent undisturbed habitat may result in increased competition for food, shelter, territory, mates, and other necessities. This may result in the loss of some of these animals.

In terms of economic value and public interest, the most important wildlife species that utilizes the permit area is probably the Pronghorn Antelope. It is estimated that the density of antelope in this region is five to seven animals per square mile and that they remain in the area throughout the year. Consequently, the loss of 40 acres of vegetation due to the recovery plant and associated facilities may result in a reduction in antelope carrying capacity on the permit area by less than one (1) animal, while mining activities on an average of 40 acres/year may reduce Antelope carry capacity by the same amount. Operation of the additional Satellite facilities (an average of 80 acres/year) could reduce antelope carrying capacity by one (1) animal.

The increased number of people in the permit area could have an additional impact on Antelope and other wildlife populations, since some animals are likely to be killed by increased vehicular traffic. These additional wildlife losses are not expected to result in any long-term decrease in any wildlife populations, including antelope, since the number lost each year is expected to be a very small percentage of the total population.

Other than actual removal of vegetation and the potential of accidents resulting from activity in the area, project activities are not expected to significantly affect the antelope population. These animals do not appear to be disturbed by mining and processing activities similar to those proposed for this project. This has been well documented at the Highland Uranium Project and the Smith Ranch Operations where Antelope and Mule Deer are commonly observed near active mining areas without any noticeable concern. No reduction in the antelope population has been observed in the vicinity of that facility since it was originally constructed by Exxon in the early 1970's. The Mule Deer population of the area has shown a significant increase since the 1970's.

Continued operation of the SR-HUP/Reynolds Ranch should not have a significant effect on raptors utilizing the permit area due to the small percentage of prey that would be lost as a result of vegetation removal.

Wildlife species will re-invade disturbed areas after they are reclaimed. The time required for re-invasion is a function of the habitat requirements of each species. Herbivores capable of feeding on grasses and weedy plant species (e.g., deer mouse, thirteen-lined ground squirrel, mourning dove, and horned lark) would be the first animals to establish themselves on re-vegetated areas. Those animals also nest on the ground and prefer open habitats. Predaceous arthropods, such as ground beetles and assassin bugs, and insectivorous animals, such as the grasshopper mouse, meadowlark, loggerhead shrike, and horned lizard, would also be expected to be early invaders of re-vegetated areas. Several other species of animals (such as sage grouse) that are heavily dependent on sagebrush and other shrubs for food, cover, and/or nesting could take several years to successfully re-invade reclaimed areas because of the time required for shrubs to become re-established.

Although it is likely that noise has some effect on certain species of wildlife, the EPA states that a thorough literature search "revealed an almost complete lack of information concerning the effects of noise on wildlife" (EPA, 1972). Specific effects of mining noise on the wildlife in the permit area cannot be determined; however, from experience at similar mine sites, it is likely that most species will quickly become accustomed to noise from operating machinery. For example, at the SR-HUP, the deer and Pronghorn Antelope are commonly observed within active mining and drilling areas and they display no noticeable concern. Although this does not prove that noise created by mining has no effect on wildlife, it tends to indicate that effects, if any, are minor.

Impacts to wetlands and surface water sources available to wildlife are expected to be minimal during the life of the project. At this time, no disturbances to any wetlands or water sources are planned. If, in the future, a change in the mine plan should involve an impact to a wetlands area or water source, appropriate agencies will be contacted for development of a mitigation plan. All proposed drainage crossings will comply with appropriate regulations.

7.3 RADIOLOGICAL EFFECTS

Exposure pathways to radiological materials at ISL mining operations are considerably different from pathways associated with other uranium mining and milling methods. The environmental advantages of the ISL mining method and the processing of uranium for this project are two-fold. First, the majority of the radioactive daughter products remains underground and is not removed with the uranium. Second, the use of modern vacuum dryers reduces the potential radiological air particulate releases typically associated with conventional uranium milling facilities to insignificant levels (FEIS, NUREG-1508, 1997).

7.3.1 Exposure Pathways

There are no routine particulate emissions from the facility. Liquids released from the facility are treated on site to reduce radiation/ concentration levels of uranium and radium to levels acceptable for release to unrestricted areas as specified in 10 CFR 20 Appendix B Table II (1992). The only avenue, which is considered a potentially significant radiological exposure pathway for the proposed project, is the release of gaseous radon-222 to the atmosphere.

The effects of radon gas release from wellfields, Satellites, Central Processing Facilities, and ponds during production and restoration were modeled with the use of MILDOS-Area, a dispersion model approved by NRC for estimating potential radiological impacts caused by air emissions. The 1997 version of the model allows comparison of specific receptor site air concentrations with the ALCs given in 10 CFR 20.

7.3.2 Background Radiation Exposures to the Population

The major population areas within 50 miles of the recovery plant site are the towns of Glenrock with a population of approximately 2,000 (17 miles SSW), Douglas with a population of approximately 5,000 (23 miles SE), and Casper with a population of approximately 52,000 (36 miles WSW). A regional population within 50 miles of the plant site is approximately 59,000 persons.

In the FEIS for the Teton ISL Project (NUREG-0925, Section 4.5.7), the NRC staff stated the primary sources of radiological exposure to the population in the vicinity of the Teton project were naturally occurring cosmic and terrestrial radiation (174 mRem/yr), naturally occurring radon-222 (up to 625 mRem/yr), and diagnostic medical procedures (75 mRem/yr. Since the Teton ISL project is only some 10 miles from the Smith Ranch Central Processing Facilities, it can be assumed that natural background radiological exposure are similar in nature at Smith Ranch.

7.3.3 Annual Population Doses from the Project

Annual population doses computed for the SR-HUP by MILDOS-Area for the period of maximum mine emissions of radon-222 indicated a dose of 0.3 person-Rem/yr from mine activities to persons living within 50 miles of the site. Annual population doses computed by MILDOS-Area for the Reynolds Ranch Satellite operations indicate the highest effective population dose for people within 50 miles (80 km) is 2 person-Rem/yr. This dose is not significantly higher than the dose determined previously for SR-HUP, however, the difference may be accountable to a greater number of people at downwind residences closer to the Reynolds Ranch Satellite area.

7.3.4 Dose to Individuals

A series of nearby receptors were assessed in the MILDOS-Area model runs. These receptors included nearby dwellings and ranches, towns as far distant as Casper, and a series of hypothetical receptors placed around the perimeter of the project on the permit boundary. These last receptors included locations downwind of the satellites and the main processing facility.

The highest radon working level at a SR-HUP permit boundary receptor with access to an unrestricted area was 7.99E-05 WL compared to an ALC (allowable concentration) of 1.10E-03 WL.

The Total Effective Dose was predicted to be 2.24 mRem/yr at this receptor (downwind of the main processing facility). Dose to Bronchi at two unrestricted area boundary receptors were more that 25 mRem/yr but within the error of the model. These two locations are monitored for dosage during the period of maximum mine activity.

The maximum annual Total Effective Dose from the Reynolds Ranch Satellite was predicted to be 4 mRem/yr at the nearest occupied, downwind residence (Reynolds Ranch residence) during the estimated period of maximum mine activity. This dose is well below the 10CFR20 limit of 100 mRem/year. The results of the MILDOS-Area conducted for the Reynolds Ranch Satellite area are provided in Attachment 7-1 of this Chapter.

7.3.5 Radiological Impacts on Biota Other than Man

Standard Operating Procedures for spill prevention and clean-up, restrictive fencing, and equipment design, restrict contact between native biota and the radioactive materials accumulated during mining. Some small mammals, insects, and birds will have occasional contact with materials containing small amounts of radioactivity. No significant impact is expected from this contact.

The primary radioactive emission from the project is airborne radon-222. Since the levels are closely monitored within the restricted area for worker safety, it is reasonable to assume that wildlife mobility and limited access will lead to lower exposures to wildlife in comparison to workers. In unrestricted areas, radiological impacts on biota other than man should be at least as low as the impacts predicted for man.

7.4 NONRADIOLOGICAL EFFECTS

7.4.1 Nonradioactive Airborne Effluents

It is not anticipated that there will be a significant environmental impact from the nonradioactive airborne effluent releases. Nonradioactive airborne effluents at the SR-HUP/Reynolds Ranch will be limited to fugitive dust from access roads and wellfield activities and non-radioactive particulate emissions from the Highland Yellowcake Dryer and Packaging Room scrubber exhaust stacks. The project is permitted under WDEQ-AQD Air Quality Permit No. OP-202.

Fugitive dust emissions will be minimal and dust suppressants will only be used if conditions warrant their use. When operational, WDEQ-AQD Permit No. OP-202 requires particulate emission testing of the Yellowcake Dryer (which is fueled with natural gas) and Yellowcake Packaging Room scrubber exhaust stacks annually. Currently (December 2004) the Highland Central Plant is not operational.

7.4.2 Nonradioactive Liquid Effluents

It is not anticipated that there will be any nonradioactive liquid effluents discharged to the environment during the operation of the SR-HUP or Reynolds Ranch Satellite other than those discussed in Section 4.2 of Chapter 4. During ground water restoration, treated water may be surface discharged under a National Pollutant Discharge Elimination System (NPDES) permit. In the event that restoration water is surface discharged, the treated water will be monitored to ensure that the NPDES discharge limits are not exceeded.

7.5 EFFECTS OF ACCIDENTS

7.5.1 Tank Failure

Under normal operating conditions the process fluids are contained in the process vessels and piping circuits within the CPP and Satellite buildings. Alarms and automatic controls are used to monitor and keep levels within prescribed limits. In the unlikely event of a failure of process vessel or tank in a process building, the fluid would be contained within the building, collected in sumps and pumped to other tanks or to a lined evaporation pond. The area would then be washed down with the water contained in a similar manner eliminating any environmental impact from the failure.

Failure of a tank outside the process building could result in the spill of leach solution to a retention or containment system. The liquids would then be pumped to another tank or lined pond. The environmental impact of such an accident could result in some soils being contaminated requiring controlled disposal. All areas affected by such a failure or leak would be surveyed and any contaminated soils or material requiring controlled disposal would be removed and disposed of in accordance with NRC and/or State requirements. Therefore, there would be no long-term impact from such an accident.

7.5.2 Pipeline Failure

The rupture of a pipeline between the CPP or a Satellite and a wellfield could result in a loss of either pregnant or barren solutions to the surface. To minimize the volume of fluid that could be lost, the pipeline systems are equipped with high pressure and low pressure shutdown systems and flowmeters. The systems also are equipped with alarms so the operator will be alerted immediately if a major malfunction occurs. If the volume and/or concentration of the solutions released in such an accident did constitute an environmental concern, the area would be surveyed and the contaminated soils would be removed and disposed according to NRC and/or State regulations. The pipelines will normally be buried approximately five feet below the surface and will be of a corrosion free high density polyethylene material. Therefore, the probability of such a failure after the pipelines have been tested and placed in service is considered small.

A worst case scenario for a pipeline would involve a major pipeline rupture going unchecked for an hour at full operating capacity. This event could potentially release 240,000 gallons of barren or pregnant lixiviant to the adjacent environment. Such an event would involve a complete pipeline rupture, and a failure by operators to detect the rupture in a timely manner. The NRC staff in their review of Hydro Resources Inc. Final Environmental Impact Statement for the Crownpoint Uranium Solution Mining Project, (NUREG-1508, 1997),indicate that the industry experience has been that major pipeline ruptures are not complete breaks in the line, but are more likely smaller openings in the pipes such as cracks, punctures and other types of partial line breaks. Monitoring systems typically enable operators to detect a leak, determine its cause, and shut down the appropriate pumps in less than 15 minutes. According to the NRC Staff in the Crownpoint EIS, actual experience for pipeline ruptures often represents less than 25% of the volume of lixiviant within the pipeline is spilled in the worst-case scenario, and in actuality, most leaks and spills occur through minor cracks or disconnection on smaller pipes.

7.5.3 Fires and Explosions

The fire and explosion hazard of the CPP will be minimal as the plant does not use flammable liquids in the recovery process. Natural gas used for building heat would be the primary source for a potential fire or explosion. In the CPP the uranium will be in solution, adsorbed on ion exchange resin, wet yellowcake slurry, or as a dried yellowcake powder contained in a sealed drum or the vacuum dryer. An explosion, therefore, would not appreciably disperse the uranium to the environment. Spilled liquids or slurries would be confined to the building sump or to the runoff control system. The sealed drums and Vacuum Dryer at Smith Ranch would contain the dried yellowcake powder, and any potential releases would be contained within the Dryer Building.

In the wellfields, injection and recovery well piping systems are manifolded for ease of operational control. Piping manifolds, submersible pump motor starters/controllers, and gaseous oxygen delivery systems are situated within electrically heated, all weather buildings. These are commonly referred to as "Headerhouses". An accumulation of gaseous oxygen would be the primary source for a potential fire or explosion. Such an event could result in the rupture of a leaching solution pipeline within the building and a spill of leaching solution. Both the gaseous oxygen and primary leaching solution lines entering each headerhouse are equipped with automatic low pressure shut off valves to minimize the delivery of oxygen to a fire or of liquids to a spill. Additionally, each Headerhouse is equipped with a continuously operating exhaust fan that would assist in preventing the build-up of oxygen in the building.

7.5.4 Tornadoes

The SR-HUP/Reynolds Ranch amendment area is located in Converse County Wyoming, in which 30 tornado touch downs were recorded in a period from 1950 through 1995. Of those, 14 tornadoes were classified as F0 with wind speeds of 40-72 miles per hour and described as a gale tornado. F1 tornadoes described as moderate with wind speeds of 73-112 miles per hour accounted for 14 tornadoes. Finally, 2 were classified as F2 with wind speeds of 113-157 miles per hour and described as significant tornadoes. (Tornado Project, State Data from the Storm Prediction Service – Wyoming, 1999). The F scales for the tornadoes is based on the Fujita Scale that is commonly used to measure the relative strength of a tornado based on the destruction.

The probability of occurrence of a tornado in the area in which the project is located is about 3×10^{-4} per year (NUREG 0706 – Section 7.1.3.1). The area is categorized as Region 3 in relative tornado intensity. For this category, the wind speed of the "design" tornado is 240 mph, of which 190 mph is rotational and 50 mph is translational. None of the plant structures are designed to withstand a tornado of this intensity.

The nature of the operation is such that little more could be done to secure the facility with advance warning than without it. The yellowcake product has the highest specific activity of any material processed at the site. However, since the material would be a wet slurry or as a contained dry powder, the potential environmental effects would be minimal. The strongest tornado recorded in Converse county is an F2. Based on the Fujita Scale, the type of damage that can be expected from an F2 tornado is roof damage, unsecured mobile homes pushed off foundations, and light structures severely damaged or destroyed. At the SR-HUP, all of the dried yellowcake is contained and stored in sealed 55 gallon drums or in the vacuum dryer within an engineered metal building. Because of the density of the material, it is not reasonable to expect the container to become mobile due solely to the winds of the tornado. However, if a portion of the building superstructure were to collapse where the dried yellowcake is stored, there is a possibility that a portion of the drums could be crushed and potentially release yellowcake.

In the Generic Environmental Statement for Uranium Milling, (NUREG-0706, NRC, 1980), NRC staff assumed 25,100 lbs. of dry yellowcake, the equivalent of 26 55-gallon drums, were picked up by a tornado. From the model study, NRC staff concluded the maximum radiation exposure due to the accident would occur at a distance of 2.5 miles from the facility, and the 50 year dose commitment to the lungs of an individual was estimated to be 8.3×10^{-7} rem. For the model site, the 50 year dose commitment to an individual of the public at the fenceline, 1,600 feet from the facility, and at the nearest residence, 6,500 feet from the facility, would be estimated to be 2.2×10^{-7} rem and 4.8×10^{-7} rem, respectively.

7.5.5 Well Casing Failure

A casing failure in an injection well would have the potential for the most significant environmental impact because the leaching fluid is being injected under pressure. It is possible that this type failure could occur and continue for several days before being detected by the monitoring system. If such a failure did occur, the defective well would either be repaired or plugged and abandoned. If contamination of another aquifer was indicated, wells would be drilled and completed in the contaminated aquifer then produced until concentrations of leaching solution constituents were reduced to acceptable levels. With proper casing, cementing and testing procedures, the probability of such a failure is very low.

To minimize the risk of a casing failure significantly impacting the environment, should one occur, monitor wells were completed in the aquifers above and below the ore zone. The fluid levels and quality of the water in the adjacent aquifers routinely is monitored during mining to check for fluid movement into these aquifers. In addition, casing integrity tests will be performed on all injection wells prior to using the wells for injection and after any work that involves entering a fiberglass or PVC cased well with a cutting tool, such as a drill bit or underreamer.

Failure of a production well casing would normally not cause fluid migration to overlying aquifers because the production wells operate at pressures lower than the aquifer pressures.

7.5.6 Leakage Through Old Exploration Holes

Movement of leaching solution between aquifers through old exploration holes in the project area is very unlikely. The drill holes were left full of bentonite abandonment mud when they were abandoned and the mud is an effective seal against fluid interchange between the various aquifer units penetrated by the drilling. The rapid swelling and bridging of the isolating shales between the sandstone aquifer units provides additional well bore sealing.

However, to ensure there is no communication between aquifers, monitor wells completed in aquifers above and below the ore zone are checked routinely for changes in aquifer pressure and water composition. In addition, pump tests are conducted prior to start-up of a mining unit to demonstrate no significant communication between the aquifers exists. Should leakage between aquifers through old drill holes be indicated during the tests, the old holes would be re-entered and plugged. If contamination of another aquifer was indicated, wells would be drilled and completed in the contaminated aquifer, water samples collected, and, if needed, the wells produced to reduce the concentration of any leaching solution fluids to acceptable levels.

7.5.7 Transportation Accidents

Materials transportation to and from the processing sites can be classified into four categories:

1) Shipments of dried yellowcake product from the Central Processing Plant to an offsite licensed facility;

2) Shipments of resin to the Central Processing Plant from the Satellite IX Facilities;

3) Shipments of yellowcake slurry from offsite licensees to the central processing plant for drying; and

4) Shipments of process chemicals from suppliers to the processing facilities.

7.5.7.1 Shipments of Dried Yellowcake Offsite

Yellowcake produced by the SR-HUP, and its shipment for further processing, does not differ significantly from yellowcake produced at a conventional mill. The NRC has evaluated transportation accidents associated with yellowcake shipments from uranium mills and published the results in a generic

Environmental Statement, (NUREG-0706, NRC, 1980). The following analysis is based upon that earlier study.

The dried yellowcake is generally packed in 55-gallon, 18-gauge steel drums holding an average of 950 lbs. and classified by the Department of Transportation as Type A packaging (49 CFR Parts 171-189 and 10 CFR part 71). The yellowcake is shipped by truck approximately 1,200 miles to a conversion plant, which processes the yellowcake in the first step of manufacturing reactor fuel. An average truck shipment contains approximately 45 to 52 drums, or up to an average net weight of 42,000-lbs yellowcake. Using an average annual production rate of 2 million lbs. U_3O_8 or 2.4 million lbs. yellowcake, approximately 57 such shipments would be required annually. By increasing the annual production rate to 3.5 million lbs. U_3O_8 or 4.2 million lbs. yellowcake, approximately 100 such shipments would be required annually.

Based on published accident statistics, the average probability of a truck accident is 2.1×10^{-6}/mi (from NUREG-0706). Truck accident statistics include three categories of events: collisions, non-collisions, and other events. Collisions are between the transport vehicle and any other objects, whether moving vehicles or fixed objects. Non-collisions are accidents involving only the one vehicle, such as when it leaves the road and rolls over. Other events include personal injuries suffered on the vehicle, persons falling from or being thrown against the standing vehicle, cases of stolen vehicles, and fires occurring on a standing vehicle. The likelihood that a transport vehicle being involved in an accident of any type during a one-year period is 14 percent.

A generalized accident-risk evaluation was performed by NRC (NUREG-0706) that classified accidents into eight categories, depending upon the combined stresses of impact, puncture, crush and fire. On the basis of this classification scheme, conditional accident probability was developed for eight severity levels (see Table 7-1). The NRC utilized two release models for this analysis. Model I is hypothetical, assuming complete loss of drum contents, and Model II is based on actual tests, assuming a partial loss of drum contents. The quantity estimated to be released in the event of a truck accident was 17,000 lbs. for Model I and 1,200 lbs. for Model II, (NUREG 0706, NRC, 1980). Most of the yellowcake released from the container would be deposited directly on the ground in the immediate vicinity of the accident. Some fraction of the released material would be dispersed to the atmosphere. The NRC used the following expression to estimate material dispersion (NUREG-0706, 1977).

$$F = 0.001 + 4.6 \times 10^{-4} (1 - e^{-0.15ut}) u^{1.78}$$

where:

F = the fractional airborne release
u = the wind speed at 50ft in m/s
t = the duration of release (hours)

The first term represents the initial "puff" immediately airborne when the container falls in an accident. Using an assumed wind speed of 10 mph (5m/s) and a release time of 24 hours, the environmental release fraction would be $9x10^{-3}$. Since the conversion facility is located in Illinois, a population density of 160 persons/mi^2 was used for the eastern U.S. In NUREG-0706, the NRC found that the 50 year dose commitment to the lungs would be about 2 man-Sv (200 man-rem) and 0.14 man-Sv (14 man-rem) for Models I and II respectively. The integrated dose estimate would be lower for more sparsely populated areas.

An accident involving vehicles transporting the yellowcake product could result in some yellowcake being spilled. In the unlikely event of such an accident, all yellowcake and contaminated soils would be removed and processed through a mill or disposed in a licensed facility. All disturbed areas would then be reclaimed in accordance with all applicable State and NRC regulations.

The risk of an accident involving a yellowcake spill will be kept to a minimum by use of Department of Transportation approved containers and exclusive use shipments. To further reduce the environmental impact should an accident occur, a "Transportation Accident Response Guide" for the facility has been prepared and copies of the special instruction are included with every yellowcake shipment. A copy of the current Transportation Accident Response Guide, which will be updated as needed, is included in Appendix G.

Commercial yellowcake shipments are required to meet the fuel needs of the licensed power generation facilities and all risks associated with the transportation of yellowcake cannot be eliminated. However, the potential environmental impacts of an accident involving the shipment of yellowcake can be kept to a minimum by having proper procedures in place to ensure that the yellowcake is contained and the spill area is secure from unauthorized personnel.

7.5.7.2 Shipments of Resin

The operation of Satellite IX facilities requires that the resin used for IX operations be transferred from the Satellite facility to the Central Processing Plant. The resin holds the recovered uranium. While attached to the resin, the uranium will remain fixed until stripped using a strong brine solution. When the resin is transferred, it is moved using barren process water. This process water has uranium concentrations consistent with barren lixiviant (1-3 mg/l U_3O_8). The resin is transported in specially designed 500 to 700 ft^3 aluminum tanks. The tanker trucks typically haul 500 ft^3 of loaded resin. Such tanker trucks would withstand the impact of most collisions.

In the event of an accident that could rupture the tank, a portion of the resin and a small amount of residual water would spill on the ground. Uranium loaded resin is slightly denser than water and settles to the bottom of the tank, and any water decants to the top. Should the tanker truck overturn and rupture, the limited amount of water would carry some of the resin to only a short distance in the proximity of the tank. The risk of environmental impact is slight with respect to uranium loaded resin beads. The beads will retain the uranium, and prevent the contamination of the soil. The resin will typically collect in low places that confines the beads and ensures cleanup. There is no risk of airborne release of uranium since it will remain fixed to the beads.

An accident involving vehicles transporting resin could result in some of the resin being spilled. In the unlikely event of such an accident, all resin and contaminated soils would be removed and processed through the elution circuit or disposed in a licensed facility. All disturbed areas would then be reclaimed in accordance with all applicable State and NRC regulations. There have been no spills from resin transport during operations at the SR-HUP.

7.5.7.3 Yellowcake Slurry Shipments

The SR-HUP facility receives yellowcake slurry shipments for the purposes of drying from other licensed facilities and potentially Satellite facilities such as those planned for the Gas Hills Project and the Ruth/North Butte Project. When yellowcake slurry is transported, it is carried in specifically designed stainless steel tanks or 55-gallon steel drums that are lined with plastic and contain a waterproof seal. Tanker trucks would withstand the impact of most collisions. In the most severe conditions, an accident would result in a rupture of the tank and the release of only a portion of the slurry. During this accident, the slurry would pour onto the ground and thicken as water in the slurry soaked into the ground.

An accident involving vehicles transporting the yellowcake slurry could result in some yellowcake slurry being spilled. In the unlikely event of such an accident, all yellowcake slurry and contaminated soils would be removed and processed through a mill or disposed in a licensed facility. All disturbed areas would then be reclaimed in accordance with all applicable State and NRC regulations.

The risk of an accident involving a yellowcake slurry spill is kept to a minimum by use of Department of Transportation approved containers and exclusive use shipments. To further reduce the environmental impact should an accident occur, PRI has emergency response procedures which would be used in the unlikely occurrence of a spill of yellowcake, resin, or slurry during transportation. In addition, truckers/vendors also carry spill response plans in the truck.

7.5.7.4 Shipment of Chemicals

Accidents involving truck shipments of process chemicals to the project site could result in a local environmental impact. Any spills would be removed and the area would be cleaned and reclaimed. Shipments of the chemicals used in ISL mining in truck load quantities are common to many industries and present no abnormal risk. These chemicals include dry solid sodium carbonate, liquid carbon dioxide, liquid oxygen, concentrated sulfuric acid, liquid (50%) hydrogen peroxide, and dry solid sodium chloride (salt). Since most of the material would be recovered or could be removed no significant long-term environmental impact would result from a shipping accident involving these materials.

The exception to the above chemicals is anhydrous ammonia, which is used at the facility in the precipitation circuit. If involved in an accident, the presence of anhydrous ammonia could result in a significant environmental impact. It is delivered in bulk shipments of 7,500 gallons using a tanker truck. Approximately 12 to 14 shipments are made annually, and the supplier is assumed to be 150 miles away. From the Generic Environmental Impact Statement for Uranium Mills, (NUREG-0706, NRC, 1980), an accident rate of 4.8×10^{-7}/mile is used for determining risk of a traffic accident.

7.5.8 Evaporation Pond Failure

The evaporation ponds are constructed with leak detection systems and these systems will be monitored daily. If a liner leak were detected, the fluid would be pumped to another pond and the liner repaired as needed. The pond area will be surveyed and reclaimed as part of the final reclamation eliminating any significant long-term impact.

An evaporation pond embankment failure would be the most severe type of evaporation pond failure. To minimize the risk of an embankment failure, the ponds are inspected daily to ensure there is no significant deterioration of the embankments. Should a failure occur, all impacted areas would be surveyed, cleaned up as needed, and reclaimed.

7.6 SOCIOECONOMIC IMPACTS

Continued operation of the SR-HUP/Reynolds Ranch amendment area will provide jobs for about 100 company employees and 20 to 40 contract employees. The general population of Converse County declined approximately 20 percent between 1980 and 1984 and the overall economy remains depressed; therefore, the impact of the project, although limited, will be beneficial to the local communities. No adverse impact is anticipated as current housing, schools and other support facilities are more than adequate to accommodate the projected employment.

7.7 MINERAL RESOURCE IMPACTS

The only mineral known to be present in economically recoverable quantities in the project area is uranium. Oil and gas exploration has been conducted and is expected to continue in the general area. However, exploration and production drilling for oil and gas within the permit area is aimed at pay sands at subsurface depths of 8,000 feet or more. To date, such drilling has been unsuccessful.

Extensive drilling and evaluation has shown that economic coal beds that could be conventionally mined are not underlying the SR-HUP/Reynolds Ranch amendment area. Although there has been some very limited activity in the area for coal bed methane prospects, no concerns are anticipated due to the unlikeliness of large-scale development in areas where ISL mining will occur. In the unlikely case that both ISL mining and coal bed methane development occurs in the same area, working agreements between operations will alleviate any concerns.

Table 7-1

Fractional Probabilities of Occurrence and Corresponding Package Release Fractions for Each of the Release Models for Low Specific Activity (LSA) and Type A Containers Involved in Truck Accidents (NUREG-0170, NRC, 1977)

Accident Severity Category	Fractional Occurrence of Accident	Release Fractions	
		Model I	Model II
I	0.55	0.0	0.0
II	0.36	1.0	0.01
III	0.07	1.0	0.1
IV	0.016	1.0	1.0
V	0.0028	1.0	1.0
VI	0.0011	1.0	1.0
VII	8.5×10^{-5}	1.0	1.0
VIII	1.5×10^{-5}	1.0	1.0

ATTACHMENT 7-1

MILDOS MODEL RESULTS FOR THE REYNOLDS RANCH AMENDMENT AREA

Radiation Protection Consultant
Noel Savignac, Ph.D.

RADIATION DOSES ANTICIPATED FROM POWER RESOURCES INC. REYNOLDS RANCH SATELLITE URANIUM IN-SITU LEACHING OPERATION

By: Noel Savignac, Ph.D.
September 13, 2004

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EXECUTIVE SUMMARY

Radiation doses from the release of radon-222 at the proposed Reynolds Ranch Satellite Uranium In-Situ Leaching Operation near Glenrock Wyoming were estimated using the computer code MILDOS written for the Nuclear Regulatory Commission. The code used weather data from Casper, Wyoming to calculate annual average concentrations and radiation doses at nearby ranches. Results include:

The maximum radiation dose at the nearest residence (Mason House which is unoccupied) from the release of radon-222 is 27 mrem/year.

The maximum radiation dose at the nearest resident (Reynolds Ranch) is 4 mrem/yr.

The 10CFR20 regulatory maximum allowable dose to the public is 100 mrem/yr.

The maximum population dose within 80 km of the site is 2 person-rem/yr and for all populations is 111 person-rem/yr.

The maximum radiation dose occurs in year 8 of the project.

OBJECTIVE

Model the dispersion of radon-222 from the Power Resources Inc. Reynolds Ranch Satellite uranium in-situ leaching operation using the computer code MILDOS to predict the radiation doses to people in the vicinity of the project.

PROJECT DESCRIPTION

Eight well fields will be developed for injection and recovery of uranium leaching solutions over the life of the project, approximately 15 years. The leaching solution is pumped into the underground uranium ore body to oxidize the uranium to a soluble and stable form. The leach solution will consist of oxygen (O_2), carbon dioxide (CO_2) and native groundwater. The solution is removed in extraction wells and passed over ion exchange resins to remove the uranium. The resins are then removed and transported by truck to the Smith Ranch Highland Uranium Project where the uranium is extracted from the resin which is returned to the Reynolds Ranch.

RADIOACTIVE EFFLUENTS

In the ore body uranium-238 decays to form radium-226 and then to radon-222. Both uranium and radon are soluble in the leach solution that is pumped through the ore body to the ground surface. Radioactive effluents from an operating in-situ uranium recovery facility include:

1. Radon-222 from new well fields. When the wells are drilled into the ore body, ore cuttings are transported to the ground surface in the drilling mud. The cuttings are temporarily stored in mud pits where radon-222 is released from the radium-226 in the cuttings.

2. Radon-222 from the production well fields. Radon-222 that is dissolved in the leach solution is released from the purge water which is water in excess of the water that is injected back into the ore body. Radon-222 is only released from the purge water during storage in tanks prior to being injected down deep disposal wells. As a result, only a portion of radon-222 carried in the purge water is released. Therefore, estimates generated from MILDOS for radon-222 releases from purge water are considered conservative. In addition radon-222 is released from occasional venting of the wellheads and from the removal of resin from the ion exchange columns.

3. Uranium from the drying of yellowcake. Drying of yellowcake will not take place in the Reynolds Ranch Permit Area. Yellowcake is dried at the Smith Ranch Central Plant, which is a no emissions vacuum dryer.

4. Radon-222 from the pumping of fresh water during the restoration of the well fields. The primary source of radon-222 is from the restoration water circulating within and discharged from the wells. These releases are very similar to the radon releases during uranium production.

5. Radon-222 from land application areas. Purge water from production wells or restoration wells is sometimes treated and released for irrigation. This source of radon-222 is not applicable at the Reynolds Ranch operations because the wastewater is pumped into deep wells for disposal.

REYNOLDS RANCH OPERATIONS

For each Mine Unit an estimated 1 year will be required to drill the wells, 4 years to produce uranium, and 3 years to restore the Mine Units. Each year, for 8 years, a new Mine Unit will begin the drilling, production, and restoration cycle. Table 1 shows which wells are in the drilling (D), production (P), or restoration (R) phase for any given year. Mine Units are numbered 21 through 28. By reading horizontally across the table from any year, one can determine the status of the Mine Units at the project. For example in year three, Mine Units 21 and 22 are in production, and Mine Unit 23 is in the drilling phase.

Table 1 Reynolds Ranch Mine Units in Drilling (D), Production (P), or Restoration (R) by Year of Operation. Mine Units are numbered 21 through 28.

Year	Mine Units in Production or Restoration							
1	21D							
2	21P	22D						
3	21P	22P	23D					
4	21P	22P	23P	23D				
5	21P	22P	23P	24P	25D			
6	21R	22P	23P	24P	25P	26D		
7	21R	22R	23P	24P	25P	26P	26D	
8	21R	22R	23R	24P	25P	26P	27P	28D
9		22R	23R	24R	25P	26P	27P	28P
10			23R	24R	25R	26P	27P	28P
11				24R	25R	26R	27P	28P
12					25R	26R	27R	28P
13						26R	27R	28R
14							27R	28R
15								28R

YEAR OF MAXIMAL RADON-222 RELEASE

Radon-222 releases during the drilling, production, and restoration phases of the operation are calculated by the computer program MILDOS from the input parameters to the program. Production and restoration account for nearly all of the releases of radon-222 from the Mine Units. Drilling releases are very small, e.g. 0.001% of the total radon-222 releases from Mine Units 28. The year of maximal radon-222 release can then be determined from Table 1 by adding the number of wells in production and restoration for each year. The year(s) with the largest number are the years of maximal radon-222 releases. Years 8 and 9 have 7 Mine Units in production and restoration while all the other years have less. Since year 8 also has one Mine Unit in the drilling phase, year 8 is the year of maximal radon release and impact on the surrounding population.

MILDOS

The computer code MILDOS was used to determine the impact of radon-222 release on the surrounding populations. The code was originally designed to address the impacts of uranium mill operations but was subsequently updated in 1998 to address the impacts of uranium in-situ leaching operations. The code was developed by Argonne National Laboratory for the Nuclear Regulatory Commission to assess the radiological impacts and regulatory compliance of the release. To determine the maximal impact the code was run for Year 8 during which the most radon-222 will be released from the Reynolds Ranch operations. The purge water rate for restoration as opposed to production was used in the calculations to maximize the calculated radon-222 releases.

INPUT DATA

The weather data used by MILDOS was the joint frequency of wind speed by direction and stability class in the STAR format collected by the National Oceanic and Atmospheric Administration for Casper, WY. For example the wind blew from the north at a speed of 1.5 mph 0.007 percent of the year for stability class 1. The most recent data available was the file CRP0335.str. Local data for the Reynolds Ranch were not available. The Casper data is considered representative of the Reynolds Ranch area since it is the closest meteorological station and there are no significant barriers between the two sites that could significantly alter weather patterns.

Power Resources Inc provided the population data for people in an 80 km distance from the site. Of note was the Mason House where an elderly woman has been an occasional resident during the summer months. However the house was not visited in 2004. Power Resources Inc. owns the property. The nearest resident and nearest downwind resident in 2004 is at the Reynolds house at a distance and direction of 9 km NNE from the Satellite.

Table 2 presents the other input data for MILDOS.

Table 2 MILDOS INPUT DATA FOR REYNOLDS RANCH

NEW WELL FIELD	
Average ore activity of U-238 and each progeny in secular equilibrium	574 pCi/g
Ore porosity	0.27
Ore Density	1.93 g/cm^3
Average storage time of mud in mud pit	365 days/yr.
Average mass of mud in mud pit	7.2 E 5 g
Number of mud pits generated per year	330
Number of new wells per peak year	330
Number of new wells per mud pit	1
Number of mud pits	330
Ore zone thickness	6 m
Dill hole diameter	8"
Area of active drilling per year	
Mine Unit 21	347,659 m^2
Mine Unit 22	279,736 m^2
Mine Unit 23	244,827 m^2
Mine Unit 24	199,181 m^2
Mine Unit 25	335,638 m^2
Mine Unit 26	275,664 m^2
Mine Unit 27	544,938 m^2
Mine Unit 28	419,030 m^2
Expected duration of drilling operations	1 yr/Mine Unit

PRODUCTION WELL FIELD

Volume of water in circulation	
Mine Unit 21	5.63E8 L
Mine Unit 22	4.53E8 L
Mine Unit 23	3.97E8 L
Mine Unit 24	3.23E8 L
Mine Unit 25	5.44E8 L
Mine Unit 26	4.47E8 L
Mine Unit 27	8.83E8 L
Mine Unit 28	6.79E8 L
Fraction of radon source carried by circulating water	0.8
Rate of radon venting from piping and valves during circulation	0.01/d
"Purge" rate of treated water	2.1E5 L/d
Water discharge rate from resin unloading of IX columns	2.65E4 L/d
Resin porosity	0.37
IX column volume, 6 columns @ 28,317 L/d	71,548 L
Column unloading rate 1X/4d	0.25 column/d
Operating days per year	365 d
Expected duration of production operations	4 yrs/m unit

RESTORATION WELL FIELD

Flow rate in restoration well field	4.5E6 L/d
Total treated water "purge" rate	1.06E6 L/d
Rate of radon venting during circulation in fraction per day	0.01/d
Expected duration of restoration operations	3 yrs/Mine Unit

LAND APPLICATION

None. Waste and purge water will be disposed in a deep well.

GENERAL DATA

Location of <u>**EACH**</u> well field from Satellite	
MU-21	0.00 km N
	0.20 km E
MU-22	-1.37 km N
	0.79 km E
MU-23	1.61 km N
	-0.20 km E
MU-24	-0.79 km N
	-0.67 km E
MU-25	1.65 km N
	2.53 km E
MU-26	0.43 km N
	2.74 km E
MU-27	0.70 km N

0.49 km E

MU-28 -1.68 km N
0.70 km E

Location of restoration well fields from Satellite
Same as above

Location of nearest residence from Satellite
Mason House (not occupied in2004) -0.30 km N
-0.46 km E

Location of nearest downwind resident from Satellite
Reynolds Ranch (2 people) 4.02 km N
8.05 km E

Location of other residents of interest to PRI
Sundquist Ranch (unoccupied) -12.87 km N
1.37 km E

Lenzen Ranch (2 people) -5.15 km N
-7.40 km E

Crouch Ranch (unoccupied) -11.43 km N
-7.32 km E

Vollman Ranch (3 people) -7.40 km N
7.89 km E

Baker Ranch (2 people) 6.92 km N
8.53 km E

Hornbuckle Ranch (4 people) 8.53 km N
5.15 km E

Population distribution within 80 km

Distance (km)

	1	2	3	4	5	10	20	30	40	50	60	70	80
N	0	0	0	0	0	5	20	5	15	10	25	25	25
NE	0	0	0	0	0	25	13	15	40	65	95	85	110
E	0	0	0	0	0	5	10	5	25	35	20	15	85
SE	0	0	0	0	0	68	65	275	770	6830	420	290	345
S	0	0	0	0	0	49	45	185	40	130	100	70	10
SW	1	0	0	0	0	137	128	3125	190	3210	31430	23140	710
W	0	0	0	0	0	40	45	140	20	55	480	560	220
NW	0	0	0	0	0	60	275	160	25	115	455	745	100

MILDOS OUTPUT

The printout from the MILDOS computer model of the impacts of Radon-222 emissions on the people around the Reynolds Ranch Satellite operations is attached.

The meteorological data as the joint frequency in percent wind speed by direction and by stability class for Casper, WY is presented on page 2.

The receptor locations are the locations where the radiological doses from the releases of radon-222 are calculated. The locations and distances from the ion exchange column are presented on page 2. Since the Mason House is only occasionally visited, the nearest resident and the nearest downwind resident is located at the Reynolds Ranch.

The population distribution within 80 km of the Satellite is listed on page 4.

The sources for release of radon-222 are listed on page 5. Sources 1-8 are Mine Units 21-28. Sources 1-7 list radon-222 emissions of approximately 1000 Ci/yr because those sources have wells that are either in production or restoration during year 8. The emissions from source 8 are much smaller, 0.03 Ci/yr because the wells at that source are in the drilling phase. Radon-222 emissions from removing the resins from the 6 ion exchange columns are listed with source 1.

THE FOLLOWING AIR CONCENTRATIONS AND RADIATION DOSES ARE FOR THE MAXIMUM RELEASE OF RADON-222 IN YEAR 8 OF THE PROJECT.

1) The calculated air concentrations of radon-222 and its progeny are presented on pages 6-10. The highest radon-222 concentration is 1.1E-3 WL, 1.5 km to the ENE of the Satellite. That concentration is 4% of the effluent concentration limit presented for radon-222 in 10CFR20 (100 mrem/yr).

2) Population doses (the number of people exposed times their dose in mrem/yr) are presented on pages 11-23. The highest effective population dose for people within 80 km of the Satellite is 2 person-rem/year and beyond 80 km is 109 person-rem/yr. (That value is large compared to the dose within 80 km of the Satellite because the calculation uses the large United States population, approximately 3E8 people). The maximum total population dose is 111 person-rem/yr.

3) The 40CFR190 annual dose commitments on pages 24-27 are zero because 40CFR190 excludes the dose from radon-222 and its progeny and radon-222 and its progeny are the only effluents from the in-situ leaching operation.

4) The total annual effective dose commitments for the different ranches in the vicinity of the project are presented on pages 24-27 and are summarized in Table 3. The doses are all less than the 100 mrem/yr limit for the public in 10CFR20.

Table 3 Total Annual Effective Dose Commitments from Reynolds Ranch In-Situ Uranium Leaching Operation.

LOCATION	MREM/YR
Mason House (Unoccupied)	27
Reynolds Ranch	4
Sunquist Ranch	2
Lenzen Ranch	1
Couch Ranch	1
Vollman Ranch	1
Baker Ranch	3
Hornbuckle Ranch	2
10CFR20 limit for the public	100

ANNUAL RADIATION DOSES

The maximum release of radon-222 results in the highest annual radiation doses presented above for year 8 of the project. During that year 7 Mine Units were either in production or in restoration. The number of Mine Units in production or restoration for the other years of the project are presented in Table 1 and are summarized in Table 4. Since the number of Mine Units in production or restoration determines the amount of radon-222 released and all the Mine Units in production and restoration produce essentially the same amount of radon-222, the radiation dose for the other years can be determined as a fraction of the maximal dose in year 8. For example in year 12 the number of Mine Units in production or restoration will be 4. The number of Mine Units in production or restoration for year 8 is 7 and the dose for that year is 4 mrem to the nearest resident. The dose for year 12 is calculated as:

(4/7)(4 mrem) = 2 mrem for year 12.

The radiation doses to the nearest resident for each year of the project are presented in Table 4.

Table 4 Radiation dose at the Reynolds Ranch Residence for Each Year of the Reynolds Ranch Project

YEAR	# MINE UNITS IN PRODUCTION OR RESTORATION	MREM/YR
1	0	0
2	1	1
3	2	1
4	3	2
5	4	2
6	5	3
7	6	3
8	7	4
9	7	4
10	6	3
11	5	3
12	4	2
13	3	2
14	2	1
15	1	1

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XXXXXXXXXXXXXXXXX

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JOINT FREQUENCY IN PERCENT, DIRECTION INDICATES WHERE WIND IS FROM FREQWS=0.05735,0.21076,0.28172,0.26136,0.13155,0.05735

LITY CLASS 1

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.0070	0.0240	0.0100	0.0240	0.0170	0.0100	0.0070	0.0410	0.0140	0.0210	0.0240	0.0240	0.0380	0.0170	0.0210	0.0100	0.3090
5.5	0.0140	0.0270	0.0210	0.0070	0.0140	0.0210	0.0140	0.0620	0.0070	0.0210	0.0070	0.0270	0.0550	0.0340	0.0000	0.0210	0.3520
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0210	0.0510	0.0310	0.0310	0.0310	0.0310	0.0210	0.1030	0.0210	0.0420	0.0310	0.0510	0.0930	0.0510	0.0210	0.0310	0.6610

STABILITY CLASS 2

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.0550	0.0510	0.0370	0.0420	0.0960	0.0420	0.0660	0.0650	0.0980	0.0410	0.0620	0.0450	0.1130	0.0400	0.0210	0.0640	0.9380
5.5	0.0960	0.1230	0.0690	0.0410	0.1230	0.1160	0.1300	0.1160	0.2120	0.1030	0.1580	0.1370	0.1370	0.0960	0.0550	0.1100	1.8220
10.0	0.0690	0.0620	0.0690	0.0410	0.0620	0.0210	0.0550	0.0270	0.0550	0.0690	0.0820	0.1100	0.1780	0.0690	0.0750	0.0820	1.1260
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.2200	0.2360	0.1750	0.1240	0.2810	0.1790	0.2510	0.2080	0.3650	0.2130	0.3020	0.2920	0.4280	0.2050	0.1510	0.2560	3.8860

STABILITY CLASS 3

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.0190	0.0130	0.0110	0.0120	0.0370	0.0190	0.0130	0.0040	0.0280	0.0190	0.0190	0.0290	0.0180	0.0270	0.0320	0.0030	0.3030
5.5	0.0960	0.1370	0.0960	0.1030	0.1780	0.0960	0.1230	0.0820	0.1510	0.0960	0.0960	0.1710	0.2400	0.1300	0.0750	0.0620	1.9320
10.0	0.2530	0.1850	0.1580	0.1710	0.2330	0.1920	0.1230	0.0820	0.1230	0.1990	0.3700	0.6440	0.4730	0.2260	0.1640	0.1580	3.7540
15.5	0.0270	0.0140	0.0140	0.0140	0.0340	0.0340	0.0140	0.0000	0.0340	0.0960	0.2060	0.1710	0.1920	0.0340	0.0410	0.0690	0.9940
21.5	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0140	0.0070	0.0340	0.0340	0.0410	0.0210	0.0000	0.0000	0.1580
[illegible]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0070	0.0140	0.0070	0.0000	0.0000	0.0000	0.0280
	.3950	0.3560	0.2790	0.3000	0.4820	0.3410	0.2730	0.1680	0.3500	0.4170	0.7320	1.0630	0.9710	0.4380	0.3120	0.2920	7.1690

STABILITY CLASS 4

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.0790	0.1050	0.0850	0.0740	0.0600	0.0590	0.0550	0.0270	0.0550	0.0340	0.0410	0.0530	0.0680	0.0820	0.0430	0.1010	1.0210
5.5	0.5410	0.5820	0.4450	0.3220	0.4110	0.3220	0.1920	0.1300	0.1920	0.1230	0.2060	0.3360	0.3360	0.2400	0.1440	0.4520	4.9740
10.0	1.1400	1.4250	1.0210	0.8770	0.9250	0.4930	0.3010	0.1370	0.2120	0.6300	1.4180	2.1300	1.7470	0.5410	0.5210	0.5000	14.0180
15.5	1.1100	1.4870	1.0280	0.6510	1.0000	0.5480	0.1990	0.0550	0.3700	3.0830	6.5420	5.1990	1.9320	0.9450	0.5890	0.4040	25.1420
21.5	0.2810	0.3770	0.1710	0.0620	0.2260	0.0820	0.0410	0.0140	0.1780	2.6720	5.0080	2.2130	0.9250	0.4040	0.2400	0.1030	12.9970
28.0	0.1030	0.1030	0.0270	0.0000	0.0140	0.0070	0.0000	0.0000	0.0410	1.4800	2.2470	0.9730	0.5210	0.1160	0.0410	0.0340	5.7070
ALL	3.2540	4.0790	2.7770	1.9860	2.6360	1.5110	0.7880	0.3630	1.0480	8.0220	15.4620	10.9040	5.5290	2.3280	1.5780	1.5940	63.8590

STABILITY CLASS 5

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	0.4180	0.3360	0.2880	0.1920	0.2600	0.1580	0.1510	0.1030	0.1370	0.1160	0.2470	0.4930	0.7470	0.3630	0.3290	0.3290	4.6670
10.0	0.3430	0.3010	0.2810	0.2880	0.4040	0.3080	0.1160	0.0480	0.0550	0.4040	1.0890	2.8220	1.9040	0.4040	0.2470	0.2600	9.2740
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.7610	0.6370	0.5690	0.4800	0.6640	0.4660	0.2670	0.1510	0.1920	0.5200	1.3360	3.3150	2.6510	0.7670	0.5760	0.5890	13.9410

STABILITY CLASS 6

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
1.5	0.3720	0.1670	0.1430	0.1100	0.1610	0.1120	0.0630	0.0580	0.1220	0.1120	0.1450	0.3000	0.5750	0.2610	0.2020	0.2610	3.1640
5.5	0.6920	0.5620	0.3560	0.3560	0.3630	0.1990	0.1580	0.0890	0.1640	0.1990	0.2810	0.7810	1.2670	0.6230	0.5750	0.6640	7.3290
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
[illegible]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.0640	0.7290	0.4990	0.4660	0.5240	0.3110	0.2210	0.1470	0.2860	0.3110	0.4260	1.0810	1.8420	0.8840	0.7770	0.9250	10.4930

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
ALL	5.7150	6.0880	4.3300	3.3870	4.6180	2.8390	1.8210	1.1400	2.2620	9.5250	18.2890	16.7060	11.5140	4.6730	3.4150	3.6870	100.0090

INDIVIDUAL RECEPTOR LOCATION DATA, 8 LOCATIONS INPUT THIS RUN

	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE	I	LOCATION NAMES	X(KM)	Y(KM)	Z(M)	DIST(KM)	TYPE
1	Mason House	-0.46	-0.30	0.00	0.55	1	5	Crouch Ranch	-7.32	-11.43	0.00	13.57	1
2	Reynolds Ranch	8.05	4.02	0.00	9.00	1	6	Vollman Ranch	7.89	-7.40	0.00	10.82	1
3	Sundquist Ranch	1.37	-12.87	0.00	12.94	1	7	Baker Ranch	8.53	6.92	0.00	10.98	1
4	Lenzen Ranch	-7.40	-5.15	0.00	9.02	1	8	Hornbuckle Ranch	5.15	8.53	0.00	9.96	1

MISCELLANEOUS INPUTABLE PARAMETER VALUES

DMM	DMA	TSTART	FFORI	FHAYI	FFORP	FHAYP	FPR(1)	FPR(2)	FPR(3)	ACTRAT
100.0	100.0	2012.00	0.50	0.50	0.50	0.50	0.00	0.00	0.00	2.50

IPACT EQUALS 0, 0, 0, 0, 0, 0, 0, 0,

JC EQUALS 0, 0, 1, 1, 0, 0, 1, 0, 0, 0

TIME STEP DATA....	STEP NAMES	LENGTH, YRS	IFTODO
1		1.00	1

XRHO EQUALS 1.5, 2.5, 3.5, 4.5, 7.5, 15.0, 25.0, 35.0, 45.0, 55.0, 65.0, 75.0,

HDP EQUALS 50.0

REGION: CODE: MILDOS-AREA (02/97)

METSET: DATA: PRI.RAD 09/10/04

POPULATION DISTRIBUTION

KILOMETERS	N 0.0	NNE 22.5	NE 45.0	ENE 67.5	E 90.0	ESE 112.5	SE 135.0	SSE 157.5	S 180.0	SSW 202.5	SW 225.0	WSW 247.5	W 270.0	WNW 292.5	NW 315.0	NNW 337.5
1.0- 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0- 3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0- 4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0- 5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0-10.0	0	4	0	2	0	0	0	0	0	2	0	0	0	0	0	0
10.0-20.0	5	0	27	0	5	0	71	0	49	0	137	0	40	0	60	0
20.0-30.0	20	0	13	0	10	0	65	0	45	0	128	0	45	0	275	0
30.0-40.0	5	0	15	0	5	0	275	0	185	0	3125	0	140	0	160	0
40.0-50.0	15	0	40	0	25	0	770	0	40	0	190	0	20	0	25	0
50.0-60.0	10	0	65	0	35	0	6830	0	130	0	3210	0	55	0	115	0
[illegible]70.0	25	0	95	0	20	0	420	0	100	0	31430	0	448	0	455	0
[illegible]-80.0	25	0	85	0	15	0	290	0	70	0	23140	0	560	0	745	0
1.0-80.0	105	4	340	2	115	0	8721	0	619	2	61360	0	1308	0	1835	0

TOTAL 1-80 KM POPULATION IS 74411 PERSONS

NUMBER OF SOURCES= 8

NO.	KM X	KM Y	M Z	KM2 AREA	U-238	Th-230	CI/YEAR Ra-226	Pb-210	Rn-222	ID	PSIZE SET	M/SEC EXIT VEL	SOURCE NAME
1	0.20	0.00	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E+03	1001	1	0.00E+00	Source 1
2	0.79	-1.37	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E+03	1002	1	0.00E+00	Source 2
3	-0.20	1.61	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E+03	1003	1	0.00E+00	Source 3
4	-0.67	-0.79	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E+03	1004	1	0.00E+00	Source 4
5	2.53	1.65	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.84E+03	1005	1	0.00E+00	Source 5
6	2.74	0.43	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.57E+03	1006	1	0.00E+00	Source 6
7	0.49	0.70	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E+03	1007	1	0.00E+00	Source 7
8	0.70	-1.68	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-02	1008	1	0.00E+00	Source 8

INPUT TAILS ACTIVITIES, PCI/G

SET	URANIUM	THORIUM	RADIUM	LEAD
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	0.00E+00	0.00E+00	0.00E+00	0.00E+00

AMAD AND FRACTIONAL DISTRIBUTION

SET	1.5	3.0	7.7	54.0
1	0.000	1.000	0.000	0.000
2	1.000	0.000	0.000	0.000
3	0.000	0.000	0.300	0.700

PARTICULATE SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 1.00YRS	TSTEP 2 5.00YRS	TSTEP 3 5.00YRS	TSTEP 4 5.00YRS	TSTEP 5 5.00YRS	TSTEP 6 5.00YRS	TSTEP 7 5.00YRS	TSTEP 8 5.00YRS	TSTEP 9 5.00YRS	TSTEP10 5.00YRS
	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
[illegible]	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
4	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
5	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
6	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
7	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
8	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

RADON SOURCE STRENGTH MULTIPLIERS BY TIME STEP, 1 TIME STEP(S) USED FOR THIS RUN

SOURCE NUMBER	TSTEP 1 1.00YRS	TSTEP 2 5.00YRS	TSTEP 3 5.00YRS	TSTEP 4 5.00YRS	TSTEP 5 5.00YRS	TSTEP 6 5.00YRS	TSTEP 7 5.00YRS	TSTEP 8 5.00YRS	TSTEP 9 5.00YRS	TSTEP10 5.00YRS
1	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
2	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
3	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
4	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
5	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
6	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
7	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
8	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE N DIRECTION, THETA EQUALS 0.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.042E+03	5.091E+02	5.790E+01	1.532E+01	1.609E-05	8.751E-04
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.060E+02	8.552E+01	3.156E+01	1.507E+01	2.157E-05	3.043E-04
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.654E+01	4.415E+01	2.343E+01	1.414E+01	2.845E-05	2.170E-04
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.002E+01	2.942E+01	1.847E+01	1.266E+01	3.484E-05	1.712E-04
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.440E+01	1.436E+01	1.122E+01	8.987E+00	4.785E-05	1.052E-04
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.750E+00	6.753E+00	6.148E+00	5.496E+00	6.350E-05	5.862E-05
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.794E+00	3.796E+00	3.666E+00	3.486E+00	6.852E-05	3.550E-05
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.584E+00	2.585E+00	2.548E+00	2.484E+00	6.962E-05	2.485E-05
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.938E+00	1.939E+00	1.928E+00	1.902E+00	6.956E-05	1.887E-05
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.536E+00	1.537E+00	1.536E+00	1.524E+00	6.900E-05	1.505E-05
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.263E+00	1.264E+00	1.266E+00	1.261E+00	6.820E-05	1.242E-05
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.066E+00	1.066E+00	1.069E+00	1.068E+00	6.730E-05	1.050E-05

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.032E+02	4.032E+02	4.032E+02	1.490E+00
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.774E+01	6.774E+01	6.774E+01	1.997E+00
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.497E+01	3.497E+01	3.497E+01	2.634E+00
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.331E+01	2.331E+01	2.331E+01	3.226E+00
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.137E+01	1.137E+01	1.137E+01	4.430E+00
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.348E+00	5.348E+00	5.348E+00	5.879E+00
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.006E+00	3.006E+00	3.006E+00	6.344E+00
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.048E+00	2.048E+00	2.048E+00	6.446E+00
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.536E+00	1.536E+00	1.536E+00	6.440E+00
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.218E+00	1.218E+00	1.218E+00	6.388E+00
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.001E+00	1.001E+00	1.001E+00	6.315E+00
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.446E-01	8.446E-01	8.446E-01	6.231E+00

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	4.828E-08
2.5	0.000E+00	0.000E+00	0.000E+00	6.470E-08
3.5	0.000E+00	0.000E+00	0.000E+00	8.536E-08
4.5	0.000E+00	0.000E+00	0.000E+00	1.045E-07
7.5	0.000E+00	0.000E+00	0.000E+00	1.436E-07
15.0	0.000E+00	0.000E+00	0.000E+00	1.905E-07
25.0	0.000E+00	0.000E+00	0.000E+00	2.056E-07
35.0	0.000E+00	0.000E+00	0.000E+00	2.089E-07
45.0	0.000E+00	0.000E+00	0.000E+00	2.087E-07
55.0	0.000E+00	0.000E+00	0.000E+00	2.070E-07
65.0	0.000E+00	0.000E+00	0.000E+00	2.046E-07
75.0	0.000E+00	0.000E+00	0.000E+00	2.019E-07

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE ENE DIRECTION, THETA EQUALS 67.5 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.501E+02	4.348E+02	1.084E+02	3.397E+01	2.294E-05	1.124E-03
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.322E+02	3.456E+02	9.354E+01	3.570E+01	3.824E-05	9.634E-04
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.374E+02	2.691E+02	8.074E+01	3.482E+01	5.462E-05	8.164E-04
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.123E+02	1.900E+02	7.406E+01	3.782E+01	7.407E-05	7.123E-04
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.497E+01	7.374E+01	4.113E+01	2.622E+01	1.024E-04	3.823E-04
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.820E+01	2.820E+01	2.128E+01	1.572E+01	1.193E-04	1.956E-04
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.479E+01	1.480E+01	1.300E+01	1.092E+01	1.227E-04	1.219E-04
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.881E+00	9.887E+00	9.255E+00	8.350E+00	1.238E-04	8.825E-05
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.359E+00	7.363E+00	7.111E+00	6.683E+00	1.239E-04	6.856E-05
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.821E+00	5.825E+00	5.719E+00	5.507E+00	1.231E-04	5.554E-05
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.789E+00	4.792E+00	4.749E+00	4.642E+00	1.218E-04	4.633E-05
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.051E+00	4.053E+00	4.038E+00	3.984E+00	1.204E-04	3.951E-05

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.443E+02	3.443E+02	3.443E+02	2.124E+00
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.737E+02	2.737E+02	2.737E+02	3.541E+00
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.131E+02	2.131E+02	2.131E+02	5.057E+00
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.505E+02	1.505E+02	1.505E+02	6.857E+00
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.840E+01	5.840E+01	5.840E+01	9.480E+00
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.233E+01	2.233E+01	2.233E+01	1.104E+01
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.172E+01	1.172E+01	1.172E+01	1.136E+01
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.831E+00	7.831E+00	7.831E+00	1.147E+01
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.832E+00	5.832E+00	5.832E+00	1.147E+01
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.613E+00	4.613E+00	4.613E+00	1.139E+01
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.795E+00	3.795E+00	3.795E+00	1.128E+01
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.210E+00	3.210E+00	3.210E+00	1.114E+01

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	6.881E-08
2.5	0.000E+00	0.000E+00	0.000E+00	1.147E-07
3.5	0.000E+00	0.000E+00	0.000E+00	1.638E-07
4.5	0.000E+00	0.000E+00	0.000E+00	2.222E-07
7.5	0.000E+00	0.000E+00	0.000E+00	3.072E-07
15.0	0.000E+00	0.000E+00	0.000E+00	3.578E-07
25.0	0.000E+00	0.000E+00	0.000E+00	3.682E-07
35.0	0.000E+00	0.000E+00	0.000E+00	3.715E-07
45.0	0.000E+00	0.000E+00	0.000E+00	3.716E-07
55.0	0.000E+00	0.000E+00	0.000E+00	3.692E-07
65.0	0.000E+00	0.000E+00	0.000E+00	3.655E-07
75.0	0.000E+00	0.000E+00	0.000E+00	3.611E-07

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE E DIRECTION, THETA EQUALS 90.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.625E+02	3.076E+02	9.276E+01	3.390E+01	2.659E-05	9.136E-04
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.724E+02	3.482E+02	9.626E+01	4.037E+01	4.794E-05	9.973E-04
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.356E+02	2.096E+02	8.123E+01	4.063E+01	6.937E-05	7.793E-04
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.426E+02	1.363E+02	6.811E+01	4.014E+01	9.203E-05	6.354E-04
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.744E+01	6.704E+01	4.569E+01	3.310E+01	1.476E-04	4.242E-04
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.798E+01	2.799E+01	2.386E+01	1.990E+01	1.916E-04	2.240E-04
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.471E+01	1.472E+01	1.379E+01	1.259E+01	1.990E-04	1.320E-04
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.685E+00	9.690E+00	9.402E+00	8.948E+00	1.973E-04	9.103E-05
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.103E+00	7.107E+00	7.007E+00	6.813E+00	1.936E-04	6.826E-05
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.550E+00	5.553E+00	5.518E+00	5.431E+00	1.894E-04	5.395E-05
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.515E+00	4.517E+00	4.509E+00	4.469E+00	1.851E-04	4.418E-05
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.779E+00	3.782E+00	3.784E+00	3.767E+00	1.809E-04	3.713E-05

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.437E+02	2.437E+02	2.437E+02	2.462E+00
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.758E+02	2.758E+02	2.758E+02	4.438E+00
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.660E+02	1.660E+02	1.660E+02	6.423E+00
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.079E+02	1.079E+02	1.079E+02	8.521E+00
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.310E+01	5.310E+01	5.310E+01	1.367E+01
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.217E+01	2.217E+01	2.217E+01	1.774E+01
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.166E+01	1.166E+01	1.166E+01	1.842E+01
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.675E+00	7.675E+00	7.675E+00	1.826E+01
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.629E+00	5.629E+00	5.629E+00	1.792E+01
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.398E+00	4.398E+00	4.398E+00	1.753E+01
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.578E+00	3.578E+00	3.578E+00	1.714E+01
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.995E+00	2.995E+00	2.995E+00	1.675E+01

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	7.978E-08
2.5	0.000E+00	0.000E+00	0.000E+00	1.438E-07
3.5	0.000E+00	0.000E+00	0.000E+00	2.081E-07
4.5	0.000E+00	0.000E+00	0.000E+00	2.761E-07
7.5	0.000E+00	0.000E+00	0.000E+00	4.429E-07
15.0	0.000E+00	0.000E+00	0.000E+00	5.748E-07
25.0	0.000E+00	0.000E+00	0.000E+00	5.969E-07
35.0	0.000E+00	0.000E+00	0.000E+00	5.918E-07
45.0	0.000E+00	0.000E+00	0.000E+00	5.807E-07
55.0	0.000E+00	0.000E+00	0.000E+00	5.682E-07
65.0	0.000E+00	0.000E+00	0.000E+00	5.553E-07
75.0	0.000E+00	0.000E+00	0.000E+00	5.427E-07

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE S DIRECTION, THETA EQUALS 180.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.652E+02	2.235E+02	7.121E+01	2.929E+01	3.555E-05	7.005E-04
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.358E+02	1.262E+02	5.588E+01	2.975E+01	5.238E-05	5.243E-04
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.582E+01	8.338E+01	4.546E+01	2.817E+01	6.786E-05	4.215E-04
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.286E+01	6.208E+01	3.863E+01	2.617E+01	8.149E-05	3.574E-04
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.406E+01	3.400E+01	2.567E+01	1.972E+01	1.072E-04	2.387E-04
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.519E+01	1.520E+01	1.357E+01	1.180E+01	1.276E-04	1.285E-04
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.303E+00	8.307E+00	7.954E+00	7.448E+00	1.308E-04	7.667E-05
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.573E+00	5.576E+00	5.475E+00	5.293E+00	1.294E-04	5.325E-05
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.131E+00	4.134E+00	4.104E+00	4.032E+00	1.268E-04	4.011E-05
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.251E+00	3.253E+00	3.247E+00	3.218E+00	1.241E-04	3.181E-05
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.657E+00	2.659E+00	2.662E+00	2.651E+00	1.213E-04	2.612E-05
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.233E+00	2.234E+00	2.240E+00	2.237E+00	1.186E-04	2.200E-05

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.770E+02	1.770E+02	1.770E+02	3.291E+00
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.996E+01	9.996E+01	9.996E+01	4.849E+00
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.604E+01	6.604E+01	6.604E+01	6.283E+00
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.917E+01	4.917E+01	4.917E+01	7.545E+00
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.693E+01	2.693E+01	2.693E+01	9.924E+00
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.204E+01	1.204E+01	1.204E+01	1.181E+01
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.580E+00	6.580E+00	6.580E+00	1.211E+01
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.416E+00	4.416E+00	4.416E+00	1.198E+01
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.274E+00	3.274E+00	3.274E+00	1.174E+01
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.576E+00	2.576E+00	2.576E+00	1.149E+01
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.106E+00	2.106E+00	2.106E+00	1.123E+01
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.769E+00	1.769E+00	1.769E+00	1.098E+01

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	1.067E-07
2.5	0.000E+00	0.000E+00	0.000E+00	1.571E-07
3.5	0.000E+00	0.000E+00	0.000E+00	2.036E-07
4.5	0.000E+00	0.000E+00	0.000E+00	2.445E-07
7.5	0.000E+00	0.000E+00	0.000E+00	3.216E-07
15.0	0.000E+00	0.000E+00	0.000E+00	3.828E-07
25.0	0.000E+00	0.000E+00	0.000E+00	3.924E-07
35.0	0.000E+00	0.000E+00	0.000E+00	3.881E-07
45.0	0.000E+00	0.000E+00	0.000E+00	3.805E-07
55.0	0.000E+00	0.000E+00	0.000E+00	3.723E-07
65.0	0.000E+00	0.000E+00	0.000E+00	3.640E-07
75.0	0.000E+00	0.000E+00	0.000E+00	3.558E-07

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

CONCENTRATION DATA FOR THE W DIRECTION, THETA EQUALS 270.0 DEGREES

TOTAL AIR CONCENTRATIONS, PCI/M3, AND WL

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210	WL
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.122E+02	1.026E+02	3.949E+01	1.854E+01	2.618E-05	3.751E-04
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.739E+01	6.486E+01	3.185E+01	1.822E+01	3.658E-05	2.963E-04
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.673E+01	4.593E+01	2.626E+01	1.682E+01	4.540E-05	2.432E-04
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.601E+01	3.570E+01	2.258E+01	1.548E+01	5.313E-05	2.090E-04
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.168E+01	2.166E+01	1.618E+01	1.225E+01	6.903E-05	1.500E-04
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.035E+01	1.035E+01	9.164E+00	7.861E+00	8.280E-05	8.645E-05
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.897E+00	5.900E+00	5.628E+00	5.231E+00	8.751E-05	5.412E-05
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.048E+00	4.051E+00	3.972E+00	3.827E+00	8.851E-05	3.858E-05
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.052E+00	3.053E+00	3.031E+00	2.973E+00	8.836E-05	2.960E-05
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.431E+00	2.432E+00	2.428E+00	2.405E+00	8.769E-05	2.379E-05
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.007E+00	2.008E+00	2.011E+00	2.003E+00	8.673E-05	1.973E-05
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.700E+00	1.701E+00	1.706E+00	1.705E+00	8.564E-05	1.676E-05

GROUND SURFACE CONCENTRATIONS, PCI/M2

XRHO, KM	U-238	Th-230	Ra-226	Pb-210	Rn-222	Po-218	Pb-214	Bi-214	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.129E+01	8.129E+01	8.129E+01	2.424E+00
2.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.137E+01	5.137E+01	5.137E+01	3.387E+00
3.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.638E+01	3.638E+01	3.638E+01	4.203E+00
4.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.828E+01	2.828E+01	2.828E+01	4.919E+00
7.5	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.715E+01	1.715E+01	1.715E+01	6.391E+00
15.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.201E+00	8.201E+00	8.201E+00	7.666E+00
25.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.673E+00	4.673E+00	4.673E+00	8.102E+00
35.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.208E+00	3.208E+00	3.208E+00	8.195E+00
45.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.418E+00	2.418E+00	2.418E+00	8.180E+00
55.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.927E+00	1.927E+00	1.927E+00	8.119E+00
65.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.591E+00	1.591E+00	1.591E+00	8.030E+00
75.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.347E+00	1.347E+00	1.347E+00	7.929E+00

TOTAL DEPOSITION RATES, PCI/M2-SEC

XRHO, KM	U-238	Th-230	Ra-226	Pb-210
1.5	0.000E+00	0.000E+00	0.000E+00	7.854E-08
2.5	0.000E+00	0.000E+00	0.000E+00	1.097E-07
3.5	0.000E+00	0.000E+00	0.000E+00	1.362E-07
4.5	0.000E+00	0.000E+00	0.000E+00	1.594E-07
7.5	0.000E+00	0.000E+00	0.000E+00	2.071E-07
15.0	0.000E+00	0.000E+00	0.000E+00	2.484E-07
25.0	0.000E+00	0.000E+00	0.000E+00	2.625E-07
35.0	0.000E+00	0.000E+00	0.000E+00	2.655E-07
45.0	0.000E+00	0.000E+00	0.000E+00	2.651E-07
55.0	0.000E+00	0.000E+00	0.000E+00	2.631E-07
65.0	0.000E+00	0.000E+00	0.000E+00	2.602E-07
75.0	0.000E+00	0.000E+00	0.000E+00	2.569E-07

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO	XRHO
DIRECTION	1.5	2.5	3.5	4.5	7.5	15.0	25.0	35.0	45.0	55.0	65.0	75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.319E-05	1.001E-04	2.544E-05	7.629E-05	5.048E-05	1.248E-04	1.232E-04
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.372E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.365E-04	7.106E-05	8.488E-05	2.308E-04	3.790E-04	5.565E-04	4.987E-04
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.495E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.996E-05	1.454E-04	7.209E-05	3.538E-04	4.848E-04	2.709E-04	1.986E-04
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.356E-04	3.889E-04	1.590E-03	4.304E-03	3.709E-02	2.224E-03	1.498E-03
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.566E-04	4.301E-04	1.749E-03	3.710E-04	1.180E-03	8.877E-04	6.077E-04
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.063E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.976E-04	6.806E-04	1.672E-02	1.011E-03	1.690E-02	1.633E-01	1.186E-01
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.419E-04	2.877E-04	9.057E-04	1.292E-04	3.528E-04	2.843E-03	3.511E-03
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.040E-04	9.715E-04	5.681E-04	8.821E-05	4.024E-04	1.578E-03	2.555E-03
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 3.898E-01 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.881E-04	8.119E-04	2.062E-04	6.182E-04	4.088E-04	1.010E-03	9.968E-04
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.114E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.108E-03	5.763E-04	6.882E-04	1.871E-03	3.071E-03	4.508E-03	4.038E-03
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.213E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.676E-04	1.179E-03	5.844E-04	2.867E-03	3.927E-03	2.193E-03	1.608E-03
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.534E-03	3.153E-03	1.289E-02	3.487E-02	3.005E-01	1.801E-02	1.213E-02
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.704E-03	3.487E-03	1.418E-02	3.006E-03	9.559E-03	7.188E-03	4.919E-03
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.629E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.659E-03	5.519E-03	1.355E-01	8.193E-03	1.369E-01	1.322E+00	9.599E-01
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.962E-03	2.333E-03	7.342E-03	1.047E-03	2.858E-03	2.302E-02	2.842E-02
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.655E-03	7.878E-03	4.605E-03	7.148E-04	3.260E-03	1.278E-02	2.068E-02
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 3.157E+00 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS AVG.LUNG

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.730E-06	1.207E-05	3.139E-06	9.630E-06	6.516E-06	1.647E-05	1.661E-05
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.586E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.603E-05	8.512E-06	1.036E-05	2.866E-05	4.784E-05	7.139E-05	6.497E-05
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.726E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.221E-06	1.747E-05	8.854E-06	4.439E-05	6.212E-05	3.542E-05	2.650E-05
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.124E-05	4.678E-05	1.956E-04	5.408E-04	4.762E-03	2.915E-04	2.005E-04
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.381E-05	5.184E-05	2.156E-04	4.671E-05	1.518E-04	1.165E-04	8.143E-05
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.232E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.223E-05	8.196E-05	2.055E-03	1.268E-04	2.162E-03	2.130E-02	1.577E-02
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.853E-05	3.470E-05	1.116E-04	1.626E-05	4.532E-05	3.728E-04	4.696E-04
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.403E-05	1.170E-04	6.997E-05	1.110E-05	5.174E-05	2.072E-04	3.426E-04
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 5.081E-02 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS INHAL. EXPOSED ORGAN IS BRONCHI

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.219E-02	9.484E-02	1.615E-02	3.634E-02	1.921E-02	3.947E-02	3.331E-02
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.309E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.436E-01	2.008E-01	1.594E-01	3.224E-01	4.202E-01	5.111E-01	3.908E-01
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.874E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.749E-01	1.839E-01	6.053E-02	2.220E-01	2.428E-01	1.129E-01	7.086E-02
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.340E-01	4.348E-01	1.193E+00	2.421E+00	1.668E+01	8.326E-01	4.803E-01
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.306E-01	4.670E-01	1.289E+00	2.066E-01	5.282E-01	3.322E-01	1.954E-01
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.813E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.636E+00	8.611E-01	1.436E+01	6.561E-01	8.804E+00	7.105E+01	4.430E+01
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.175E-01	3.317E-01	7.084E-01	7.629E-02	1.671E-01	1.124E+00	1.190E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.137E-01	1.031E+00	4.029E-01	4.675E-02	1.699E-01	5.530E-01	7.647E-01
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 1.806E+02 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS GROUND EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.834E-06	1.098E-05	1.890E-06	4.298E-06	2.296E-06	4.768E-06	4.065E-06
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.458E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.443E-05	2.292E-05	1.826E-05	3.707E-05	4.851E-05	5.923E-05	4.546E-05
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.091E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.998E-05	2.118E-05	7.029E-06	2.599E-05	2.866E-05	1.343E-05	8.499E-06
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.068E-04	5.019E-05	1.389E-04	2.845E-04	1.978E-03	9.960E-05	5.797E-05
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.065E-04	5.393E-05	1.502E-04	2.428E-05	6.264E-05	3.974E-05	2.357E-05
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.724E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.870E-04	9.917E-05	1.667E-03	7.673E-05	1.037E-03	8.436E-03	5.300E-03
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.920E-05	3.826E-05	8.241E-05	8.950E-06	1.977E-05	1.341E-04	1.432E-04
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.735E-05	1.191E-04	4.699E-05	5.505E-06	2.021E-05	6.640E-05	9.269E-05
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 2.138E-02 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS CLOUD EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.054E-04	7.685E-04	1.364E-04	3.129E-04	1.671E-04	3.455E-04	2.925E-04
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.739E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.035E-03	1.129E-03	1.068E-03	2.393E-03	3.321E-03	4.201E-03	3.293E-03
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.155E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.117E-03	1.395E-03	4.931E-04	1.872E-03	2.086E-03	9.799E-04	6.192E-04
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.500E-03	3.456E-03	9.974E-03	2.074E-02	1.448E-01	7.277E-03	4.216E-03
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.452E-03	3.702E-03	1.077E-02	1.770E-03	4.586E-03	2.905E-03	1.715E-03
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.255E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.089E-02	6.688E-03	1.189E-01	5.598E-03	7.630E-02	6.209E-01	3.890E-01
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.515E-03	2.602E-03	5.895E-03	6.527E-04	1.450E-03	9.830E-03	1.045E-02
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.938E-03	8.371E-03	3.428E-03	4.056E-04	1.488E-03	4.862E-03	6.738E-03
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 1.550E+00 PERSON-REM/YR

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS VEG. ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MEAT ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS EFFECTIV

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

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TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

EXPOSURE PATHWAY IS MILK ING EXPOSED ORGAN IS BONE

DOSES SHOWN BELOW ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DIRECTION	XRHO 1.5	XRHO 2.5	XRHO 3.5	XRHO 4.5	XRHO 7.5	XRHO 15.0	XRHO 25.0	XRHO 35.0	XRHO 45.0	XRHO 55.0	XRHO 65.0	XRHO 75.0
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

TOTAL DOSE COMMITMENT IS 0.000E+00 PERSON-REM/YR

WARNING--POPULATION FOOD INGESTION DOSES SHOWN ABOVE HAVE NOT BEEN CORRECTED TO REFLECT POTENTIAL FOOD EXPORT AND MAY EXCEED DOSES ACTUALLY RECEIVED BY THE POPULATION OF THIS REGION. SEE SUMMARY TABLE FOR THIS INFORMATION.

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

..Y PRINT OF POPULATION DOSES COMPUTED FOR TSTEP 1--DOSES SHOWN ARE ANNUAL POPULATION DOSE COMMITMENTS, PERSON-REM PER YEAR

DOSES RECEIVED BY PEOPLE WITHIN 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	3.898E-01	3.157E+00	5.081E-02	2.368E+00	1.138E+00	1.806E+02
GROUND	2.138E-02	2.138E-02	2.138E-02	2.138E-02	2.138E-02	2.138E-02
CLOUD	1.550E+00	1.550E+00	1.550E+00	1.550E+00	1.550E+00	1.550E+00
VEG. ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MEAT ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTALS	1.962E+00	4.729E+00	1.623E+00	3.940E+00	2.710E+00	1.821E+02

DOSES RECEIVED BY PEOPLE BEYOND 80 KILOMETERS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GROUND	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CLOUD	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
VEG. ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MEAT ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	1.086E+02	1.481E+03	2.468E+01	1.086E+02	1.086E+02	6.910E+02
TOTALS	1.086E+02	1.481E+03	2.468E+01	1.086E+02	1.086E+02	6.910E+02

TOTAL DOSES COMPUTED OVER ALL POPULATIONS

PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INHAL.	3.898E-01	3.157E+00	5.081E-02	2.368E+00	1.138E+00	1.806E+02
GROUND	2.138E-02	2.138E-02	2.138E-02	2.138E-02	2.138E-02	2.138E-02
CLOUD	1.550E+00	1.550E+00	1.550E+00	1.550E+00	1.550E+00	1.550E+00
VEG. ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MEAT ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MILK ING	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RNPLUS50	1.086E+02	1.481E+03	2.468E+01	1.086E+02	1.086E+02	6.910E+02
TOTALS	1.106E+02	1.486E+03	2.630E+01	1.125E+02	1.113E+02	8.732E+02

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

1 NAME=Mason House X= -0.5KM, Y= -0.3KM, Z= 0.0M, DIST= 0.5KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	2.75E+01	3.20E-01	3.10E-01	3.65E-01	3.31E-01	4.54E+02
CHILD	TOTALS	2.75E+01	3.27E-01	3.12E-01	3.37E-01	3.21E-01	4.54E+02
TEENAGE	TOTALS	2.75E+01	3.45E-01	3.14E-01	3.24E-01	3.18E-01	4.54E+02
ADULT	TOTALS	2.75E+01	3.43E-01	3.16E-01	3.25E-01	3.19E-01	4.54E+02

NUMBER 2 NAME=Reynolds Ranch X= 8.1KM, Y= 4.0KM, Z= 0.0M, DIST= 9.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	4.37E+00	3.01E-01	2.53E-01	5.21E-01	3.55E-01	6.86E+01
CHILD	TOTALS	4.36E+00	3.35E-01	2.65E-01	3.84E-01	3.10E-01	6.86E+01
TEENAGE	TOTALS	4.36E+00	4.23E-01	2.72E-01	3.23E-01	2.92E-01	6.86E+01
ADULT	TOTALS	4.37E+00	4.16E-01	2.82E-01	3.24E-01	2.96E-01	6.86E+01

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

3 NAME=Sundquist Ranch X= 1.4KM, Y= -12.9KM, Z= 0.0M, DIST= 12.9KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	1.53E+00	2.21E-01	1.59E-01	5.07E-01	2.90E-01	2.27E+01
CHILD	TOTALS	1.52E+00	2.65E-01	1.74E-01	3.28E-01	2.32E-01	2.27E+01
TEENAGE	TOTALS	1.52E+00	3.80E-01	1.84E-01	2.50E-01	2.09E-01	2.27E+01
ADULT	TOTALS	1.52E+00	3.70E-01	1.96E-01	2.51E-01	2.14E-01	2.27E+01

NUMBER 4 NAME=Lenzen Ranch X= -7.4KM, Y= -5.2KM, Z= 0.0M, DIST= 9.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	1.30E+00	1.41E-01	1.12E-01	2.76E-01	1.74E-01	1.97E+01
CHILD	TOTALS	1.29E+00	1.62E-01	1.19E-01	1.91E-01	1.46E-01	1.97E+01
TEENAGE	TOTALS	1.29E+00	2.16E-01	1.23E-01	1.54E-01	1.35E-01	1.97E+01
ADULT	TOTALS	1.30E+00	2.11E-01	1.29E-01	1.55E-01	1.38E-01	1.97E+01

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

5 NAME=Crouch Ranch X= -7.3KM, Y= -11.4KM, Z= 0.0M, DIST= 13.6KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	1.08E+00	1.44E-01	1.06E-01	3.19E-01	1.87E-01	1.61E+01
CHILD	TOTALS	1.07E+00	1.71E-01	1.15E-01	2.10E-01	1.51E-01	1.61E+01
TEENAGE	TOTALS	1.07E+00	2.41E-01	1.21E-01	1.62E-01	1.37E-01	1.61E+01
ADULT	TOTALS	1.08E+00	2.36E-01	1.29E-01	1.63E-01	1.40E-01	1.61E+01

NUMBER 6 NAME=Vollman Ranch X= 7.9KM, Y= -7.4KM, Z= 0.0M, DIST= 10.8KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	1.37E+00	1.72E-01	1.32E-01	3.57E-01	2.17E-01	2.06E+01
CHILD	TOTALS	1.36E+00	2.01E-01	1.42E-01	2.42E-01	1.79E-01	2.06E+01
TEENAGE	TOTALS	1.37E+00	2.75E-01	1.48E-01	1.91E-01	1.65E-01	2.06E+01
ADULT	TOTALS	1.37E+00	2.69E-01	1.56E-01	1.92E-01	1.68E-01	2.06E+01

TIME STEP NUMBER 1, DURATION IN YRS IS... 1.0

7 NAME=Baker Ranch X= 8.5KM, Y= 6.9KM, Z= 0.0M, DIST= 11.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	2.82E+00	1.98E-01	1.62E-01	3.66E-01	2.39E-01	4.44E+01
CHILD	TOTALS	2.82E+00	2.24E-01	1.71E-01	2.61E-01	2.05E-01	4.44E+01
TEENAGE	TOTALS	2.82E+00	2.91E-01	1.77E-01	2.15E-01	1.92E-01	4.44E+01
ADULT	TOTALS	2.82E+00	2.86E-01	1.84E-01	2.16E-01	1.94E-01	4.44E+01

NUMBER 8 NAME=Hornbuckle Ranch X= 5.2KM, Y= 8.5KM, Z= 0.0M, DIST= 10.0KM, IRTYPE= 1

40CFR190 ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CHILD	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TEENAGE	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADULT	TOTALS	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TOTAL ANNUAL DOSE COMMITMENTS COMPUTED FOR THIS LOCATION, MREM/YR

AGE	PATHWAY	EFFECTIV	BONE	AVG.LUNG	LIVER	KIDNEY	BRONCHI
INFANT	TOTALS	1.97E+00	1.37E-01	1.12E-01	2.55E-01	1.66E-01	3.09E+01
CHILD	TOTALS	1.96E+00	1.55E-01	1.18E-01	1.81E-01	1.42E-01	3.09E+01
TEENAGE	TOTALS	1.96E+00	2.03E-01	1.22E-01	1.49E-01	1.33E-01	3.09E+01
ADULT	TOTALS	1.97E+00	1.99E-01	1.27E-01	1.50E-01	1.35E-01	3.09E+01

Program execution time = 5.94 seconds

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CHAPTER 8
ALTERNATIVES TO THE PROPOSED ACTION

The solution mining method is proposed over other mining methods for recovery of uranium from these deposits because in situ mining is the most economical and environmentally sound method presently available for mining these reserves. This conclusion is based on the history of uranium mining in the South Powder River Basin area, which includes open pit mining, underground mining, and the solution mining projects.

8.1 ALTERNATE MINING METHODS

Underground and open pit mining represent the two currently available alternatives to solution mining for the uranium deposits in the project area. Both of these methods are not economically viable methods for producing the reserves in these deposits at this time.

From an environmental perspective, open pit mining or underground mining and the associated mill involve higher risks to employees, the public, and the environment. Radiological exposure to the personnel in these processes is increased not only from the mining process but also from milling and the resultant mill tailings. Moreover, the personnel injury rate is traditionally much higher in open pit and underground mines than has been the experience at ISL solution mining operations.

Both open pit and underground mining methods would require substantial de-watering to depress the potentiometric surface of the local aquifers to provide access to the ore. The ground water would contain naturally high levels of Ra-226 that would have to be removed prior to discharge resulting in additional radioactive solids that would have to be disposed of. For conventional mining, a mill tailings pond that could contain 5 to 10 million tons of solid tailings waste from the uranium mill would also be required.

In a comparison of the overall impacts of in situ leaching of uranium compared with conventional mining, an NRC evaluation [NUREG-0925 (1983) Para. 2.3.5] concluded that environmental and socioeconomic advantages of in situ leaching include the following:

(1) Significantly less surface area is disturbed than in surface mining, and the degree of disruption is much less.

(2) No mill tailings are produced, and the volume of solid wastes is reduced significantly. The gross quantity of solid wastes produced by in situ leaching is generally less than 1% of that produced by conventional

milling methods [more than 948 kg (2090 lb) of tailings usually result from processing each metric ton (2200 lb) of ore].

(3) Because no ore and overburden stockpiles, or tailings pile(s), are created and the crushing and grinding ore-processing operations are not needed, the air pollution problems caused by windblown dusts from these sources are eliminated.

(4) The tailings produced by conventional mills contain essentially all of the radium-226 originally present in the ore. By comparison, less than 5% of the radium in an ore body is brought to the surface when in situ leaching methods are used. Consequently, operating personnel are not exposed to the radionuclides present in and emanating from the ore and tailings, and the potential for radiation exposure is significantly less than that associated with conventional mining and milling.

(5) By removing the solid wastes from the site to a licensed waste disposal site and otherwise restricting them from contaminating the surface and subsurface environment, the entire mine site can be returned to unrestricted use within a relatively short time.

(6) Solution mining results in significantly less water consumption than conventional mining and milling.

(7) Socioeconomic advantages of in situ leaching include:

- ability to mine a lower grade ore,
- a minimum of capital investment,
- less risk to the miner,
- shorter lead time before production begins, and
- lower manpower requirements.

8.2 ALTERNATIVE SITES FOR THE PROCESSING PLANTS

No alternative sites for the processing plants was considered since most of the facilities and support systems are already in place from past uranium operations. Additions to the existing facilities will be required; however, no new surface disturbances will be needed for the yellowcake processing facilities.

8.3 ALTERNATIVE ENERGY SOURCES

A discussion of alternative energy sources available to the USA has been prepared by US NRC in prior solution mining licensing actions. A summary of the subject is included in Chapter 2.2 of NUREG-0925 (US NRC, 1983) prepared for the Teton Uranium ISL Project (Docket 40-8781).

8.4 ALTERNATE LEACH SOLUTIONS

The sodium carbonate/carbon dioxide leach solution was selected for the proposed project because of favorable performance in the pilot programs and other commercial ISL operations with no significant adverse environmental impact. Alternate leach solutions include ammonium carbonate solutions and acidic leach solutions. These solutions have been used in solution mining programs; however, operators have experienced difficulty in restoring and stabilizing the aquifer, therefore these solutions were excluded from consideration.

8.5 GROUND WATER RESTORATION ALTERNATIVES

The proposed combination of ground water sweep and EDR/RO clean water reinjection was selected because of the proven success in the pilot program and other commercial ISL operations. It is currently considered the Best Practicable Technology (BPT) available by the NRC and state regulatory authorities.

8.6 LIQUID WASTE DISPOSAL ALTERNATIVES

The use of deep waste disposal wells in conjunction with storage/evaporation ponds to dispose of the high TDS liquid wastes that primarily results from the yellowcake processing and drying facilities is considered the best alternative to dispose of these types of wastes. The zones receiving these wastes are approximately 9,000 – 10,000 feet below the ground surface and are authorized by the State of Wyoming and the EPA UIC Program to receive such wastes.

The use of the deep disposal wells in combination with the existing land application (irrigation) facilities to dispose of the treated wellfield purge fluids has proven to be the most cost effective way to dispose of this relatively good quality waste water.

CHAPTER 9
MANAGEMENT ORGANIZATION AND ADMINISTRATIVE PROCEDURES

9.1 ENVIRONMENT, HEALTH, AND SAFETY MANAGEMENT

Power Resources, Inc. (PRI) will maintain a performance-based approach to the management of the environment, health and safety program, including radiation safety. The Environment, Health and Safety Systems Management Program encompasses licensing, compliance, environmental monitoring, industrial hygiene, and health physics programs under one umbrella, and it includes involvement by the individual worker to the senior management of PRI. This program will allow PRI to operate efficiently and maintain an effective Environment, Health and Safety Program (EHS Program).

9.2 ENVIRONMENT, HEALTH AND SAFETY MANAGEMENT ORGANIZATION

Figure 9-1 is a partial organization chart for PRI with respect to the operation of the Smith Ranch – Highland Uranium Project (SR-HUP) and associated operations, and represents the management levels that play a key part in the Environmental, Health and Safety Systems Management Program and may serve a functional part of the Safety and Environmental Review Panel (SERP) described under Section 9.5.2.1. The dashed line of reporting signifies a dual reporting function. This organization allows environmental, health, industrial safety, and radiation safety matters to be considered at any management level.

9.3 ENVIRONMENT, HEALTH AND SAFETY MANAGEMENT QUALIFICATIONS

9.3.1 Board of Directors

The Board of Directors has the ultimate responsibility and authority for radiation safety and environmental compliance for PRI, including the SR-HUP and associated operations. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors directly provides operational direction to the President of PRI.

9.3.2 President

The President is responsible for interpreting and acting upon the Board of Directors policy and procedural decisions. The President directly supervises the Senior Vice President of Operations. The President is empowered by the Board of Directors to have the responsibility and authority for the radiation safety and environmental compliance programs. He is responsible for ensuring that Operations staff are complying with all applicable regulations and permit/license conditions through direct supervision of the Senior Vice President of Operations.

9.3.3 Senior Vice President of Operations

The Senior Vice President of Operations reports to the President and is directly responsible for ensuring that Corporate Operations personnel (including the Smith Ranch - Highland Uranium Project) comply with Industrial Safety, Radiation Safety, and Environmental Protection Programs as stated in the EHS Management System. The Senior Vice President of Operations is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The Senior Vice President of Operations has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health, the environment, or potentially a violation of state or federal regulations as indicated in reports from the Manager-Health, Safety and Environmental Affairs/CRSO or the RSO.

The Senior Vice President of Operations directly supervises the General Manager of Operations.

9.3.4 Mine Manager

The Mine Manager is responsible for managing the day-to-day operations at the SR-HUP/Reynolds Ranch, and reports directly to the Senior Vice President of Operations. The Mine Manager is responsible for ensuring that SR-HUP/Reynolds Ranch personnel comply with Industrial Safety, Radiation Safety, Environmental Protection Programs, and all relevant state and federal regulations.

The Mine Manager has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Mine Manager cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the Senior Vice President of Operations, the Manager-Health, Safety and Environmental Affairs/CRSO, or the RSO.

The position of Mine Manager requires a Bachelor's Degree in engineering or science form an accredited college or university, or equivalent work experience, and a minimum of five years supervisory experience. Work experience will include industrial process/production experience, and industrial process/production management.

9.3.5 Manager-Health, Safety and Environmental Affairs/Corporate Radiation Safety Officer (CRSO)

Reporting directly to the Mine Manager, the Manager-Health, Safety and Environmental Affairs/Corporate Radiation Safety Officer (CRSO) oversees all Radiation Protection, Health, and Environmental Programs as stated in the EHS Management System, at company operations, including the SR-HUP/Reynolds Ranch. This position assists in the development and review of radiologic and environmental sampling and analysis procedures and is responsible for routine auditing of the programs. The Manager-Health, Safety and Environmental Affairs/CRSO has the responsibility and authority to suspend, postpone, or modify any activity that is determined to be a threat to employees, public health, the environment or potentially a violation of state or federal regulations. As such, the Manager-Health, Safety and Environmental Affairs/CRSO has a secondary reporting requirement to the Senior Vice President of Operations.

The position of Manager-Health, Safety and Environmental Affairs/CRSO requires a Bachelor's degree in an engineering or science field from an accredited college or university, or an equivalent level of work experience. Additionally, a minimum of five years of experience in environmental and safety management and operations functions will be required as well as the ability to meet the requirements of Regulatory Guide 8.31 for the position of RSO.

9.3.6 Senior Environmental Scientist

The Senior Environmental Scientist is primarily responsible for assisting in the implementation of the environmental compliance programs and the compilation of required reports. This position also assists with the industrial and radiation safety programs. This position supervises the Environmental Specialist or Environmental Technician. This position reports directly to the Manager-Health, Safety and Environmental Affairs/CRSO.

The position of Senior Environmental Scientist requires a minimum of a Bachelor's Degree from an accredited college or university in the physical sciences, biology, engineering or related discipline and must be computer literate and have at least four years experience in environmental compliance and permitting.

9.3.7 Environmental Specialist or Environmental Technician

The Environmental Specialist or Environmental Technician assists with the implementation of the environmental compliance programs including maintaining ground water monitoring data bases and waste management programs. This position also assists with the industrial and radiation safety programs and may be used as a training position for Radiation Safety Technician (RST). The position normally reports to the Senior Environmental Scientist, but will report radiation safety items directly to the RSO or CRSO.

The position of Environmental Specialist requires a minimum of a Bachelor's Degree in the physical sciences, environmental science, engineering or a related field. One year of directly related experience is desired, but not required.

The position of Environmental Technician may be utilized in lieu of the Environmental Specialist depending on the level of responsibility given to the position and required qualifications for that level of responsibility. The position of Environmental Technician requires a minimum of an Associates Degree, or relevant experience in physical sciences, environmental science, or related field.

9.3.8 Radiation Safety Officer (RSO)

Reporting directly to the Manager-Health, Safety and Environmental Affairs/CRSO, the Radiation Safety Officer (RSO) is responsible for the daily supervision of the radiation safety programs at company operations, including the SR-HUP. Responsibilities include the development and implementation of all radiation safety programs, ensuring that all records are correctly maintained, and assisting the Manager-Health, Safety and Environmental Affairs/CRSO in ensuring compliance with NRC regulations and license conditions applicable to worker health.

The RSO conducts training programs for the supervisors and employees with regard to the proper application of radiation protection procedures. The RSO personally inspects facilities to verify compliance with all applicable radiological health and safety requirements. The RSO has the responsibility and the authority, through appropriate line management, to suspend, postpone, or modify any work activity that is unsafe or potentially a violation of NRC regulations or license conditions, including the ALARA program. Depending on the level of activity at the site, the RSO may also fulfill the responsibilities of the RST.

The position of RSO requires a minimum of a Bachelor's Degree in an engineering or science field from an accredited college or university, or an equivalent level of work experience. Additionally, the position of RSO requires a combination of education, training, and/or experience in applied health physics and radiation protection to meet the requirements of NRC Regulatory Guide 8.31.

9.3.9 Radiation Safety Technician (RST)

The Radiation Safety Technician (RST) conducts radiological surveys, collects air, water, soil and vegetation samples, performs analyses and collects data for the radiation safety program, performs calculations of employee radiation exposures, keeps records, and conducts various other activities associated with implementation of the environmental and radiation protection programs. The RST reports directly to the RSO. Depending on the level of activity at the site, the responsibilities of the RST and RSO may be combined.

The position of RST requires a minimum of a high school diploma, or alternatively, an equivalent combination of experience and training in radiation protection at uranium mining and/or processing operations.

9.3.10 Safety Supervisor

The Safety Supervisor is responsible for the non-radiation related health and safety programs. Responsibilities include the development and implementation of health and safety programs in compliance with the Wyoming State Mine Inspector Office regulations. Responsibilities include safety training of new and existing employees, and the maintenance of appropriate records to document compliance with regulations. The Safety Supervisor may also be a qualified RST and functions in this capacity when needed. The Safety Supervisor reports directly to the Manager-Health, Safety and Environmental Affairs/CRSO.

In addition to meeting the qualifications and training requirements of the RST (as described in Section 9.3.7 above), the Safety Supervisor should have two (2) years of college in the physical sciences, engineering, or health fields. Two years of applied occupational safety experience may be substituted for each one (1) year of college. In any event, a minimum of a High School Diploma or equivalent is required.

9.4 ALARA POLICY

The purpose of the ALARA (As Low As Reasonably Achievable) Policy is to keep exposures to all radioactive nuclides and other hazardous material as low as possible and to as few personnel as possible, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

In order for an ALARA Policy to correctly function, all individuals including management, supervisors, health physics staff, and workers, must take part and each share in the responsibility to keep all exposures as low as reasonably achievable. This policy addresses this need and describes the responsibilities of each.

9.4.1 Management Responsibilities

Consistent with Regulatory Guide 8.31, the licensee Management is responsible for the development, implementation, and enforcing the applicable rules, policies, and procedures as directed by regulatory agencies and company policies. These shall include the following:

1. The development of a strong commitment to and continuing support of the implementation and operations of the ALARA program;

2. An Annual Audit Program which reviews radiation monitoring results, procedural, and operational methods;

3. A continuing evaluation of the Health Physics Program including adequate staffing and support;

4. Proper training and discussions which address the ALARA program and its function to all facility employees and, when appropriate, to contractors and visitors.

9.4.2 Radiation Safety Officer Responsibility

The RSO shall be charged with ensuring technical adequacy, proper radiation protection, and the overall surveillance and maintenance of the ALARA program. The RSO shall be assigned the following:

1. The responsibility for the development and administration of the ALARA program;

2. Sufficient authority to enforce regulations and administrative policies that affect any aspect of the Health Physics Program;

3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the Health Physics Program;

4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA program;

5. Assist with conducting an Annual ALARA Audit with Management to determine the effectiveness of the program and make any appropriate

recommendations or changes as may be dictated by the ALARA philosophy;

6. Review annually all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure the procedures are ALARA and do not violate any newly established or instituted radiation protection practices;

7. Conduct or designate daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle.

9.4.3 Supervisors Responsibility

Supervisors shall be the front line for implementing the ALARA program. Each shall be trained and instructed in the general radiation safety practices and procedures. Their responsibilities include:

1. Adequate training to implement the general philosophy behind the ALARA program;

2. Provide direction and guidance to subordinates in ways to adhere to the ALARA program;

3. Enforcement of rules and policies as directed by regulatory agencies and company management;

4. Seek additional help from management and the RSO should radiological problems be deemed by the supervisor to be outside their sphere of training.

9.4.4 Worker Responsibility

Because success of both the radiation protection and ALARA programs are contingent upon the cooperation and adherence to those policies by the workers themselves, the facility employees must be responsible for certain aspects of the program in order for the program to accomplish its goal of keeping exposures as low as possible. Worker responsibilities include:

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO;

2. Making valid suggestions which might improve the ALARA program;

3. Reporting promptly, to immediate supervisor, any malfunction of equipment or violation of procedures which could result in an unacceptable increased radiological hazard;

4. Proper use and fit testing of any respirator;

5. Proper use and returning of any bioassay sample kit at its required time.

9.5 MANAGEMENT CONTROL PROGRAM

9.5.1 PRI Environment, Health and Safety Management System

PRI's Environment, Health and Safety (EHS) Management System formalizes the Company's approach to EHS management to ensure a consistency across its operations. The management system is a key element assuring that the management demonstrates "due diligence" in addressing EHS issues and describes how the operations of the facility will comply with the requirements of the PRI EH&S Policy and Regulatory requirements.

The EHS Management System:

- Assures that sound management practices and processes are in place to ensure that strong EHS performance is sustainable.
- Clearly sets out and formalizes the expectations of EHS management.
- Provides a systematic approach to the identification of EHS issues and ensures that a system of risk identification and management is in place.
- Provides a framework for personal, site and corporate EHS responsibility and leadership.
- Provides a systematic approach for the attainment of PRI's EHS objectives.
- Ensures continued improvement of EHS programs and performance.

The EHS Management System has the following characteristics:

- The system is compatible with the ISO 14001 Environment Management System.
- The system is straightforward in design and is intended as an effective management tool for all types of activities and operations, and is capable of implementation at all levels of the organization.

- The system is supported by standards that clearly spell out PRI's expectations, while leaving the means by which these are attained as a responsibility of line management.
- The system is readily auditable.
- The system is designed to provide a practical tool to assist the operations in identifying and achieving their EHS objectives while satisfying PRI's governance requirements.

The EHS Management System uses a series of standards that aligned with specific management processes and sets out the minimum expectations for EHS performance. The standards consist of management processes that consist of assessment, planning, implementation (including training, corrective actions, safe work programs, and emergency response), checking (including auditing, incident investigation, compliance management, and reporting), and management review. PRI has developed procedures consistent with these standards and regulatory requirements to implement these management controls.

9.5.1.1 Historical Management Program Activities

Commercial operations at the Highland Facility were authorized by the NRC in July 1987. Both the Smith Ranch and Highland operations are located at past surface or underground uranium mining operations and substantially use buildings and other facilities remaining from those historic operations. Both operations utilized numerous Standard Operating Procedures (SOPs) to assist with implementation of radiation safety, environmental monitoring, and management procedures.

In July 2000, Rio Algom Mining Corp. (RAMC) finalized the EHS Management System Procedures for the Smith Ranch Facility. The procedures are contained in the following 8 volumes:

Volume 1 – Management System Manual
Volume 2 – Management Procedures
Volume 3 – Operating Procedures (SOPs)
Volume 4 – Health Physics Manual
Volume 5 – Health and Safety Manual
Volume 6 – Environmental Manual
Volume 7 – Training and Awareness Manual
Volume 8 – Emergency Procedure Manual

In July 2002 PRI acquired the Smith Ranch facility and combined operations with the Highland operation into the Smith Ranch – Highland Uranium Project (SR-HUP). Soon after the workforces of both operations were combined and EHS Department personnel were consolidated at the Smith Ranch Main Office complex, activities began to modify the EHS Management System Procedures in order that it could be utilized by PRI Management and the newly combined SR-HUP workforce. The initial focus of these efforts included revising procedures detailing emergency procedures and the processing of resin from the Highland Satellites at the Smith Ranch CPP. Currently (December 2004), revisions to the EHS Management System are approximately 80% complete.

As committed to the NRC during the license transfer process as well as during the September 9-11, 2002 NRC Inspection for the combined SR-HUP facilities, PRI is committed to revising the EHS Management System Procedures accordingly and utilizing the system to augment the operation of the combined operations. No violations were determined during the latest (August 23-25, 2004) NRC inspection.

9.5.2 Performance Based License Condition

This license application is the basis of the Performance Based License, and under that license PRI may, without prior U.S. Nuclear Regulatory Commission approval or the need to obtain a License Amendment:

1) Make changes to the facility or process, as presented in the license application (as updated).

2) Make changes in the procedures presented in the license application (as updated).

3) Conduct tests or experiments not presented in the license application (as updated).

A License Amendment and/or NRC approval will be necessary prior to implementing a proposed change, test or experiment if the change, test or experiment would:

1. Result in any appreciable increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);

2. Result in any appreciable increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the license application (as updated);

3. Result in any appreciable increase in the consequences of an accident previously evaluated in the license application (as updated);

4. Result in any appreciable increase in the consequences of a malfunction of an SSC previously evaluated in the license application (as updated);

5. Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);

6. Create a possibility for a malfunction of an SSC with a different result than previously evaluated in the license application (as updated);

7. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER) or the environmental assessment (EA) or technical evaluation reports (TERs) or other analysis and evaluations for license amendments.

8. For purposes of this paragraph as applied to this license, SSC means any SSC which has been referenced in a staff SER, TER, EA, or environmental impact statement (EIS) and supplements and amendments thereof.

Additionally, the licensee must obtain a license amendment unless the change, test, or experiment is consistent with the NRC conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility Safety Evaluation Report, TER, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, EISs issued with amendments to this license.

Determination of compliance concerning the above listed conditions will be made by a "Safety and Environmental Review Panel (SERP)." The SERP will consist of a minimum of three individuals. One member of the SERP will have expertise in management and will be responsible for managerial and financial approval for changes; one member will have expertise in operations and/or construction and will have expertise in implementation of any changes; and one member will be the Radiation Safety Officer (RSO), or equivalent. Other members of the SERP may be utilized as appropriate, to address technical aspects of the change, experiment or test, in several areas, such as health physics, ground water hydrology, surface water hydrology, specific earth sciences, and others. Temporary members, or permanent members other than the three identified above, may be consultants.

9.5.2.1 Organization of the Safety and Environmental Review Panel

The composition of the SERP shall be as follows:

Number of Participants: No less than 3 persons. It may consist of more participants.

Required Participants:

Radiation Safety Officer or equivalent (such as the CRSO)

A member of Facility Management
(e.g. Facility General Manager)

A member of Operations Management
(e.g. Plant Manager, Wellfield Manager, etc.)

Other members of the SERP may be utilized as appropriate to address technical aspects described in Section 9.5.2 shown above in several areas of expertise such as health physics, ground water hydrology, surface water hydrology, specific earth sciences, and other areas. Temporary or permanent members other than the three above may be consultants

9.5.3 <u>Safety and Environmental Review Panel Responsibilities</u>

This procedure will be used for the evaluation of all major changes to the facility operations as described in Section 9.5.2 of this chapter. The changes may be derived from operational and/or economic considerations, and can include changes dictated by regulatory requirements including Federal and State agencies outside of the NRC organization. The following reviews shall be carried out by the SERP. The SERP may delegate any portion of these responsibilities to a committee of two or more members of the SERP. This committee will report their findings to the full SERP for a determination of compliance with Section 9.5.2 of this chapter.

1. Operations / Technical Review
   a. Review operating criteria and critical equipment and determine the following:
      i. Does the proposed change impact the operations as described in the license application?
      ii. Does the proposed change significantly change the processes used at the facility as described in the license application?
   b. Review the Standard Operating Procedures, (SOP), for the proposed change and determine the impact on current SOP's.

Make the necessary updates to the current SOP's or develop new ones.

c. If applicable, review the Emergency Response Plan and determine compatibility with it.

2. Environmental / Health Physics / Safety Review

a. Review the proposed change to determine if any changes in monitoring and record keeping are required to ensure compliance with existing programs.
b. Review the proposed changes and determine the need for additional training.
c. Review key personnel training records and determine training needs as required by the proposed change.

3. Compliance Review

a. Review the proposed change and determine whether it will conflict with Corporate or facility policies regarding training, safety, and responsibility concerns.
b. Review the proposed change and determine compliance with the facility NRC Source Material License.
c. Review the proposed change and determine compliance with NRC regulations and other Federal and State regulations.

Upon completion of this review, the SERP will determine if the proposed change meets the criteria listed in Section 9.5.2. If the proposed change does meet those criteria, then the SERP may implement the change and provide a record of that change as described in Section 9.5.4 of this chapter. If the proposed change does not meet those criteria, then the change will not be implemented until approval of a License Amendment is received from the U.S. Nuclear Regulatory Commission.

9.5.4 Record Keeping and Reporting

Records will be kept of all changes made following the Performance Based License requirements. These records shall include written safety and environmental evaluations, performed by the SERP, that provide the basis for the determination that the change is in compliance with the requirements referred to in Section 9.5.2. These records shall be maintained by the RSO and a copy provided to the facility General Manager and members of the SERP.

An Annual Report will be submitted to the U.S. NRC that provides a description of changes, tests, or experiments made pursuant to the SERP approval process including a summary of the safety and environmental evaluation of each review.

Additionally, all pages that reflect a change made to the license application under the Performance Based License Condition will be submitted with this report. Each replacement page shall include both a change indicator for the area of change, (e.g., Bold marking vertically in the margin adjacent to the portion actually change), and a page change identification, (date of change or change number, or both).

9.6 EMPLOYEE TRAINING

All newly hired permanent facility employees will attend a training program conducted by the RSO or another qualified individual on the basic principles of radiation safety, health hazards of exposure to uranium, personal hygiene practices for uranium facilities, radiation safety procedures, and responses to emergencies or accidents involving radioactive materials. A written examination will be given at the completion of the training and the instructor will review all questions with incorrect answers with the employees. Each worker must achieve a predetermined passing score before being allowed to work in a controlled or restricted area of the facility. The written examination for these employees shall be maintained on file.

All permanent facility workers will also receive an Annual Refresher Training course that includes a review of any new radiation safety regulations, site safety experience and radiation exposure trends. Radiation safety problems or subjects will also be offered for discussion at least four times per year in the Quarterly Safety Meetings. Safety Meeting subjects and attendance records will be maintained on file at the site. Specialized instruction on the radiation health and safety aspects of jobs involving higher than normal exposure risks will be provided by the RSO, RST and/or Supervisor.

Each worker who may be required to use respiratory protective equipment will receive training in the use of the specific equipment to be used. No person shall use respiratory equipment until they are specifically trained in the use of the equipment.

9.7 STANDARD OPERATING PROCEDURES

Written Standard Operating Procedures (SOPs) will be established for all operational activities involving radioactive materials that are handled, processed, stored, or transported by employees. The procedures will enumerate pertinent radiation safety procedures to be followed. Written procedures shall also be established for in-plant and environmental monitoring, bioassay analysis, and instrument calibration for activities involving radiation safety. A copy of the written procedure will be kept in the area where it is used. All procedures involving radiation safety will be reviewed and approved in writing by the RSO or another individual with similar qualifications prior to being implemented. The RSO and/or his designee(s) will review the operating procedures annually.

In the case that employees are required to conduct activities of a non-routine nature where there is the potential for significant exposure to radioactive materials, and no SOPs exist for the activity, a Radiation Work Permit (RWP) will be required. The RWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The RWP shall be reviewed and approved in writing by the RSO, RST, or a designated supervisor in the absence of the RSO or RST, prior to initiation of the work.

9.8 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM

External radiation exposure was monitored at the Highland Uranium Project during the period 1988 through 1993 by the use of personal radiation dosimeters, such as Thermoluminescent Dosimeter badges (TLDs) or Optically Stimulated Luminescent dosimeter badges (OSLs). All employees, except several office personnel that did not enter areas where potential exposures existed, utilized dosimeters. During the period 1988 through 1993 the monitoring data collected from the dosimeters shows that the annual dose to all workers was less than 10 percent of the 5000 mrem annual limit contained in 10 CFR 20.1201(a). Therefore, consistent with 10 CFR 20.1502, beginning on January 1, 1994, individual monitoring devices, such as TLDs, were only used to monitor occupational exposures to Central Plant Operators because they could potentially exceed 10 percent of the annual limit contained in 10 CFR 20.1201(a) due to the potential exposure to airborne uranium. Accordingly, it is not required that occupational exposures to external radiation be determined or recorded for other workers, although PRI has continued to monitor some additional workers.

To ensure that potential exposures to gamma radiation remain less than 10 percent of the annual limit (or less than 500 mrem), the two work groups with the greatest potential for exposure (Central Plant Operators and Satellite/Restoration Operators) will utilize NRC approved dosimeters. Quarterly monitoring data collected from these badges will be recorded and reviewed annually to ensure that exposures do not exceed 500 mrem.

Additionally, quarterly gamma surveys are performed at specified locations throughout the Satellite buildings and Central Processing Facilities (CPFs) to assure that areas requiring posting as "Radiation Areas" are identified, posted, and monitored to assess external radiation conditions. "Radiation Areas" are those areas exhibiting 5 to 100 mrem per hour at a distance of 30 cm from the source. Radiation Areas are posted at various locations in the yellowcake processing areas of the CPFs and Satellites, and consist of IX columns and, various tanks and filter apparatuses. Both Yellowcake Warehouses, located at each CPF, are posted as Radiation Areas.

9.9 BIOASSAY PROGRAM

A Bioassay (urinalysis) Program consistent with the program outlined in Revision 1 of NRC Regulatory Guide 8.22 "Bioassay at Uranium Mills" has been implemented and will be maintained at the SR-HUP. All permanent employees that will handle yellowcake submit a baseline urinalysis prior to their initial assignment at the facility. A urinalysis is also required from all permanent employees at the time of termination of employment if they were recently involved in yellowcake processing activities. Central Plant and Dryer Operators, who are the only workers to routinely work in the yellowcake precipitation, drying and packaging areas, are required to submit monthly urine specimens for uranium analysis. Specimens are collected 2 to 4 days after the employee has left the work area (i.e., after a weekend and prior to entering the work area). Consistent with Regulatory Guide 8.22, quality control of the monthly urinalyses is assured by including one blank and two spiked samples with each month's batch of specimens. The blank and spiked samples are labeled with non-employee names in order that the contract laboratory is not aware of the particular specimens content. Laboratory results for these specimens are compared with known values to ensure that laboratory results are accurate.

Workers potentially exposed to concentrations of uranium above regulatory limits are also required to submit urine specimens for uranium analysis 2 to 4 days following the potential exposures. Workers meeting this requirement are typically working under the direction of a Radiation Work Permit (RWP). This is done even if respiratory protection has been utilized to ensure that the respiratory protection equipment has been worn properly and to ensure that respirators are functioning as designed.

PRI also randomly obtains, on a monthly basis, urine specimens from other workers at the facility to confirm that workers are not subject to an unknown uptake of uranium.

The contract laboratory provides immediate notification (via telephone or fax) of all urinalyses exceeding 15 μg/L uranium. Table 9-1 lists the actions taken for individual urinalysis results.

9.10 AIRBORNE RADIATION MONITORING PROGRAM

9.10.1 Airborne Uranium Particulate Monitoring

There is no potential for exposure to ore dust at the SR-HUP/Reynolds Ranch since the facility is an ISL uranium mine. However, there is the potential for exposure of workers to yellowcake dust in certain areas of the SR-HUP. In the drying and packaging areas at Highland the potential exists for exposure to yellowcake dust that is classified as "insoluble" since the operating temperature of the Dryer is in excess of 400°C (752°F) The Highland Dryer typically operates at about 600°C (1100°F).

In the drying and packaging areas at Smith Ranch the potential exists for exposure to yellowcake dust that is classified as "soluble" since the operating temperature of the Vacuum Dryer is low (about 77°C or 170°F). In the slurry unloading area the potential for exposure to airborne uranium is considerably less than in the drying and packaging areas. The yellowcake dust is classified as soluble in the slurry unloading area. Slurry unloading is performed on a very infrequent basis.

9.10.1.1 Airborne Uranium Monitoring at the Highland Central Plant

When the Highland Central Plant is operating, there is continuous monitoring of airborne uranium particulates at the drying and packaging areas. During periods of drying and packaging activity, the filters of the continuous air monitors are changed and analyzed daily. During periods that drying and packaging activities are not occurring, the filters are changed and analyzed on a weekly basis.

Exposures to workers are determined from the conservatively estimated uranium particulate concentration data, occupancy time studies, and the application of the Applied Protection Factor (APF) of 100 for the routine use of fullface air purifying respirators. Consistent with the Respiratory Protection Program, all Highland Central Plant Operators utilizing negative pressure respirators are required to pass the quantitative fit test.

When the Highland Central Plant is operating, the Precipitation Area of the plant is monitored on a quarterly basis for airborne uranium. A review of the historic data shows that maximum airborne uranium concentrations were less than 1% of the DAC for soluble uranium (5E-10 μCi/ml).

9.10.1.2 Airborne Uranium Monitoring at the Smith Ranch Central Processing Plant (CPP)

Airborne uranium particulate monitoring at the Smith Ranch CPP and Pilot Building was historically performed on a monthly basis. Given the extensive data base that exists for the Pilot Building that shows the virtual lack of airborne uranium in this area, and the fact that IX equipment and tanks have been removed, it is not necessary to further monitor this area for airborne uranium.

Airborne uranium particulates at the Smith Ranch CPP are monitored to assess any unanticipated occurrence of uranium in the air and provide uranium airborne concentration data used in the exposure determinations for the CPP Operators and the Dryer Operators. The monitoring locations and frequency are as follows:

Location	Frequency
Precipitation Area	Monthly
Yellowcake Storage Area	Monthly
Dryer Room	Monthly

To estimate the routine exposure of Dryer Operators to uranium, a high volume sampler is set up in the yellowcake packaging area or representative samples are collected with a Breathing Zone (BZ) sampler. Dryer Operators are required to wear respiratory protection during yellowcake packaging operations because of the potential release of airborne uranium during this procedure.

9.10.1.3 Airborne Uranium Monitoring at Satellites

Due to the fact that the uranium bearing fluids at the Satellite facilities are fully contained within pipes, tanks, and IX vessels the likelihood of any significant quantities of uranium in the air is very remote. This is supported by many years of data collected at both Smith Ranch and Highland Satellites that show virtually no occurrence of airborne uranium at these facilities. Therefore, uranium particulates are not routinely monitored at these facilities.

9.10.1.4 Radon Daughter Monitoring

Radon daughters are routinely monitored on a monthly basis at the Highland CPF (when operating), the Smith Ranch CPP, and Satellite facilities. Routine exposures to radon daughters are only determined for Central Plant Operators. The method of analysis is the modified Kusnetz method or other commonly accepted method of measurement. In the case that radon monitoring determines concentrations above 0.08 WL, the monitoring frequency will be increased to weekly until the following four samples return to less than 0.08 WL.

During the period 1988 through 1993, weekly and monthly monitoring results at numerous sites throughout the project showed that radon daughter concentrations were routinely less than 10% of the regulatory limit of 0.33 working level. Therefore, it was determined that the routine exposure of workers to radon daughters only needed to be determined for Central Plant Workers (Central Plant and Dryer Operators).

9.10.1.5 Airborne Radioactive Areas

Any area, room, or enclosure will be designated an "Airborne Radioactivity Area" as defined in 10 CFR 20.1003, if at any time the uranium concentration exceeds 5E-10 µCi/ml for soluble uranium or 2E-11 µCi/ml for insoluble uranium.

When operating, both the Yellowcake Dryer Room and Yellowcake Packaging Room at Highland are posted as Airborne Radioactivity Areas as concentrations of insoluble uranium may at times exceed 2E-11 μCi/ml. Because the predominant form of airborne uranium in these areas is comprised of high-fired (above 400°C) dried yellowcake, the insoluble uranium DAC (2E-11 μCi/ml) is used.

Additionally, areas will be posted as "Airborne Radioactivity Areas" in the case that an individual present in the area without respiratory protection could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the ALI or 12 DAC-hours. Airborne Radioactivity Areas are posted in accordance with 10 CFR 20.1902. PRI will avoid posting radiation hazard signs in areas that do not require them.

9.11 EXPOSURE CALCULATION

Employee exposures at the SR-HUP are monitored in accordance with USNRC Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses." A bioassay program consistent with USNRC Regulatory Guide 8.22, Rev. 1 "Bioassay at Uranium Mills" is utilized as a means of ensuring the adequacy of the monitoring and respiratory protection programs for protection from airborne uranium dust.

Employee exposure to airborne uranium is estimated for routine and non-routine activities. The exposure to dried yellowcake at Highland is considered "insoluble" (Y-Class) and the exposure to dried yellowcake at Smith Ranch is considered "soluble" (D-Class). Exposure to any uranium that has not been through any drying process is considered "soluble" (D-Class).

The exposure estimates are based on exposure times and the concentrations of airborne uranium as determined from routine air monitoring or non-routine air monitoring (i.e. breathing zone monitoring or specific area air monitoring). Routine exposures to uranium and radon daughters are only determined for the Central Plant Workers (Central Plant Operators, Dryer Operators) as, in accordance with 10 CFR 20.1502(b)(1), they are the only workers routinely exposed to airborne radionuclides in concentrations which are likely to result in annual exposures in excess of 10% of the ALI, without respiratory protection. These potential exposures result from the need to work in the yellowcake dryer and yellowcake packaging facilities. Routine exposures are estimated using exposure times generated from Annual Time Studies or actual occupancy times. Time Studies are updated after any significant change in equipment procedures, or job functions.

Non-routine exposures to uranium result from performing non-routine operational or maintenance tasks that have the potential for creating a significant exposure to airborne uranium. These types of exposures are monitored utilizing a Radiation Work Permit (RWP). The RWP specifies the types of radiological monitoring required for the task (soluble or insoluble uranium) and the protective equipment and clothing employees must wear while performing the task. The sampling results are evaluated and documented. This data, together with the employee's time in the area, is used to estimate the non-routine exposure. Each Central Plant Worker's routine and non-routine exposure to soluble and insoluble uranium is recorded at least monthly and summarized annually.

Routine employee exposure to radon daughters is determined for only the Central Plant Workers. Similar to non-routine uranium exposures, non-routine radon daughter exposures are monitored utilizing an RWP. Routine exposure times are determined by annual time studies or actual occupancy times. Time studies are also updated after any significant change in equipment, procedures, or job functions. Each Central Plant Worker's routine and non-routine exposure to radon daughters is recorded monthly and summarized annually.

9.11.1 Airborne Uranium Exposure Calculation

The intake of soluble or insoluble yellowcake during the weekly or annual period being evaluated is estimated using the following equation:

$$I_u = \sum_{i=1}^{n} \frac{(x_i)(t_i)}{(DAC)(PF)}$$

Where:

I_u	=	uranium intake, DAC-hours
t_i	=	time that the worker is exposed to concentration x_i, hr
x_i	=	average concentration of uranium in the air, µCi/ml
DAC	=	the derived air concentration value for uranium (5E-10 µCi/ml for soluble, 2E-11 µCi/ml for insoluble) from Appendix B Table 1 of 10 CFR Part 20
PF	=	respirator protection factor from Appendix A of 10 CFR Part 20
n	=	number of exposures during the period of evaluation

9.11.2 Radon Daughter Exposure Calculation

The modified Kusnetz or equivalent method for determining exposure to radon daughters is utilized at the SR-HUP. From the monitoring data collected, the employees' intake of radon daughters is calculated using the following equation:

$$I_r = \sum_{i=1}^{n} \frac{(w_i)(t_i)}{(DAC)(PF)}$$

Where:

I_r	=	radon daughter intake, DAC-hours
t_i	=	time of exposure to concentration W_i, hr
w_i	=	average number of working levels in the air during time t_i
DAC	=	the derived air concentration value for radon daughters, (3E-8 µCi/ml or 0.33 WL) from Appendix B of 10 CFR Part 20
PF	=	respirator protection factor
n	=	number of exposure periods during the year

Section 20.2203 of 10 CFR requires that overexposure reports be made to the appropriate NRC Regional Office if the intake of uranium and/or radon exceeds the quantities specified in 10 CFR 20.1201. The following exposure limits require NRC notification:

1. Soluble Uranium - if an employee has an intake of more than 10 mg of soluble uranium in one week. This intake is in consideration of chemical toxicity.

2. Total Effective Dose Equivalent (TEDE) - if an employee exceeds the TEDE annual limit of 5 rem. The annual TEDE is determined by summing annual doses from soluble uranium, insoluble uranium and radon.

9.11.3 Calculation of Total Effective Dose Equivalent (TEDE)

In accordance with 10 CFR 20.1201, the Total Effective Dose Equivalent (TEDE) is determined on an annual basis for each Central Plant Worker by adding the deep dose external gamma exposures for the year to the internal exposures to radon daughters and uranium. The annual limit for the TEDE is 5 rem.

9.12 ADMINISTRATIVE ACTION LEVELS

An administrative action level is set at 2.5 mg of soluble uranium for any calendar week. An administrative action level is set at 125 DAC-hours for exposure to insoluble uranium and/or radon daughters for any calendar quarter. If the action level is exceeded, the RSO will initiate an investigation into the cause of the occurrence, determine any corrective actions that may reduce future exposures and document the corrective actions taken. Results of the investigation will be reported to management within one month of the action level being exceeded.

The results of the personal gamma radiation monitoring from the dosimeters are evaluated on a quarterly basis and an administrative action level is set at 312 mrem per quarter. If an employee's exposure exceeds this level, the RSO will investigate the reason for the exposure and initiate corrective measures to prevent a recurrence.

The results of the bioassay program are also used to evaluate the adequacy of the respiratory protection program at the facility. An abnormally high urinalysis will be investigated both to determine the cause of the high result and determine if the exposure records adequately reflected that such an exposure may have actually occurred.

9.13 CONTAMINATION CONTROL PROGRAM

9.13.1 General

The primary sources of potential surface contamination at the SR-HUP Project are associated with yellowcake precipitation, drying, and packaging activities. The recovery and elution portions of the process do not present a significant surface contamination problem except for dried spills or when special equipment maintenance is required. The primary method for control of surface contamination is instruction in, and enforcement of, good housekeeping and personal hygiene practices. Any visible yellowcake or production fluid spills will be cleaned up as soon as possible to prevent drying and possible suspension into the air which could pose an inhalation hazard. Plant Operators are instructed in the proper use of equipment and the prevention of spills and solution leaks at various stages of the process. Inadvertent contamination of designated Clean Areas is controlled by instructing employees not to enter such areas with clothing or equipment contaminated with radioactive materials.

9.13.2 Surface Contamination Control

To ensure these administrative controls are effective in controlling surface contamination, alpha contamination surveys are performed monthly in Process Areas and weekly in designated Clean Areas. Routine surveys in the Process Areas of the Central Processing Plants and Satellite facilities consist of both a visual inspection for obvious signs of contamination and instrument surveys to determine total alpha contamination. Visible yellowcake, outside the drying and packaging facilities, will require prompt cleanup to minimize the potential for the material to become airborne. If the total alpha survey indicates contamination greater than 200,000 dpm/100 cm^2, the area will be cleaned and resurveyed.

In designated Clean Areas, such as Lunch Rooms and offices, the target level of contamination is "nothing detectable". If the total uranium alpha survey in these areas indicates contamination in excess of 250 dpm/100 cm^2 (25% of the Table 9-2 Removable Contamination Limits) a smear test will be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area will be cleaned promptly and resurveyed. The RSO will investigate the cause of the contamination and implement corrective action to minimize the potential for a recurrence. Total alpha surface contamination levels exceeding the Table 9-2 limits will also require cleanup and investigation.

Before yellowcake drums leave the packaging area, they are washed to remove all visible yellowcake. Prior to shipment, the drums are surveyed for total alpha contamination. Although the limit for removable contamination on drums shipped in sole use vehicles is 2200 dpm/100 cm^2, a target level of 1500 dpm/100 cm^2 is used at the SR-HUP. If the total alpha survey results reveal contamination in excess of 1500 dpm/100 cm^2, a smear survey is performed. If this survey indicates contamination in excess of 1500 dpm/100 cm^2, the drums will be rewashed and resurveyed.

Yellowcake processing equipment that must be removed for maintenance or repair is thoroughly decontaminated prior to its removal from the area to prevent the possibility of contamination in the Maintenance Shop or other areas.

9.13.3 Personnel Contamination Control

Change rooms, showers and lockers for clean clothing are provided for employee use. An operable and appropriately calibrated alpha survey meter is made available for employee use at the exit of the Central Processing facilities and at the entrance to the Lunch Room at these facilities.

Employees are instructed in the use of the survey meter, techniques for minimizing contamination, for maintaining good personal hygiene, and in basic decontamination methods. Employees are also instructed on methods and procedures for good housekeeping practices within process areas to minimize the potential for contamination of personnel and equipment. The RSO or designee performs unannounced spot check surveys for alpha contamination on workers leaving the yellowcake production facilities. These unannounced spot check surveys are conducted on at least a quarterly basis.

Employees working in the precipitation, drying and packaging areas, as well as those involved in process equipment maintenance or repair are provided with appropriate protective clothing and equipment. Protective clothing is laundered on site or, if a disposable type, is disposed of in a facility licensed to accept such wastes.

All employees with potential exposure to yellowcake dust can shower and change clothes each day prior to leaving the site. An employee who showers and changes clothes is considered to be free of significant contamination. In lieu of showering, employees are required to survey their clothing, shoes, hands, face and hair with an alpha survey instrument prior to leaving the site. These surveys and/or showers are documented and maintained on site.

9.13.4 Surveys for Release of Potentially Contaminated Materials and Equipment

Materials and equipment which have been used or stored in an area where contamination by uranium or uranium daughters could have occurred are surveyed for contamination prior to release from the site. The survey is conducted in accordance with the limits specified in Table 9-2. If the equipment or material does not meet the limits, it will be decontaminated and resurveyed. The survey results are documented and maintained on site.

9.14 PROTECTIVE EQUIPMENT & PROCEDURES

All process and maintenance workers who work in yellowcake areas or work on equipment contaminated with yellowcake will be provided and required to wear protective clothing including coveralls, boots or shoe covers. Workers who package yellowcake for transport will also be provided gloves. Before leaving the yellowcake processing area, all workers involved in the precipitation or packaging for transport of yellowcake, will, at a minimum, monitor their hands and feet using a calibrated alpha survey instrument. In addition, spot surveys will be performed for alpha contamination at least quarterly on all workers leaving the recovery plant area. The monitoring results are documented and maintained on file.

At the Central Processing Plants, eating is only allowed in designated Lunch Room areas that are separated from the process areas. Eating or smoking in the plant controlled areas is prohibited and violators are subject to disciplinary action.

9.15 MANAGEMENT AUDIT AND INSPECTION PROGRAMS

Routine inspections of yellowcake processing areas at the CPP and Satellite facilities are conducted daily by the RST, or trained designee, to ensure that all radiation protection, monitoring, and safety requirements are being followed and/or are properly functioning. The EHS staff performs a Weekly Safety and Environmental Inspection that covers all major facilities at the SR-HUP, including the CPP areas, Satellites, and Wellfields.

In accordance with NRC requirements, an "Annual ALARA Audit" is performed to review the radiation safety program and associated monitoring data and survey results to ensure that the program is acting consistent with the ALARA philosophy. An important part of this audit includes recommendations to further improve the radiation safety and environmental programs.

In accordance with the EHS Management System, audits of the environmental, radiation safety, and industrial safety programs are periodically conducted by PRI's parent company, or outside consultants specializing in these types of operations.

9.16 RECORD KEEPING AND RETENTION

PRI, as part of its EHS Management System, maintains a record keeping and retention program that is consistent with requirements of 10 CFR 20 Subpart L, 10 CFR 40.61 (d) and (e). Records of surveys, calibrations, personnel monitoring, bioassays, transfers or disposal of source or byproduct material, and transportation accidents will be maintained on site until license termination. Records containing information pertinent to decommissioning and reclamation such as description of spills, excursions, contamination events, and etc. as well as information related to site and aquifer characterization and background radiation levels will be maintained on site until license termination. Duplicates of all significant records will be maintained in the corporate office or other offsite locations.

9.17 SECURITY

Measures to secure licensed material from unauthorized removal and access are in place at the SR-HUP. The operating facilities are manned 24 hours per day, 7 days per week, and in controlled and/or unrestricted areas, surveillance is maintained through the presence of the operators and workers on site. Licensed Material in the form of dry and slurry yellowcake is stored at the Smith Ranch Central Processing Plant. Access to both the Smith Ranch and Highland Central Processing Plants by the public is limited by the use of a locked, automatic gate. All visitors are required to check and sign in at the office before being allowed to enter the controlled access areas of the facility. Also, PRI has further increased security at the Smith Ranch CPP/Main Office Complex by installing continuous video surveillance of outside areas.

9.18 QUALITY ASSURANCE

PRI has established the following Quality Assurance Program for all radiological, non-radiological effluent and environmental (including ground water) monitoring programs at the SR-HUP. This Quality Assurance Program addresses elements discussed in USNRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment."

Quality assurance comprises those planned and systematic actions which are necessary to provide adequate confidence in the results of a monitoring program. Quality control includes those quality assurance actions that provide a means to control and measure the characteristics of measurement equipment and processes to established requirements. Therefore, quality assurance includes quality control.

The overall objectives of the Quality Assurance program are:

1. To identify deficiencies in the sampling and measurement processes to those responsible for these operations so that corrective action can be taken.

2. To obtain a measure of confidence in the results of the monitoring programs to assure regulatory agencies and the public that the results are valid.

The first step of any reliable Quality Assurance Program is a formal delineation of the organization structure, management responsibilities, and training requirements for management personnel. These items have been covered in the previous section. Other components of the program are described below.

9.18.1 Radiological and Environmental Monitoring Procedures

A critical step to insuring quality assurance objectives includes written procedures for various aspects of the radiological and environmental monitoring programs. Procedures for radiological and environmental monitoring programs are contained in EMS Manual IV-Health Physics Manual (radiological monitoring program procedures), and EMS Manual VI- Environmental Manual (environmental monitoring program procedures). These manuals describe the procedures used to collect samples, complete laboratory analyses and survey, calibrate equipment, evaluate data, etc. for the radiological and environmental monitoring programs.

Procedures contained in EMS Manual IV-Health Physics Manual include the following programs:

- Airborne Radioactivity Monitoring
- External Radiation Monitoring
- Contamination Control
- Respiratory Protection
- Exposure Monitoring
- Transportation of Radioactive Materials
- Radiological Laboratory Programs

Procedures contained in EMS Manual VI-Environmental Manual include the following programs:

- Liquid Effluent Monitoring
- Air Monitoring
- Soil and Sediment Monitoring
- Vegetation Monitoring
- Wellfield Development and Monitoring
- Waste Management
- Topsoil Management
- Other Management Programs

9.18.2 Duplicative Sampling and Inter and Intra Laboratory Analyses

A good Quality Assurance Program provides provisions to ensure that contract and in-house laboratories are accurately analyzing and reporting radiologic and chemical analyses. PRI utilizes an EPA certified laboratory for all off site radiologic and chemical samples.

For every 20 excursion monitor well samples, a duplicate sample and a spiked sample are analyzed by PRI's in-house laboratory. The duplication begins with original sample aliquots and allows the analyst to determine the precision of the analytical result. Standard addition spikes consist of the addition of a known amount of analyte to a duplicate sample aliquot. These spiked samples are useful in estimating the accuracy of an analytical result as well as identifying potential interferences.

In accordance with the applicable SOP's, baseline water quality samples for new wellfield areas are filtered and preserved on site and transported to an EPA approved laboratory for analysis. Additionally, protocols have been established for the storage and shipment of samples, including standard Chain of Custody procedures.

9.18.3 Instrument Calibrations

Electronic instruments used to conduct radiologic surveys or determine the concentrations of radiologic material are calibrated by a qualified contractor on a routine basis to ensure that they are operating within specified ranges for the radionuclides being measured. In accordance with SOP's certain instruments, such as alpha and GM probes, are functionally checked with a known radiologic source on a more frequent basis (daily or weekly). Additionally, air pumps used to collect environmental or breathing air samples are routinely calibrated. PRI only utilizes EPA approved laboratories which adhere to strict protocols to ensure that their electronic instruments are properly calibrated to ensure valid results.

9.18.4 Records

Records of radiologic surveys, instrument calibrations, radiological and chemical analyses, and employee exposures are retained on site under the direction of the RSO. To maintain the integrity of the program, the RSO and others, through the audit program, periodically review records to ensure that they are complete and accurate, and calculations have been done properly. These types of records are maintained on site until license termination. Critical records are periodically duplicated and stored in a second location in the case of fire or a similar type disaster. Computer programs used to determine employee exposures or other components of the program are verified with hand calculations to ensure that they are accurate.

9.18.5 Audits

PRI management periodically conduct audits of the radiation safety and environmental monitoring programs to verify compliance with applicable rules, regulations, license requirements and to ensure that exposures of employees, the public, and the environment are ALARA. Audit teams are comprised of knowledgeable individuals from within the project or from other PRI operations, the parent company, or outside contractors specializing in such audits. The Annual ALARA Audit is conducted on an annual basis to assist with achieving the above objectives.

Figure 9-1: PRI Environmental, Health, and Safety Reporting Structure

Table 9-1
Actions Taken for Individual Urinalysis Results

Uranium Content of Specimen	Required Action(s)
a) Less than 15 µg/L or 9 nCi in vivo	None
b) 15 to 35 µg/L or 9 to 16 nCi in vivo	1) Confirm results (repeat analysis) 2) Attempt to identify cause of elevated result 3) Take corrective measures and/or limit employee's exposure 4) Document corrective actions 5) Submit documentation to NRC, as part of required 10 CFR 40.65 report
c) Greater than 35 µg/L	1) Take actions specified for (b) above 2) Restrict employee from yellowcake area work until results of subsequent specimens are less than 15 µg/L 3) Notify NRC in writing within 30 days of exceeding the action level
d) Greater than 35 µg/L for 2 consecutive specimens, or greater than 130 µg/L for any single specimen	1) Take actions specified for (c) above 2) Analyze urine specimens for albuminuria

Table 9-2

ALLOWABLE LIMITS FOR REMOVAL TO UNCONTROLLED AREAS

These values are taken from: Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," and "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Byproduct, Source or Special Nuclear Material."

Surface contamination levels for uranium, radium and their associated decay products on equipment to be released for unrestricted use, clothing and nonoperating areas of mills are as follows:

Nuclide (a)	Average (b)	Maximum (c)	Removable
Natural Uranium	5,000 dpm/100 cm^2	15,000 dpm/100 cm^2	1,000 dpm/100 cm^2
Radium-226	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2

a. Averaged over no more than 1 cm^2

b. Applies to an area of not more than 100 cm^2.

c. Determined by smearing with dry filter or soft absorbent paper, applying moderate pressure and assessing the amount of radioactive material on the smear.

Beta-Gamma Radiation

Average: 0.2 mR/hr above background
Highest: 1.0 mR/hr above background

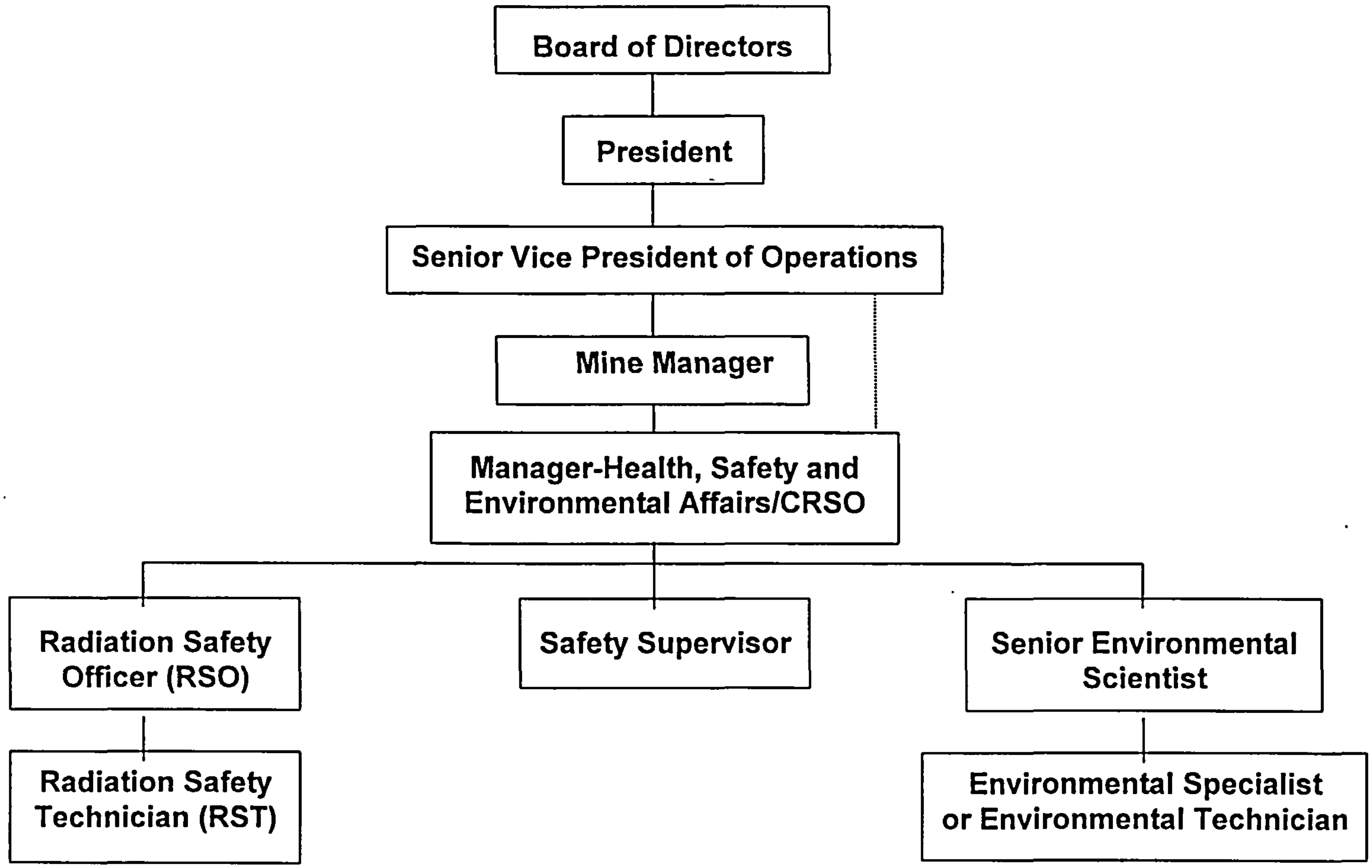

Figure 9-1: PRI Environmental, Health, and Safety Reporting Structure

CHAPTER 10
BENEFIT-COST SUMMARY

10.1 GENERAL

The general need for uranium is for replacement of the uranium consumed in the operation of nuclear power reactors. In reactor-licensing evaluations the benefits of the energy produced are weighted against related environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. The incremental impacts of typical mining and milling operation required for the fuel cycle are justified in terms of the benefits of energy generation to the society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility must be reasonable as compared to that typical operation.

10.2 QUANTIFIABLE ECONOMIC IMPACTS

Monetary benefits will accrue to the local community from the presence of the SR-HUP, from employees living in the community, local expenditures of operating funds and the state and local taxes paid by the project. Against these monetary benefits are potential monetary costs to the communities involved, such as those for new or expanded schools and other community services. For this project however, the local communities currently have a surplus of such facilities and the only new costs for these facilities will be the additional operational costs. It is not possible to arrive at a numerical balance between the benefits and costs for any one community, or for the project, because of uncertainties in the market place and the ability of a community to alter the benefits and costs. For example, the community can use its various taxing powers to change tax rates, however the effect of such a change could be either offset or compounded by changes in price the operator receives for the end product.

10.3 ENVIRONMENTAL COST

The benefit-cost comparison for a fuel-cycle facility such as the SR-HUP also involves comparing the benefits to the United States and to the society in general of an ensured U_3O_8 supply for generating electrical energy against local environmental costs for which there may be no directly related compensation. For the SR-HUP, there are basically only three of these environmental costs: groundwater impact, radiological impact, and disturbance of the land. The radiological impacts of the project during operation are small, and during reclamation the remaining solid radioactive wastes will be disposed at a facility licensed by the NRC to receive these low level wastes. Therefore, there will be no long-term impact at the site from these materials. The disturbance of the land is also a small environmental impact. All of the disturbed land will be reclaimed after the project is decommissioned and will become available for the pre-mining uses. Restoration of aquifers impacted by the ISL mining will be restored to conditions such that the pre-mining use suitability of the ground water is maintained.

10.4 SUMMARY

In considering the energy value of the U_3O_8 produced, the economic benefit to the local communities, the minimal radiological impacts, minimal disturbance of land, and mitigable nature of all other impacts, it is believed that the overall benefit-cost balance for the project is favorable, and that extending the license for the SR-HUP is the appropriate regulatory action.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE

THAT CAN BE VIEWED AT THE RECORD TITLED:

"FACILITIES & MONITOR SITES LOCATION MAP"
PLATE 1

WITHIN THIS PACKAGE.....

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