POWER
RESOURCES

Power Resources, Inc.

NORTH BUTTE ISL SATELLITE PROJECT

CAMPBELL COUNTY, WYOMING

VOLUME I-A
(Chapters 1-10)

NRC License No. 1540
WDEQ Permit No. 632

March 2006

TABLE OF CONTENTS

Page

CHAPTER 1 – PROPOSED ACTIVITIES 1-1

1.1 INTRODUCTION 1-1
1.2 GENERAL SOLUTION MINING PROCESS 1-1
1.3 ADVANTAGES OF ISL URANIUM MINING 1-2
1.4 ORE AMENABILITY TO ISL URANIUM MINING 1-2

CHAPTER 2 - SITE CHARACTERIZATION 2-1

2.1 SITE LOCATION AND LAYOUT 2-1
2.2 USES OF ADJACENT LANDS AND WATERS 2-2
2.2.1 General 2-2
2.2.2 Agricultural Activity 2-2
2.2.3 Recreation 2-2
2.2.4 Water Rights 2-3
2.3 POPULATION DISTRIBUTION 2-4
2.4 HISTORIC, SCENIC AND CULTURAL RESOURCES 2-4
2.5 METEOROLOGY 2-5
2.5.1 General 2-5
2.5.2 Precipitation 2-5
2.5.3 Temperature 2-6
2.5.4 Wind 2-6
2.6 GEOLOGY AND SEISMOLOGY 2-7
2.6.1 Regional Geology 2-7
2.6.2 Site Geology 2-9
2.6.3 Seismology 2-10
2.7 HYDROLOGY 2-11
2.7.1 Surface Waters 2-11
2.7.2 Ground Water 2-11
2.7.3 Aquifer and Aquitard Properties 2-13
2.8 ECOLOGY 2-14
2.8.1 Topography 2-14
2.8.2 Soils 2-14
2.8.3 Vegetation 2-15
2.8.4 Wildlife 2-15
2.9 BACKGROUND RADIOLOGICAL CHARACTERISTICS 2-16
2.10 BACKGROUND NON-RADIOLOGICAL CHARACTERISTICS 2-17

CHAPTER 3 - DESCRIPTION OF THE FACILITIES 3-1

3.1 IN SITU LEACHING PROCESS AND EQUIPMENT 3-1
3.1.1 Uranium Dissolution 3-1
3.1.2 Resin Loading 3-2
3.1.3 Satellite Building 3-2
3.1.4 Wellfields 3-3
3.1.4.1 Ore Deposits 3-3
3.1.4.2 Wellfield Areas 3-3
3.1.4.3 Wellfield Injection/Production Patterns 3-4
3.1.4.4 Wellfield Operations 3-5
3.1.4.5 Well Completion 3-6
3.1.4.6 Well Casing Integrity 3-7
3.1.4.7 Monitoring of Wellfield Flow and Pressure 3-8

3.1.4.8 Pipeline Monitoring 3-8
3.2 CHEMICAL STORAGE FACILITIES 3-8
3.2.1 Process Related Chemicals *3-9*
3.2.2 Non-Process Related Chemicals *3-9*
3.3 INSTRUMENTATION AND CONTROL 3-10

CHAPTER 4 - EFFLUENT CONTROL SYSTEMS 4-1

4.1 GASEOUS AND AIRBORNE PARTICULATES 4-1
4.1.1 Tank and Vessel Ventilation Systems *4-1*
4.1.2 Work Area Ventilation System *4-1*
4.2 LIQUIDS AND SOLIDS 4-2
4.2.1 Deep Disposal Injection Wells *4-3*
4.2.2 Lined Evaporation Ponds *4-3*
4.2.3 Solid Waste *4-4*
4.3 CONTAMINATED EQUIPMENT 4-4

CHAPTER 5 – PRE-OPERATIONAL ASSESSMENT OF WELLFIELDS AND ENVIRONMENTAL MONITORING 5-1

5.1 PRE-OPERATIONAL ASSESSMENT OF WELLFIELDS 5-1
5.1.1 General *5-1*
5.1.2 Monitor Well Spacing *5-1*
5.1.3 Hydrologic Testing Proposal *5-2*
5.1.4 Mine Unit Hydrologic Test Document *5-3*
5.1.5 Baseline Water Quality Determination *5-3*
5.1.5.1 General 5-3
5.1.5.2 Data Collection 5-4
5.1.5.3 Statistical Assessment of Baseline Water Quality Data 5-5
5.1.5.4 Restoration Target Values 5-5
5.1.6 Upper Control Limits *5-5*
5.1.6.1 General 5-5
5.1.6.2 Determination of Upper Control Limits 5-6
5.2 OPERATIONAL HYDROLOGIC MONITORING PROGRAM 5-6
5.2.1 General *5-6*
5.2.2 Monitoring Frequency and Reporting *5-7*
5.2.3 Water Quality Sampling and Analysis Procedures *5-7*
5.2.4 Excursions *5-7*
5.3 EFFLUENT AND ENVIRONMENTAL MONITORING 5-8
5.3.1 General *5-8*
5.3.2 Continuous Air Particulate Monitoring *5-9*
5.3.3 Passive Radon Gas Monitoring *5-9*
5.3.4 Passive Gamma Radiation Monitoring *5-10*
5.3.5 Environmental Ground Water Monitoring Program *5-10*
5.3.6 Environmental Surface Water Monitoring Program *5-10*
5.3.6.1 Soil Sampling 5-11
5.3.6.2 Vegetation Sampling 5-11
5.3.7 Waste Disposal Well Monitoring *5-11*
5.3.8 Evaporation Ponds *5-11*
5.3.8.1 Leak Detection Monitoring 5-11
5.3.9 Wildlife Monitoring *5-12*
5.3.9.1 General 5-12
5.3.9.2 Threatened and Endangered Species 5-13
5.3.9.3 Raptor Nest Surveys 5-14
5.3.9.4 Sage Grouse Surveys 5-14
5.3.10 Cultural Resources Mitigation *5-14*
5.3.11 Spill Reporting Requirements *5-15*

CHAPTER 6 - RECLAMATION PLAN 6-1

6.1 GROUND WATER RESTORATION 6-1
6.1.1 Water Quality Criteria 6-1
6.1.2 Restoration Criteria 6-1
6.1.3 Ground Water Restoration Method 6-2
6.1.3.1 Ground Water Transfer 6-3
6.1.3.2 Ground Water Sweep 6-3
6.1.3.3 Ground Water Treatment 6-4
6.1.3.4 Restoration Monitoring 6-5
6.1.4 Restoration Stability Monitoring Stage 6-5
6.1.5 Well Plugging 6-6
6.2 SURFACE RECLAMATION AND DECOMMISSIONING 6-7
6.2.1 Introduction 6-7
6.2.2 Surface Disturbance 6-7
6.2.3 Topsoil Handling and Replacement 6-7
6.2.4 Revegetation Practices 6-8
6.2.5 Site Decontamination and Decommissioning 6-9
6.2.6 Final Contouring 6-10
6.2.7 Financial Assurance 6-10

CHAPTER 7 - ENVIRONMENTAL EFFECTS 7-1

7.1 SITE PREPARATION AND CONSTRUCTION 7-1
7.2 EFFECTS OF OPERATIONS 7-2
7.2.1 Impact to Ephemeral Drainages 7-2
7.2.2 Surface Water Impacts 7-4
7.2.3 Ground Water Impacts 7-4
7.2.4 Air Quality Impacts 7-5
7.2.5 Wildlife Impacts 7-5
7.2.5.1 Endangered Species 7-5
7.2.5.2 Wildlife 7-6
7.3 RADIOLOGICAL EFFECTS 7-6
7.3.1 Exposure Pathways 7-7
7.3.2 Background Radiation Exposures to the Population 7-7
7.3.3 Annual Population Doses from the Project 7-7
7.3.4 Dose to Individuals 7-7
7.3.5 Radiological Impacts on Biota Other than Man 7-8
7.4 NONRADIOLOGICAL EFFECTS 7-8
7.4.1 Nonradioactive Airborne Effluents 7-8
7.4.2 Nonradioactive Liquid Effluents 7-8
7.5 EFFECTS OF ACCIDENTS 7-9
7.5.1 Tank Failure 7-9
7.5.2 Pipeline Failure 7-9
7.5.3 Fires and Explosions 7-10
7.5.4 Tornadoes 7-10
7.5.5 Well Casing Failure 7-11
7.5.6 Leakage Through Old Exploration Holes 7-12
7.5.7 Transportation Accidents 7-12
7.5.7.1 Shipments of Resin 7-13
7.5.7.2 Shipment of Chemicals 7-13
7.5.8 Evaporation Pond Failure 7-13
7.5.9 Response Procedures for Reasonably Expected System Failures 7-14
7.6 SOCIOECONOMIC IMPACTS 7-14
7.7 MINERAL RESOURCE IMPACTS 7-14

CHAPTER 8 - ALTERNATIVES TO THE PROPOSED ACTION 8-1

8.1 ALTERNATE MINING METHODS 8-1
8.2 ALTERNATIVE SITES FOR THE PROCESSING PLANTS 8-2
8.3 ALTERNATIVE ENERGY SOURCES 8-2
8.4 ALTERNATE LEACH SOLUTIONS 8-3
8.5 GROUND WATER RESTORATION ALTERNATIVES 8-3
8.6 LIQUID WASTE DISPOSAL ALTERNATIVES 8-3

CHAPTER 9 – MANAGEMENT ORGANIZATION AND ADMINISTRATIVE PROCEDURES 9-1

9.1 ENVIRONMENT, HEALTH, AND SAFETY MANAGEMENT 9-1
9.2 ENVIRONMENT, HEALTH AND SAFETY MANAGEMENT ORGANIZATION 9-1
9.3 ENVIRONMENT, HEALTH AND SAFETY MANAGEMENT QUALIFICATIONS 9-1
9.3.1 Board of Directors 9-1
9.3.2 President 9-1
9.3.3 Senior Vice President of Operations 9-2
9.3.4 Mine Manager 9-2
9.3.5 Manager-Health, Safety and Environmental Affairs 9-2
9.3.6 Senior Environmental Scientist 9-3
9.3.7 Environmental Specialist or Environmental Technician 9-3
9.3.8 Radiation Safety Officer (RSO) 9-4
9.3.9 Radiation Safety Technician (RST) 9-4
9.3.10 Safety Supervisor 9-5
9.4 ALARA POLICY 9-5
9.4.1 Management Responsibilities 9-5
9.4.2 Radiation Safety Officer Responsibility 9-6
9.4.3 Supervisors Responsibility 9-7
9.4.4 Worker Responsibility 9-7
9.5 MANAGEMENT CONTROL PROGRAM 9-7
9.5.1 PRI Environment, Health and Safety Management System 9-7
9.5.1.1 Performance Based License Condition 9-9
9.5.2 Organization of the Safety and Environmental Review Panel 9-10
9.5.3 Safety and Environmental Review Panel Responsibilities 9-11
9.5.4 Record Keeping and Reporting 9-12
9.6 EMPLOYEE TRAINING 9-12
9.7 STANDARD OPERATING PROCEDURES 9-13
9.8 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM 9-13
9.9 BIOASSAY PROGRAM 9-14
9.10 AIRBORNE RADIATION MONITORING PROGRAM 9-14
9.10.1 Radon Daughter Monitoring 9-14
9.10.2 Airborne Radioactive Areas 9-15
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 9-15
9.11 EXPOSURE CALCULATION 9-15
9.11.1 Airborne Uranium Exposure Calculation 9-16
9.11.2 Radon Daughter Exposure Calculation 9-16
9.11.3 Calculation of Total Effective Dose Equivalent (TEDE) 9-17
9.12 ADMINISTRATIVE ACTION LEVELS 9-17
9.13 CONTAMINATION CONTROL PROGRAM 9-18
9.13.1 General 9-18
9.13.2 Surface Contamination Control 9-18
9.13.3 Personnel Contamination Control 9-18
9.13.4 Surveys for Release of Potentially Contaminated Materials and Equipment 9-19
9.14 PROTECTIVE EQUIPMENT & PROCEDURES 9-19
9.15 MANAGEMENT AUDIT AND INSPECTION PROGRAMS 9-19
9.16 RECORD KEEPING AND RETENTION 9-20

9.17 SECURITY 9-20
9.18 QUALITY ASSURANCE 9-20
9.18.1 Radiological and Environmental Monitoring Procedures 9-21
9.18.2 Duplicative Sampling and Inter and Intra Laboratory Analyses 9-22
9.18.3 Instrument Calibrations 9-22
9.18.4 Records 9-23
9.18.5 Audits 9-23

CHAPTER 10 - BENEFIT-COST SUMMARY 10-1

10.1 GENERAL 10-1
10.2 QUANTIFIABLE ECONOMIC IMPACTS 10-1
10.3 ENVIRONMENTAL COST 10-1
10.4 SUMMARY 10-2

CHAPTER 11 - ENVIRONMENTAL APPROVALS AND CONSULTATIONS 11-1

11.1 GENERAL 11-1

TABLES, ATTACHMENTS, AND FIGURES

CHAPTER 2

Table 2-1 Gillette station 18 SW Period of Record Monthly Climate Summary
Table 2-2 Population for Wyoming Counties, Cities, and Towns: 2000 to 2020

Figure 2-1 Site Location Map
Figure 2-2 Gillette 1977-1997 Annual Wind Rose
Figure 2-3 Annual Wind Rose for Casper, Wyoming
Figure 2-4 Seismic Risk Map of the United States

Attachment 2-1 Seismological Characteristics of Campbell County

CHAPTER 3

Figure 3-1 Primary Chemical Reactions Expected in the Aquifer
Figure 3-2 Flow Process Schematic
Figure 3-3 Satellite No. 1 Layout
Figure 3-4 Typical Wellfield Development Pattern
Figure 3-5 Estimated Time Table of Mining Related Activities
Figure 3-6 Typical Production Well
Figure 3-7 Typical Injection Well
Figure 3-8 Typical Monitor Well

CHAPTER 4

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

Figure 4-1 Potable Water Balance Usage
Figure 4-2 Water Balance North Butte

CHAPTER 5

Table 5-1 Baseline Water Quality Parameters
Table 5-2 Air Particulate Monitoring SR-HUP Perimeter Air Station No. 1
Table 5-3 Air Particulate Monitoring SR-HUP Perimeter Air Station No. 2
Table 5-4 Air Particulate Monitoring SR-HUP Perimeter Air Station No. 3
Table 5-5 Radon-222 and Gamma Summary for the SR-HUP Air Monitoring Stations 2000-2004

CHAPTER 9

Table 9-1 Actions Taken for Individual Urinalysis Results
Table 9-2 Allowable Limits for Removal to Uncontrolled Areas
Table 9-3 Radiation Survey and Monitoring Equipment
Figure 9-1 PRI Environmental, Health, and Safety Reporting Structure

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. This Operation and Reclamation Plan is being submitted to the WDEQ-LQD and NRC to address the North Butte Satellite Project as an active satellite to the Smith Ranch – Highlands Uranium Project (SR-HUP). 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 controls the proposed North Butte Project, which is a proposed Satellite Facility to the SR-HUP. The North Butte Satellite Facility lies approximately 50 miles north of the SR-HUP license area. PRI desires to amend the existing NRC License SUA-1548 and WDEQ-LQD Permit #432 to operate a commercial uranium in situ leach (ISL) Satellite Facility and accompanying well fields at the North Butte Satellite Facility. Accordingly, this Amendment Request submitted herein intends to accomplish these actions by submitting SUA-1548 Volume 1A, Chapters 1-10 for North Butte Operation, and submitting baseline information for North Butte 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.

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 North Butte area to ISL mining was demonstrated initially through core studies.

Results of the core studies indicate that operations at North Butte will be similar to the operations at Smith Ranch using bicarbonate/carbonate leaching solutions with hydrogen peroxide and oxygen. 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.

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 North Butte 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 North Butte permit area for the uranium mining project is located in the Powder River drainage of the southern Powder River Basin, Campbell County, Wyoming. The well field complex will be located approximately 35 air miles (54 road miles) southwest of the City of Gillette, Wyoming. Access to the site is by State Highway 50 South from Gillette to Savageton, then west and south on Van Buggenum Road then to Christiansen Road and an existing oil field Road. Figure 2-1 shows the general location and access to the project area. An auxiliary road may also be constructed if needed from Christiansen Road to the eastern part of the permit area. The location for this auxiliary road is included in the permit area.

Figure 9.2 in Volume II shows the lands controlled by the North Butte Uranium Project and the locations of facilities, including wellfield area including planned Mine Unit 1, major roads, the Office, well field area, and evaporation ponds. The CPP will be located at the existing Smith Ranch- Highland Uranium operations and can accommodate ten planned wellfields, which will consist of approximately 65 five-spot patterns. The North Butte mine permit area encompasses a land surface of approximately 1039 acres, all of which is privately owned. PRI owns approximately 309 acres, while the remaining 680 acres is owned by the T-Chair Land Company. Originally, as described in Volume I, the wellfield area was divided into ten planned mine units. However, it is anticipated that division of mine units will vary from the original plan depending on wellfield characteristics. The currently planned Mine Unit 1 actually encompasses the area proposed for Mine Units 1 and 2 of the original application.

Names and addresses of the surface and mineral owners of record within the current North Butte permit area and within one-half mile were updated in 2005 and are provided in Volume I, Appendix A, B, and C, and maps of the surface and mineral owners are provided in Volume II, Figures 2.1 and 2.2.

The Main Office and Central Processing Plant (CPP) is located at SR-HUP on land owned by PRI. The proposed location of the evaporation ponds is also on surface owned by PRI in the SE ¼, Section 24, T44N, R76W .

2.2 USES OF ADJACENT LANDS AND WATERS

2.2.1 General

Lands contained within and adjacent to the North Butte mine permit area have historically been used for sheep and cattle grazing. Extraction of energy related minerals is the major industrial land use in the area and in the Powder River Basin. The production of coal, uranium, oil and gas, and coal-bed methane are major factors in the economy of the area. However, within the permit area, only development for uranium and coal-bed methane extraction currently exists. There are three coal-bed methane wells located in the southern part of the permit area, but these wells are not currently in production. Oil and gas development surrounds the North Butte permit area due to the existence of the Hartzog Draw Oil Field. However, there is no existing oil and gas development within the permit area. The nearest coal mining operation to the permit area is the Cordero Coal mine, which is located approximately 32 miles east. In situ uranium production has occurred near the permit area at the Christensen Ranch Project operated by Cogema Inc.

The proposed use of the land for the immediate future includes continued livestock grazing and in situ uranium mining on a commercial scale. 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.

A maximum of 350 acres at the North Butte area is expected to be excluded from livestock by fencing from in situ mining operations.

2.2.3 Recreation

The North Butte and surrounding area is comprised of predominantly private land, although there are parcels of state, and federal (BLM) owned land. Even with federal ownership of land near the area, recreational use is very limited.

Landowners control access to the federal and state parcels of land and therefore limit access for recreational purposes. Hunting of antelope and mule deer are permitted by landowner consent only. Fishing activity in the area is nonexistent as there are no lakes, streams, or rivers that provide adequate habitat.

2.2.4 Water Rights

Section 10.3 (Appendix D-6 -Hydrology), Volume I contained a list of surface and ground water rights and their locations for the North Butte permit area plus a 3-mile radius. Due to the addition of several wells by the previous owners, PRI conducted a new search of ground water wells in the Spring of 2005. As a result, Section 10.3 was revised and the well inventory and location maps were updated. Table 10.17 lists the adjudicated ground water (well) rights and existing wells within the proposed permit boundary and within a three mile radius. Adjudicated surface water rights are listed in Table 10.16. Figure 10.8 (Volume II) shows the locations of all surface and groundwater rights, and Figure 10.5 (Volume II) shows the locations of known water wells and abandoned oil and gas wells.

All surface water rights are limited to reservoirs or stock ponds that retain surface water runoff on a limited basis. There are no surface water rights for diversion of direct flows from Willow Creek or its tributaries within this area. The majority of ground water rights in the North Butte area are used primarily for livestock watering and industrial purposes. The industrial use consists of water for exploration drilling, coal bed methane production, and environmental wells for water quality monitoring and hydrologic studies associated with ISL development. The livestock 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. Since these wells are located laterally from proposed mine areas and are vertically separated from the ore zones by 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. There is one well that was used for domestic purposes located within the permit area, which is located at the former man camp and is owned by PRI. There is also one well used for domestic purposes within ½ -mile of the permit boundary located at the Pfister Ranch site. The water from these two wells is not suitable for drinking. The residents at the Pfister Ranch haul their drinking and cooking water to their house, and personnel using the man camp bring in drinking water from town.

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 are within the permit area.

The North Butte permit area has several known stock ponds that collect small quantities of runoff. Some water also accumulates in small excavations or natural depressions at low points in the Willow Creek drainage. No other significant water bodies are present in the permit area.

2.3 POPULATION DISTRIBUTION

The population within fifty miles of the North Butte site is centered within the communities of Gillette and Wright (Campbell County), Midwest/Edgerton (Natrona County), Kaycee (Johnson County), and Buffalo (Johnson County) Wyoming as shown on Figure 2-1. 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 the three Counties.

Gillette, Wyoming is the County Seat of Campbell County. Since the original permit application, population in Campbell County has increased by 33% to a population of approximately 36,240. The population in the city of Gillette has increased by 44% to a total population of approximately 21,840. The major reason for the population growth in these areas can be attributed to increased energy development and production from coal, oil and gas, and coal-bed methane. Table 2-2 shows the latest population estimates for Campbell County, as well as other counties surrounding area of the North Butte site. Table 2-2 also contains predicted population estimates through the year 2020.

There are no occupied dwellings within the permit area. The Pfister Ranch is the nearest ranch house, which is approximately 1.2 miles from the proposed CPP location (1/2 –mile from the nearest permit boundary). Other ranch houses in the vicinity of the North Butte area include Jack Christensen (3.5 miles W), Pumpkin Butte Ranch (4.3 miles SE), Schlautman Ranch (4.4 miles NE), Ruby Ranch (6.0 miles ESE), Gilberts Ranch (6.1 miles NEE), Charles Christensen (6.6 miles N), Camblin Ranch (6.7 miles ESE), and John Groves (7.2 miles NE).

2.4 HISTORIC, SCENIC AND CULTURAL RESOURCES

A cultural resource inventory was conducted in the area by the Office of the Wyoming State Archaeologist in 1980 as part of the mine permitting process by Cleveland Cliffs Iron Company. A copy of the report entitled "Archeology of the Pumpkin Buttes: Final Report On The Archeological Investigations Carried Out In

the Cleveland Cliffs Iron Company North Butte Permit Area, Campbell County, Wyoming" was submitted with the original permit application as a separate document and summarized in Appendix D-3 of Volume 1.

The conclusions of this report show that an archeological clearance was recommended for the North Butte area, with the stipulation that, if subsurface cultural remains are found during construction activities, then the appropriate state and federal agencies will be contacted immediately. Additionally, the conclusions of the report state that no additional investigation is recommended.

The Pumpkin Buttes were used as a landmark for native Indians, scientific explorers, military activity, and travelers along the Bozeman Trail (the Bozeman Trail passes several miles to the southwest of the Pumpkin Buttes). Section 6 (Appendix D-2), Volume I contains a brief history of the area, which provides a detailed description of the above historical aspects.

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 stations closest to the permit area is located at the Gillette (Station No. 483865). Meteorological data summaries (temperature, precipitation, snowfall) for this station is shown on Table 2-1. This data was obtained from the Western Regional Climate Center and covers a period of record from 1949 to 1985 (Gillette). Figure 2-2 includes a wind rose Gillette obtained from the National Weather Service. Climate data for this area is summarized in the following sections.

2.5.2 Precipitation

Mean annual precipitation for the area is approximately 16 inches in Gillette and the average yearly total evaporation is reported as 44 inches (U.S. Weather Bureau, NOAA, 1985).

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 67 inches in Gillette, 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 range from 81° F to 84° F for the three stations while during the winter months of December, January, and February, the average minimum temperature ranges from 10° F to 15° F. The average annual maximum temperature ranges from 57° F to 61° F and the average annual minimum temperature ranges from 29° F to 32° F.

2.5.4 Wind

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. Figure 2-2 is a wind rose diagram for the Gillette station, which indicates prevailing winds from the northwest and southwest with a mean wind speed of approximately 15 mph.

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 Escarpment 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 is a large structural and topographic depression parallel to the Rocky Mountain trend. The basin is bounded on the south by the Hartville Uplift and the Laramie Range, on the east by the Black Hills, and the Big Horn Mountains and the Casper Arch on the west. The Miles City Arch in southeastern Montana forms the northern boundary of the Basin.

The basin is an asymmetrical syncline with its axis closely paralleling the western margin. During sediment deposition, the structural axis (the line of greatest material accumulation) shifted westward resulting in the asymmetry present in the basin. On the eastern flank of the Basin, sedimentary rock strata dip gently to the west at approximately 0.5 to 3 degrees. On the western flank, the strata dip more steeply, 0.5 to 15 degrees to the east towards the axis of the Basin, with the dip increasing as distance form the axis increases. The North Butte site location within the Powder River Basin is shown in Figure 9.1 of Volume II.

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 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 concentration 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.

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, the Wasatch Formation is known to be 1575 feet thick (Sharp and Gibbons, 1964). 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. 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.

2.6.2 Site Geology

The North Butte solution mining site is situated in the Eocene Wasatch Formation off the southeast flank of North Pumpkin Butte in Campbell County. The mineralized sand members are in the lower part of the formation, at an approximately average depth of 500 feet to 650 feet. The host sands are primarily arkosic in composition, very friable, and contain substantial organic debris and carbonaceous stringers. There are periodic small, localized, sandy shale intervals within the sand, but the main body of the sand is relatively free of interstitial shale, although the sands thicken and thin to the point of removal in some areas.

There are three primary mineralized sand members in the North Butte mining sand. These sand members were identified by Uranerz as "C", "B", and "A" in descending order. The "C" sand member is the shallowest and the "A" sand

member is the deepest. The primary ore bearing member of the three is the "B" sand. In most areas of the permit area these sand members are separate and distinct. However, in a substantial portion of the area, the separating aquicludes between the sands thin and allow vertical contact between either the "A" and "B" members or the "B" and "C" members. In these areas there are effectively only two mining members in the North Butte mining sand.

The North Butte mining sand, with its three sand members, is bounded above and below by impermeable shale layers. The upper and lower aquicludes are composed of shales, silty shales and shaley lignite interbeds.

The ore body is a typical Powder River Basin roll front deposit. In the North Butte area the oxidation front extends from the northeast to the southwest. The sand members also have several vertically superimposed individual roll fronts. Due to the occasional vertical contact between the mineralized sand members there are often several smaller fronts, which overlay each other.

In the North Butte ore deposit the uranium mineralization is present as amorphous uranium oxide, or sooty pitchblende with some subordinate canotite. The host sandstones are composed of quartz, feldspars, and rock fragments with locally occurring carbon fragments. Grain size ranges from very fine-grained sand to small granules. The sandstone is weakly to moderately cemented and friable. Occasional occurrences of pyrite and calcite as cementing materials can be observed. The uranium is deposited upon individual detrital sand grains and within authigenic clays in the interstices. The interstitial clays present are primarily montmorillonite with lesser amounts of kaolinite. Hematite, along with minor limonite, are common oxidation products of pyrite within the host rock. Accessory biotite and muscovite are also present.

2.6.3 Seismology

The area of central Wyoming where the North Butte site is located lies in a relatively quiet seismic region of the United States. Although distant earthquakes may produce shocks strong enough to be felt in the Powder River Basin, the region is ranked as one of minor seismic risk as shown in Figure 2-4. Few earthquakes capable of producing damage have originated in this region. 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 200 miles west of the permit area and is the most probable source of earthquakes affecting the project site.

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. More detailed information can be found in the report "Basic Seismological Characterization for Campbell County, Wyoming" by the Wyoming State Geological Survey, which is contained in Attachment 2-1.

2.7 HYDROLOGY

2.7.1 Surface Waters

The North Butte permit area is located in the Willow Creek drainage, which is a tributary of the Powder River. The permit area is some 15 miles upstream of the confluence of Willow Creek and the Powder River. The Powder River is tributary to the Yellowstone River, which is part of the Missouri River drainage basin. Willow Creek flows in westerly direction through the southern tip of the permit area. The Willow Creek drainage system is shown in Figure 10.6 (Volume II).

The size of the Willow Creek drainage basin above the Dry Willow Creek confluence is approximately 13.6 square miles. The short reach of the Willow Creek channel within the permit boundary is at an elevation of 4,900 feet MSL. The gradient of the stream channel within the permit area is about 99 feet per mile (0.0187 ft/ft), and the active stream channel averages about 14 feet in width. The length of the Willow Creek stream channel within the permit area is approximately 2,165 feet. Figures 6.1 (Volume II) and 9.2 (Volume II) show the Willow Creek drainage basin in the vicinity of the North Butte permit area.

Willow Creek is classified as an ephemeral stream in the permit area. The stream flows only in response to heavy snow melt and to large convective rainstorms. The stream channel typically flows intermittently in the spring and early summer and is dry the remainder of the year except during major thunderstorms in the area. In 1988 there was no significant flow in Willow Creek at the North Butte site.

The estimated peak flows for various recurrence intervals for the Willow Creek drainage basin above the Dry Willow Creek confluence are presented in Table 10.15 of Volume I. The techniques that were used to estimate the peak flows include those described by Patterson, Lowham, Soil Conservation Service Technical Engineering Technical Note No. 18), and Bureau of Land Management (Design of Small Dams).

2.7.2 Ground Water

The North Butte permit area is located within the southern portion of the Powder River Basin. The Powder River Basin is part of the Great Plains physiographic province and is a structural and topographic basin of approximately 65,750 km^2

(25,000 square miles) located in eastern Wyoming and southern Montana. The basin is bounded on the east by the Black Hills and on the west by the Bighorn Mountains. The southern boundary is the Laramie Range and Hartville Uplift, and the Miles City Arch in Montana forms the basin's northern extent. The most dominant topographic features within the area are the Pumpkin Buttes. The North Butte permit area is located on the southeast flank of the North Pumpkin Butte.

The Powder River Basin incorporates a sedimentary rock sequence that approaches 15,000 feet thick along the synclinal axis. These sedimentary rocks range in age from Tertiary (3 million to 70 million years, B.P.) to Cambrian (500 million to 570 million years, B.P.). The Tertiary fluvial system had a general drainage direction from south to north. Today the drainage systems, both surface and subsurface, still generally follow the Tertiary paleodrainage trends. The Tertiary rock units outcropping within and surround the North Butte permit area are the Wasatch Formation (Eocene) and the White River Formation (Oligocene).

The North Butte site is located slightly west of the axis of the Powder River Basin syncline. Each of the aquifers of interest exist in the Wasatch formation. This formation is a fluvial deposit and contains alternating layers of sands and shales. The major sands can be correlated for miles, and are the basis for regional aquifers in the Powder River Basin. Regionally, combined with the underlying Fort Union Formation, the Wasatch is developed extensively by shallow domestic and stock wells. Locally, the Wasatch Formation is developed mainly as a source of groundwater for livestock use.

Recharge to the sands of the Wasatch is mainly on their outcrops, with some influx of groundwater form vertical movement through adjacent aquitards. Flow in the aquifers generally moves to the north along the paleodrainage trends, with a small portion of the groundwater discharging to streams. Aquifer properties are locally unpredictable due to large variations in local lithologies. Transmissivities within the Wasatch are know to range anywhere from 1 to 5,000 gpd/ft.

Extensive chemical data exists for the Wasatch aquifer system. Due to the discontinuous nature of the water-bearing sandstones, water quality concentrations within the system can be quite variable. Typically, total dissolved solids (TDS) content varies from less than 250 mg/L to over 6,500 mg/L, with a general decrease in TDS with increasing depth for parts of the aquifer (Feathers, et.al., 198). Waters containing less than 500 mg/L TDS are generally enriched with bicarbonate, while higher TDS waters generally exhibit higher dissolved sulfates.

2.7.3 Aquifer and Aquitard Properties

Two North Butte sites (SS2 and SSE) were tested in 1988 to define the aquifer and aquitard properties. The detailed hydrologic analyses and supporting data are contained in Volume III, groundwater Supplement. One multi-well test was conducted at the SS2 site and is referred to in this report as HYDRO Test NB1. Two multi-well tests were performed at the SSE site. These tests are referred to HYDRO Tests NB2 and NB3. Table A-1 of Volume III, the Groundwater Supplement, Part A, presents the basic well data for wells used to define the aquifer properties. The aquifer pump test plans for the SSE and SS2 site were approved prior to running the tests by the NRC and the WDEQ/LQD in letters dated March 22, 1988, and April 24, 1988, respectively.

In addition to determining the aquifer properties at each site, HYDRO Test NB1 was designed to evaluate the Upper aquitard and HYDRO Test NB2 was designed to evaluate the Lower aquitard. The capitalized words "Upper" and "Lower" aquitards refer to the specific aquitard between the "C" and "F" sands and the aquitard between the "A" and "1" sands, respectively. Several pump tests previously conducted by Cleveland-Cliffs were analyzed and used for additional points of information.

The North Butte in situ site is located on the outcrop of the Wasatch Formation. The stratigraphy of the Wasatch at this site consist of alternating layers of sand and shale with lignite marker beds. The mineable ore exists in three sand members ("A", "B" and "C") at North Butte. These three sand members are directly connected at some locations in the North Butte area, and are essentially one sand unit referred to as the mining sand. The "B" and "C" sands are connected at the SS2 site (NB1 test) and are tested as one unit. The "BC" sand is 162 feet thick at the SS2 site. Generally, when the "B" and "C" sands are separately delineated, they are roughly 100 feet and 50 feet thick, respectively. Figure 10.1 presents a schematic of the geologic setting of the HYDRO Test No. NB1 (SS2) site). This figure also shows the relative position of the next overlying aquifer, namely the "F" sand and the overlying aquitard, "FBC", which is approximately 100 feet thick at this location.

Figure 10.2 presents a schematic of the geologic setting of the SSE site, which is the location of the NB2 and NB3 tests. This schematic shows that the tested ore sand, "A", at this site is 71 feet thick with an approximately 45 feet chick Lower aquitard ("A1"). The Lower aquitard ("A1") isolates the mining zone ("A", "B" and "C" sand members) and is between the "A" and "1" sands. The "1" sand is a marginal sand at the SSE site and is approximately 30 feet thick. Figures 10.3 and 10.4 present the locations of the cluster of wells at the SS2 (NB1 test) and SSE (tests NB2 and NB3) sites, respectively.

2.8 ECOLOGY

2.8.1 Topography

The permit area is located about one mile southeast of the North Pumpkin Butte, in southwest Campbell County, Wyoming. The lateral extent of the permit area covers about 1039 acres comprising portions of Sections 18 and 19 of Township 44. North, Range 75 West and portions of Sections 13, 23, 24, and 25 of Township 44 North, Range 76 West.

In the eastern and southern portions of the permit area the topography is fairly level although moderately dissected by ephemeral stream channels. In the northern and western portions the slope of the topography increases and the drainages become more incised due to the proximity of North Butte. The surface elevations range from about 4,900 feet in the extreme south to about 5,700 feet above seal level near the flank of North Butte.

The proposed well fields (or mining units) will occupy approximately the designated areas as shown in the site plan layout Figure 9.3 (Volume II). The planned processing facility and evaporation ponds site, located in the most topographically suitable area, are also shown in Figure 9.2 (Volume II).

The overall topographic condition of the permit area is that of flat to gently sloping terrain with two moderate to large drainages in the western portion and three moderate to small drainages in the east. All the drainages are ephemeral in nature and generally trend from the north to the south, eventually forming tributaries to Willow Creek, which runs from east to west, crossing the extreme southern tip of the permit area. In the western portion of the permit area the terrain is more sloped with the drainages more incised. The surface consists of alternating sands and sandy shales in a repeating facies environment. Large eroded material is minor except in the northwest portion where there is extensive slide material present from the erosion of North Butte. This material consists of upper Wasatch Formation and lower White River Formation materials, which form the walls and cap rock of North Butte, respectively.

2.8.2 Soils

The soils occurring on the proposed North Butte permit area are typical of the semiarid grasslands of the western United States. Due to prevailing climate and vegetation conditions, organic matter is accumulated slowly, and soils have developed with light-colored surfaces. Subsoil color is usually light brown or yellowish brown. Past soil surveys do not indicate any prime farmland within the North Butte Permit area.

The greatest proportion of the upland soils of the survey area are residual (developed in place) and are formed from weathered sedimentary bedrock, mostly sandstone and shale. Most developed soils reflect the character of the bedrock. Areas of sandy and medium-textured friable soils are underlain by sandstone and sandy shale. Heavy clay soils are underlain by clayey shale. Depending primarily on the parent material from which the soils have formed, these soils vary widely in both depth and suitability of the material for topsoiling. Depths of suitable topsoil for the different soil units range from 0 inches to greater than 60 inches.

Stream channels of the survey area are characterized by alluvial soils such as the Kishona (Kim) series. These soils are developed from a variety of material washed from the uplands and redeposited along the stream courses. The soils formed in alluvium reflect the character of the weathered, transported material. These soils often have a generally dark friable surface that contains a fair amount of organic matter.

Soil survey results as well as detailed soils information for the North Butte Permit area is contained in Section 11, Appendix D-7 of Volume I. Detailed information provided in the survey includes Soil mapping units and acreage, topsoil volume for each soil unit, and soil profile descriptions. Soil unit boundaries are mapped and shown on Figure 11.1 (Volume II) of the original application.

2.8.3 Vegetation

One Extended Reference Area was established in an area that will not be disturbed for the life of the mine. This area will be used to evaluate post-mining revegetation success.

The permit area is currently used as rangeland for domestic livestock and provides wildlife habitat. The vegetation study conducted for the North Butte area is presented in Appendix D-8 (Volume I) and Volume IV (Vegetation Supplement) of the original application and provides details such as productivity and cover information. Vegetation mapping is shown on Figures 12.1 and 12.2 (Volume II).

2.8.4 Wildlife

The wildlife in the area is typical for the region. Studies and observations of wildlife on the North Butte permit area and in the surrounding vicinity have been previously submitted. Results of wildlife studies conducted at the North Butte area are presented in Appendix D-9 (Volume I) and were based on studies conducted by Applied ECOsystems in the fall of 1987. Results of the survey are also mapped and shown on Figure 13.1 (Volume II). Important game species include the Pronghorn Antelope, Mule Deer, Cottontail Rabbit, Coyote, Red Fox,

Badger, Sage Grouse, and Mourning Dove. Non-game species are typical of the sage brush grassland habitat in the region. No rare or endangered species were observed in the North Butte area. No active prairie dog colonies were found within the permit area or within ½-mile.

No raptor nests were observed within the permit area. Several were located within 1 mile of the permit area, however, were inactive at the time of the study. Raptors observed onsite included Golden Eagle, Bald Eagle, Red-Tailed Hawk, Marsh Hawk, Ferringous Hawk, Swainson Hawk, Rough-Legged Hawk, American Kestrel, and Prairie Falcon.

No Sage Grouse leks were located within the North Butte permit area. However, two strutting grounds located in the near vicinity, which are shown on Figure 13.1.

Annual raptor surveys will be conducted on the permit area and within a ½-mile perimeter. Annual sage grouse surveys of known leks or new leks on the permit area will also be conducted. Wildlife monitoring is described in more detail in Chapter 5 of this Volume.

2.9 BACKGROUND RADIOLOGICAL CHARACTERISTICS

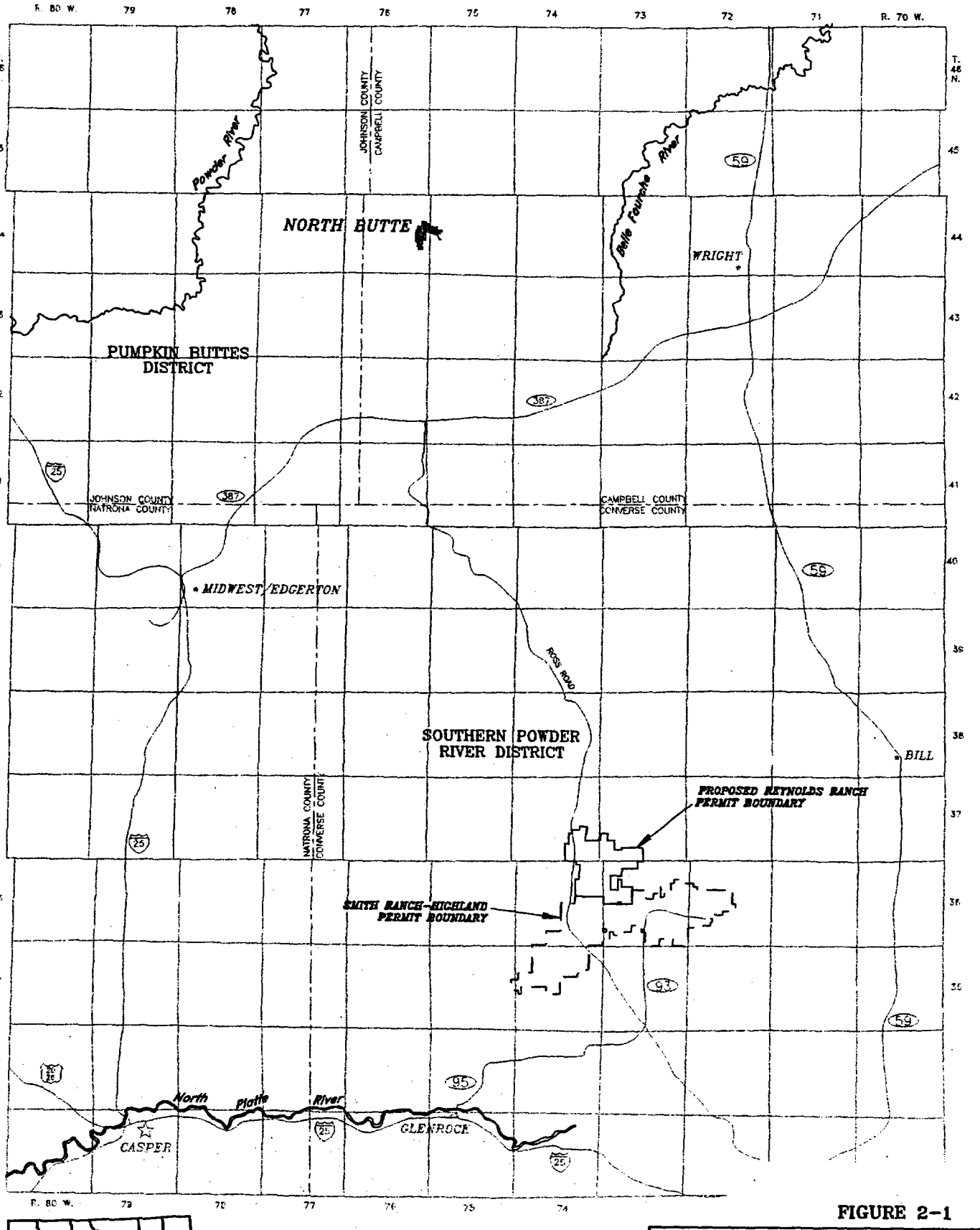
A background pre-mining radiological survey of the North Butte area was conducted by previous owners and results was submitted in the original application. Background radiation for the surface were normal and no anomalies were found. Background gamma surveys were conducted on a 500-foot grid pattern over the entire permit area. The results of these surveys show that the average background gamma radiation levels range from 11 to 13 μR/hr. All surface gamma results are presented in Table 14.4 of Appendix D-10 (Volume I) and Figure 14.1 (Volume II). This data was gathered in 1979 and select points were reverified in 1988.

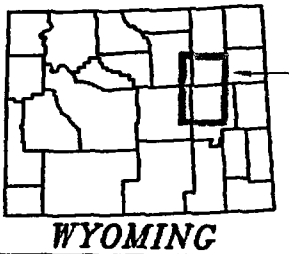
Other background pre-mining radiological surveys conducted in 1988 of the North Butte area included concentrations in vegetation, soil, sediment, atmospheric radon-222, gamma exposure, air particulates, and groundwater. Results of these surveys can be found in Section 14, Appendix D-10 (Volume I) of the original application. Background radiological concentrations for surface water could not be determined due to insufficient surface runoff from dry conditions experienced in 1988. Background conditions will be determined for surface water monitoring sites prior to commencement of operations, when sufficient water exists.

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.





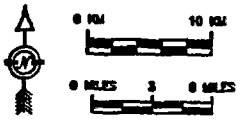


FIGURE 2-1

POWER RESOURCES, INC.

P.O. Box 1210 Gillette, WY 82717 (307) 686-6541 (307) 686-1628

REVISIONS		
NO.	DATE	BY

NORTH BUTTE PROJECT

PROJECT LOCATION MAP

PORTIONS OF NATRONA, CONVERSE CAMPBELL & JOHNSON COUNTIES, WYOMING

FIGURE 2-2

Gillette 1977-1997 Annual Wind-Run Rose
All Weather (123,909 observations)

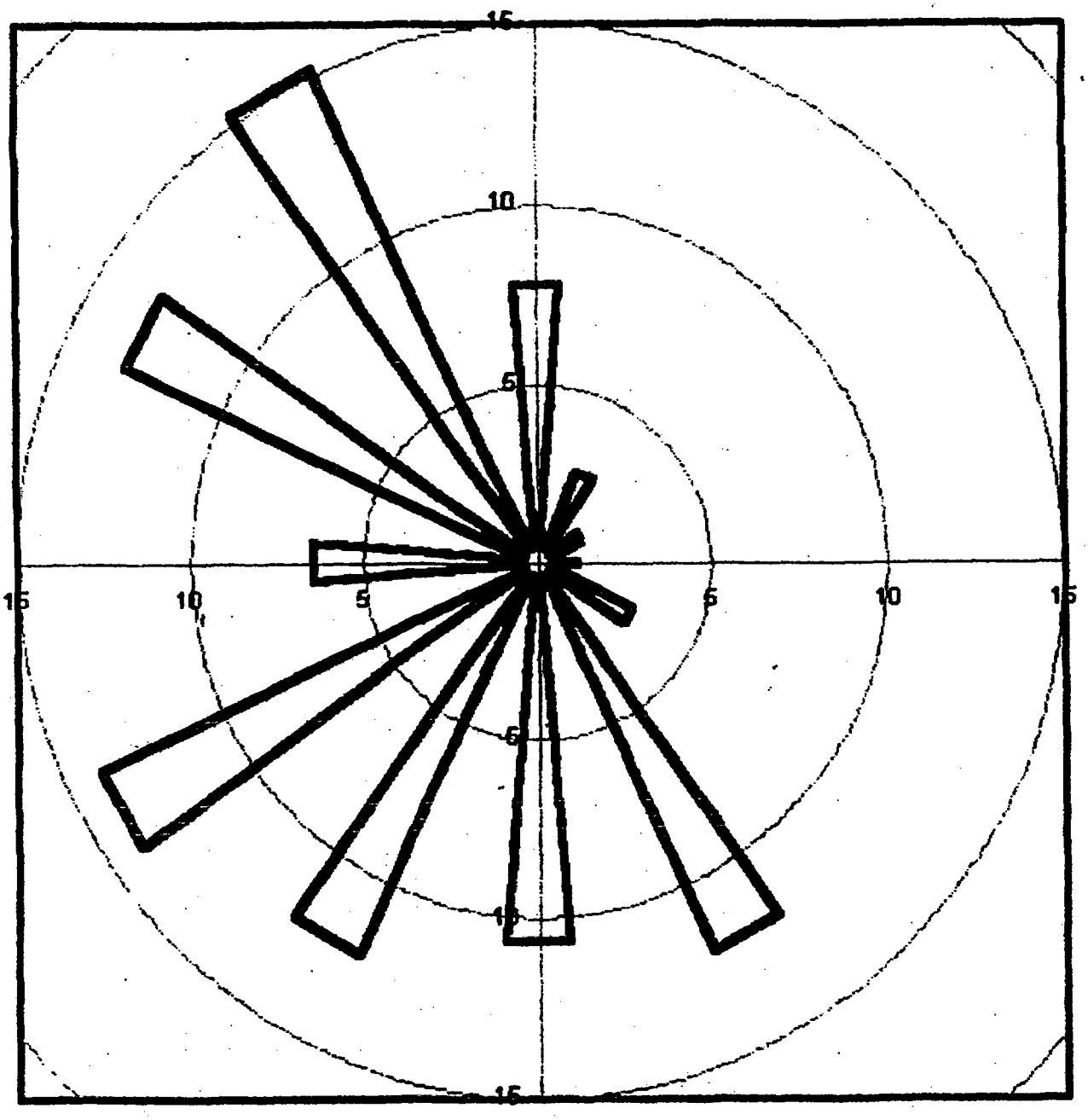
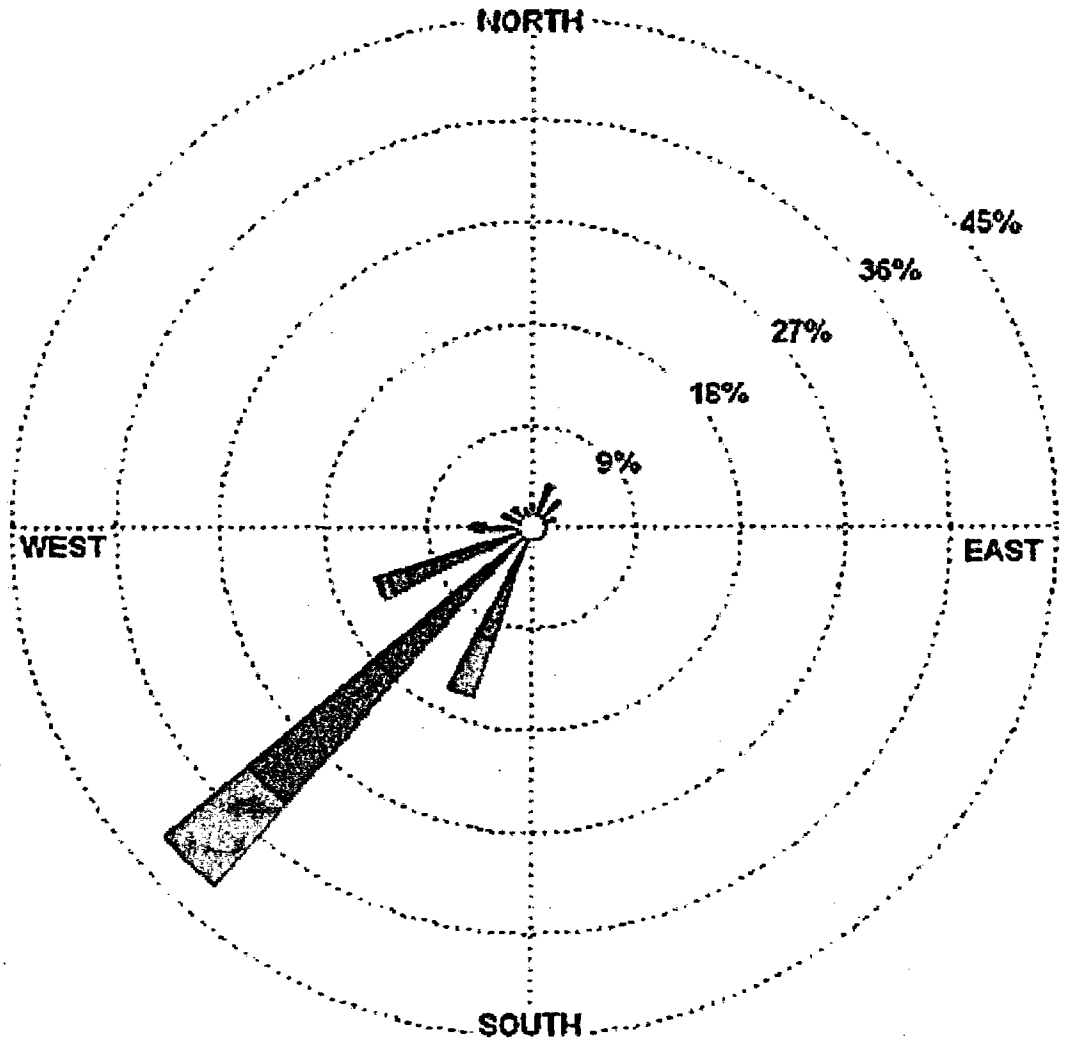


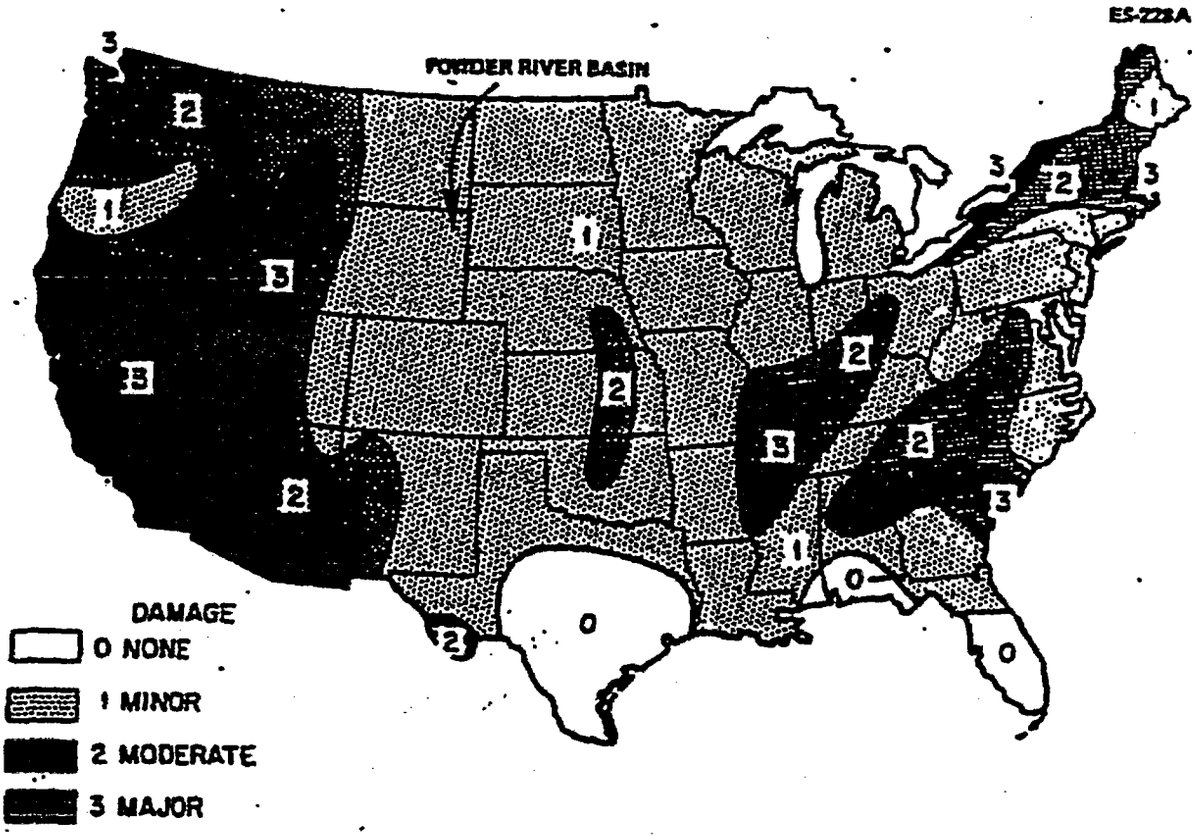
FIGURE 2-3

WIND ROSE
Station A24093: Casper/Natrona Co Int'l ARPT, WY



		Date 9/3/2002	Company Name USDA ARS
	Display Wind Speed	Unit m/s	> 11.06 > 8.49 - 11.06 > 5.40 - 8.49 > 3.34 - 5.40 > 1.80 - 3.34 > 0.51 - 1.80 Wind Speed m/s
	avg wind speed 7.59 m/s	Calm Wind 1.36%	
	Orientation Direction (Blowing From)	1961-90 Jan 1- Jan 31 Midnight-11pm	

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.

TABLE 2-1

LLETTE 18 SW, WYOMING (483865)

eriod of Record Monthly Climate Summary

eriod of Record : 8/ 1/1949 to 9/30/1985

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
verage Max. emperature (F)	31.6	37.2	43.1	54.3	64.7	75.1	85.0	83.7	72.6	60.6	44.1	35.0	57.3
verage Min. emperature (F)	9.8	15.3	19.7	28.6	38.2	46.8	53.5	52.0	41.8	32.7	21.3	13.6	31.1
verage Total ecipitation (in.)	0.55	0.63	1.05	1.91	2.79	2.93	1.30	1.36	1.10	1.09	0.71	0.61	16.02
verage Total SnowFall n.)	8.3	8.4	11.3	11.7	3.2	0.2	0.0	0.0	1.5	5.8	7.8	8.7	66.8
verage Snow Depth n.)	3	2	1	1	0	0	0	0	0	0	1	2	1

rcent of possible observations for period of record.
ax. Temp.: 99.1% Min. Temp.: 99.1% Precipitation: 99.2% Snowfall: 99.2% Snow Depth: 99.2%
ie Station Metadata or Metadata graphics for more detail about data completeness.

n Regional Climate Center, wrcc@dri.edu

TABLE 2-2

Population for Wyoming, Counties, Cities, and Towns: 2000 to 2020

AREA	2000 CENSUS	2001 Estimate	2002 Estimate	2003 Estimate	2004 Forecast	2005 Forecast	2006 Forecast	2007 Forecast	2008 Forecast	2009 Forecast	2010 Forecast	2011 Forecast	2012 Forecast	2013 Forecast	2014 Forecast	2015 Forecast	2016 Forecast	2017 Forecast	2018 Forecast	2019 Forecast	2020 Forecast
WYOMING	493,782	483,729	498,830	501,242	503,432	506,184	508,589	512,286	514,912	517,363	519,535	521,592	523,874	526,160	528,376	529,362	530,029	530,601	531,707	532,648	533,634
Campbell Cnty	33,698	34,628	36,110	36,240	36,520	37,076	37,686	38,104	38,610	39,147	39,701	40,252	40,806	41,288	41,882	42,414	42,826	43,248	43,693	44,145	44,596
Gillette	19,888	20,222	21,130	21,840	21,872	21,942	22,244	22,561	22,850	23,168	23,496	23,822	24,150	24,493	24,846	25,102	25,345	25,595	25,859	26,126	26,392
Wright	1,347	1,378	1,427	1,414	1,444	1,461	1,482	1,502	1,522	1,543	1,565	1,587	1,609	1,631	1,655	1,672	1,689	1,705	1,722	1,740	1,758
Converse Cnty	12,052	12,106	12,433	12,330	12,371	12,433	12,524	12,629	12,710	12,795	12,882	12,969	13,033	13,101	13,181	13,228	13,259	13,292	13,322	13,359	13,392
Douglas	5,280	5,306	5,443	5,398	5,418	5,445	5,485	5,527	5,566	5,603	5,641	5,675	5,707	5,737	5,772	5,792	5,807	5,821	5,834	5,850	5,865
Glenrock	2,231	2,232	2,293	2,274	2,282	2,294	2,311	2,328	2,345	2,360	2,376	2,391	2,404	2,417	2,432	2,440	2,446	2,452	2,458	2,465	2,471
Lost Springs	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rolling Hills	449	451	463	482	482	484	468	471	475	478	481	484	487	489	492	494	495	496	497	499	500
Johnson Cnty	7,076	7,170	7,374	7,643	7,629	7,728	7,829	7,937	8,047	8,159	8,266	8,376	8,482	8,592	8,706	8,769	8,867	8,948	9,029	9,114	9,196
Buffalo	3,902	3,959	4,084	4,220	4,238	4,291	4,349	4,409	4,470	4,533	4,593	4,652	4,712	4,773	4,836	4,882	4,926	4,970	5,016	5,063	5,109
Kaycee	249	253	260	266	269	272	276	280	284	288	292	295	299	303	307	310	313	315	318	321	324
Natrona Cnty	66,533	66,831	67,336	68,211	68,517	68,965	69,469	69,740	70,016	70,282	70,528	70,741	71,047	71,340	71,583	71,685	71,766	71,848	71,940	72,049	72,151
Bar Nunn	936	948	962	986	982	987	994	998	1,002	1,005	1,009	1,012	1,016	1,021	1,024	1,026	1,027	1,028	1,029	1,031	1,032
Casper	49,739	49,765	50,024	50,832	51,015	51,274	51,641	51,850	52,054	52,252	52,438	52,504	52,822	53,039	53,220	53,296	53,348	53,417	53,485	53,567	53,642
Edgerton	169	169	169	171	173	173	175	175	176	177	177	178	179	179	180	180	181	181	181	181	181
Evansville	2,255	2,277	2,297	2,324	2,337	2,349	2,366	2,376	2,385	2,394	2,403	2,410	2,420	2,430	2,439	2,442	2,444	2,448	2,451	2,454	2,458
Midwest	408	406	406	412	415	417	420	422	424	425	427	428	430	432	433	434	434	435	435	436	437
Mills	2,632	2,747	2,842	2,894	2,869	2,883	2,904	2,916	2,927	2,938	2,949	2,958	2,970	2,983	2,993	2,997	3,000	3,004	3,008	3,012	3,017

Note: 2000 state, county and municipality population are 2000 Census data; 2001-2003 state and county population estimates were produced by U.S. Census Bureau; 2004 to 2020 state and county population forecasts were developed based on trends of demographic and economic variables; municipality population forecasts was simply calculated by applying the place/county ratios to the appropriate county population forecasts.

Prepared by Wyoming Department of A & I, Economic Analysis Division (http://eadiv.state.wy.us)

ATTACHMENT 2-1

"BASIC SEISMOLOGICAL CHARACTERIZATION FOR CAMPBELL COUNTY, WYOMING

Basic Seismological Characterization for Campbell County, Wyoming

by

James C. Case, Rachel N. Toner, and Robert Kirkwood
Wyoming State Geological Survey
September 2002

BACKGROUND

Seismological characterizations of an area can range from an analysis of historic seismicity to a long-term probabilistic seismic hazard assessment. A complete characterization usually includes a summary of historic seismicity, an analysis of the Seismic Zone Map of the Uniform Building Code, deterministic analyses on active faults, "floating earthquake" analyses, and short- or long-term probabilistic seismic hazard analyses.

Presented below, for Campbell County, Wyoming, are an analysis of historic seismicity, an analysis of the Uniform Building Code, deterministic analyses of nearby active faults, an analysis of the maximum credible "floating earthquake", and current short- and long-term probabilistic seismic hazard analyses.

Historic Seismicity in Campbell County

The enclosed map of "Earthquake Epicenters and Suspected Active Faults with Surficial Expression in Wyoming" (Case and others, 1997) shows the historic distribution of earthquakes in Wyoming. Five magnitude 2.5 and greater earthquakes have been recorded in Campbell County. These earthquakes are discussed below.

The first earthquake recorded in the county occurred on May 11, 1967. This magnitude 4.8 earthquake was centered in southwestern Campbell County approximately 7 miles west-northwest of Pine Tree Junction. The second event took place on February 18,1972, when a magnitude 4.3 earthquake occurred approximately 18 miles east of Gillette. No damage was reported for either event.

Two earthquakes were recorded in Campbell County during the 1980s. On May 29, 1984, a magnitude 5.0, intensity V earthquake occurred approximately 24 miles west-southwest of Gillette. The earthquake was felt in Gillette, Sheridan, Buffalo, Casper, Douglas, Thermopolis,

and Sundance. A rancher, living 35 miles west of Gillette, reported that he could see the ground shaking, and he heard a loud noise similar to a sonic boom. Pictures were shaken from the walls of the ranch house, but no other damage occurred at the ranch (Casper Star-Tribune, May 30, 1984). Surprisingly, all other reports only indicated that dishes rattled. On October 29, 1984, a magnitude 2.5 earthquake occurred approximately 25 miles west-northwest of Gillette. No damage was reported.

Most recently, on February 24, 1993, a magnitude 3.6 earthquake occurred in southeastern Campbell County approximately 10 miles east-southeast of Reno Junction. No damage was reported.

Regional Historic Seismicity

Earthquakes have also occurred near the Campbell County-Johnson County border. On September 2, 1976, a magnitude 4.8, intensity IV-V earthquake occurred approximately 33 miles northeast of Kaycee and 38 miles west-southwest of Gillette. Although the event was felt in Kaycee, no damage was reported. A magnitude 5.1, intensity V earthquake was reported on September 7, 1984, approximately 27 miles west of Gillette. The earthquake was felt throughout northeastern Wyoming, including Buffalo, Casper, Kaycee, Linch, and Midwest, and parts of southeastern Montana. No significant damage was reported (Laramie Daily Boomerang, September 8, 1984).

Uniform Building Code

The Uniform Building Code (UBC) is a document prepared by the International Conference of Building Officials. Its stated intent is to "provide minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within this jurisdiction and certain equipment specifically regulated herein."

The UBC contains information and guidance on designing buildings and structures to withstand seismic events. With safety in mind, the UBC provides Seismic Zone Maps to help identify which design factors are critical to specific areas of the country. In addition, depending upon the type of building, there is also an "importance factor". The "importance factor" can, in effect, raise the standards that are applied to a building.

The current UBC Seismic Zone Map (Figure 1) (1997) has five seismic zones, ranging from Zone 0 to Zone 4, as can be seen on the enclosed map. The seismic zones are in part defined by the probability of having a certain level of ground shaking (horizontal acceleration) in 50 years. The criteria used for defining boundaries on the Seismic Zone Map were established by the Seismology Committee of the Structural Engineers Association of California (Building Standards, September-October, 1986). The criteria they developed are as follows:

Zone	Effective Peak Acceleration, % gravity (g)
4	30% and greater
3	20% to less than 30%
2	10% to less than 20%
1	5% to less than 10%
0	less than 5%

The committee assumed that there was a 90% probability that the above values would not be exceeded in 50 years, or a 100% probability that the values would be exceeded in 475 to 500 years.

Campbell County is in Seismic Zones 0 and 1 of the UBC. The seismic history of the area, however, does not support a Zone 0 classification. Since effective peak accelerations (90% chance of non-exceedance in 50 years) can range from 0%-10%g in these two zones, and there has been some significant historic seismicity in the county, it may be reasonable to assume that an average peak acceleration of 10.0%g could be applied to the design of a non-critical facility located in the county if only the UBC were used. Such an acceleration is significantly less than would be suggested through newer building codes.

Recently, the UBC has been replaced by the International Building Code (IBC). The IBC is based upon probabilistic analyses, which are described in a following section. Campbell County still uses the UBC, however, as do most Wyoming counties as of October 2002.

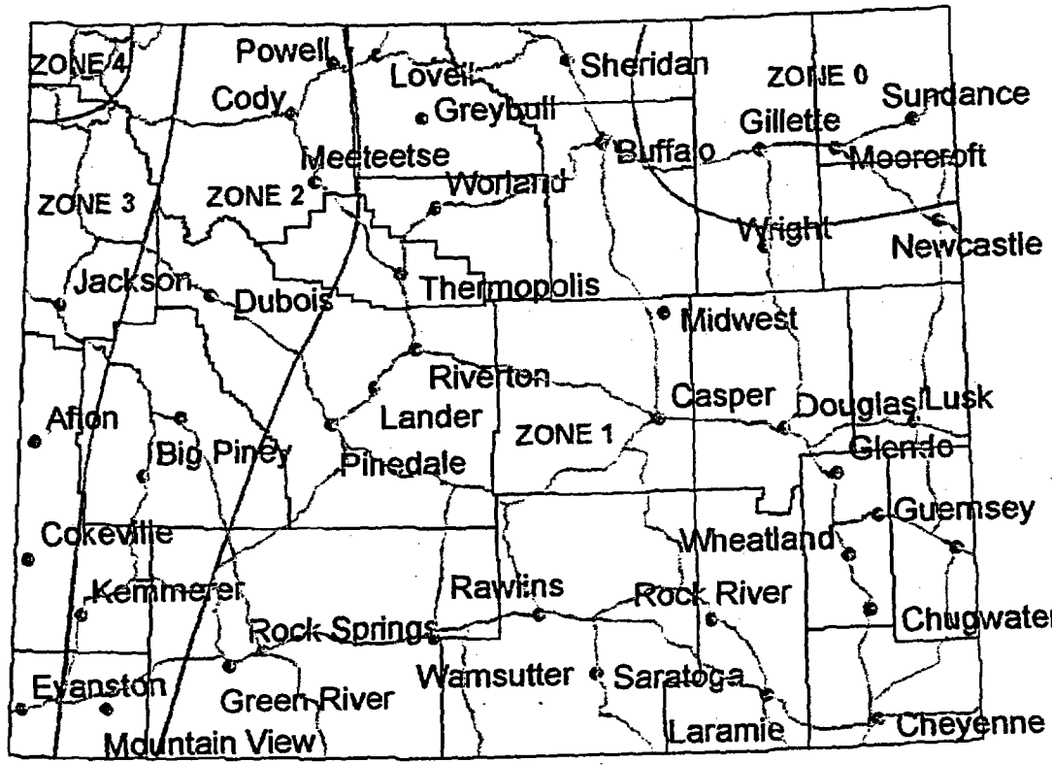


Figure 1. UBC Seismic Zone Map.

Deterministic Analysis Of Regional Active Faults With A Surficial Expression

There are no known exposed active faults with a surficial expression in Campbell County. As a result, no fault-specific analysis can be generated for Campbell County.

Floating or Random Earthquake Sources

Many federal regulations require an analysis of the earthquake potential in areas where active faults are not exposed, and where earthquakes are tied to buried faults with no surface expression. Regions with a uniform potential for the occurrence of such earthquakes are called tectonic provinces. Within a tectonic province, earthquakes associated with buried faults are assumed to occur randomly, and as a result can theoretically occur anywhere within that area of uniform earthquake potential. In reality, that random distribution may not be the case, as all earthquakes are associated with specific faults. If all buried faults have not been identified, however, the distribution has to be considered random. "Floating earthquakes" are earthquakes that are considered to occur randomly in a tectonic province.

It is difficult to accurately define tectonic provinces when there is a limited historic earthquake record. When there are no nearby seismic stations that can detect small-magnitude earthquakes, which occur more frequently than larger events, the problem is compounded. Under these conditions, it is common to delineate larger, rather than smaller, tectonic provinces.

The U.S. Geological Survey identified tectonic provinces in a report titled "Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States" (Algermissen and others, 1982). In that report, Campbell County was classified as being in a tectonic province with a "floating earthquake" maximum magnitude of 6.1. Geomatrix (1988b) suggested using a more extensive regional tectonic province, called the "Wyoming Foreland Structural Province", which is approximately defined by the Idaho-Wyoming Thrust Belt on the west, 104° West longitude on the east, 40° North latitude on the south, and 45° North latitude on the north. Geomatrix (1988b) estimated that the largest "floating" earthquake in the "Wyoming Foreland Structural Province" would have a magnitude in the 6.0 – 6.5 range, with an average value of magnitude 6.25.

Federal or state regulations usually specify if a "floating earthquake" or tectonic province analysis is required for a facility. Usually, those regulations also specify at what distance a floating earthquake is to be placed from a facility. For example, for uranium mill tailings sites, the Nuclear Regulatory Commission requires that a floating earthquake be placed 15 kilometers from the site. That earthquake is then used to determine what horizontal accelerations may occur at the site. A magnitude 6.25 "floating" earthquake, placed 15 kilometers from any structure in Campbell County, would generate horizontal accelerations of approximately 15%g at the site. Critical facilities, such as dams, usually require a more detailed probabilistic analysis of random earthquakes. Based upon probabilistic analyses of random earthquakes in an area distant from exposed active faults (Geomatrix, 1988b), however, placing a magnitude 6.25 earthquake at 15 kilometers from a site will provide a fairly reasonable estimate of design ground accelerations in

the northeastern and eastern parts of Campbell County, but will be inadequate in the southwestern part of the county.

Probabilistic Seismic Hazard Analyses

The U.S. Geological Survey (USGS) publishes probabilistic acceleration maps for 500-, 1000-, and 2,500-year time frames. The maps show what accelerations may be met or exceeded in those time frames by expressing the probability that the accelerations will be met or exceeded in a shorter time frame. For example, a 10% probability that acceleration may be met or exceeded in 50 years is roughly equivalent to a 100% probability of exceedance in 500 years.

The USGS has recently generated new probabilistic acceleration maps for Wyoming (Case, 2000). Copies of the 500-year (10% probability of exceedance in 50 years), 1000-year (5% probability of exceedance in 50 years), and 2,500-year (2% probability of exceedance in 50 years) maps are attached. Until recently, the 500-year map was often used for planning purposes for average structures, and was the basis of the most current Uniform Building Code. The new International Building Code, however, uses a 2,500-year map as the basis for building design. The maps reflect current perceptions on seismicity in Wyoming. In many areas of Wyoming, ground accelerations shown on the USGS maps can be increased due to local soil conditions. For example, if fairly soft, saturated sediments are present at the surface, and seismic waves are passed through them, surface ground accelerations will usually be greater than would be experienced if only bedrock was present. In this case, the ground accelerations shown on the USGS maps would underestimate the local hazard, as they are based upon accelerations that would be expected if firm soil or rock were present at the surface. Intensity values can be found in Table 1.

Based upon the 500-year map (10% probability of exceedance in 50 years) (Figure 2), the estimated peak horizontal acceleration in Campbell County ranges from approximately 3%g in the northeastern corner of the county to greater than 6%g in the southwestern corner of the county. These accelerations are roughly comparable to intensity IV earthquakes (1.4%g – 3.9%g) to intensity V earthquakes (3.9%g – 9.2%g). These accelerations are comparable to the accelerations to be expected in Seismic Zones 0 and 1 of the Uniform Building Code. Intensity IV earthquakes cause little damage. Intensity V earthquakes can result in cracked plaster and broken dishes. Gillette would be subjected to an acceleration of approximately 5%g or intensity V.

Based upon the 1000-year map (5% probability of exceedance in 50 years) (Figure 3), the estimated peak horizontal acceleration in Campbell County ranges from 4%g in the northeastern corner of the county to greater than 10%g in the southwestern quarter of the county. These accelerations are roughly comparable to intensity V earthquakes (3.9%g – 9.2%g) to intensity VI earthquakes (9.2%g – 18%g). Intensity V earthquakes can result in cracked plaster and broken dishes. Intensity VI earthquakes can result in fallen plaster and damaged chimneys. Depending upon local ground conditions, Gillette would be subjected to an acceleration of approximately 9%g or greater and intensity V or VI.

Based upon the 2500-year map (2% probability of exceedance in 50 years) (Figure 4), the estimated peak horizontal acceleration in Campbell County ranges from 8%g in the northeastern corner of the county to greater than 20%g in the southwestern corner of the county. These accelerations are roughly comparable to intensity V earthquakes (3.9%g – 9.2%g), intensity VI earthquakes (9.2%g – 18%g), and intensity VII earthquakes (18%g – 34%g). Intensity V earthquakes can result in cracked plaster and broken dishes. Intensity VI earthquakes can result in fallen plaster and damaged chimneys. Intensity VII earthquakes can result in slight to moderate damage in well-built ordinary structures, and considerable damage in poorly built or badly designed structures, such as unreinforced masonry. Chimneys may be broken. Gillette would be subjected to an acceleration of approximately 18%g or intensity VI to VII.

As the historic record is limited, it is nearly impossible to determine when a 2,500-year event last occurred in the county. Because of the uncertainty involved, and based upon the fact that the new International Building Code utilizes 2,500-year events for building design, it is suggested that the 2,500-year probabilistic maps be used for Campbell County analyses. This conservative approach is in the interest of public safety.

Table 1:

Modified Mercalli Intensity	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	<0.17	Not felt	None
II	0.17 – 1.4	Weak	None
III	0.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy
IX	65 – 124	Violent	Heavy
X	>124	Extreme	Very Heavy
XI	>124	Extreme	Very Heavy
XII	>124	Extreme	Very Heavy

Modified Mercalli Intensity and peak ground acceleration (PGA) (Wald, et al 1999).

Abridged Modified Mercalli Intensity Scale

Intensity value and description:

I Not felt except by a very few under especially favorable circumstances.

II Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing of truck. Duration estimated.

IV During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably.

V Felt by nearly everyone, many awakened. Some dishes, windows, and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.

VI Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight.

VII Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars.

VIII Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed.

IX Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks.

XI Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

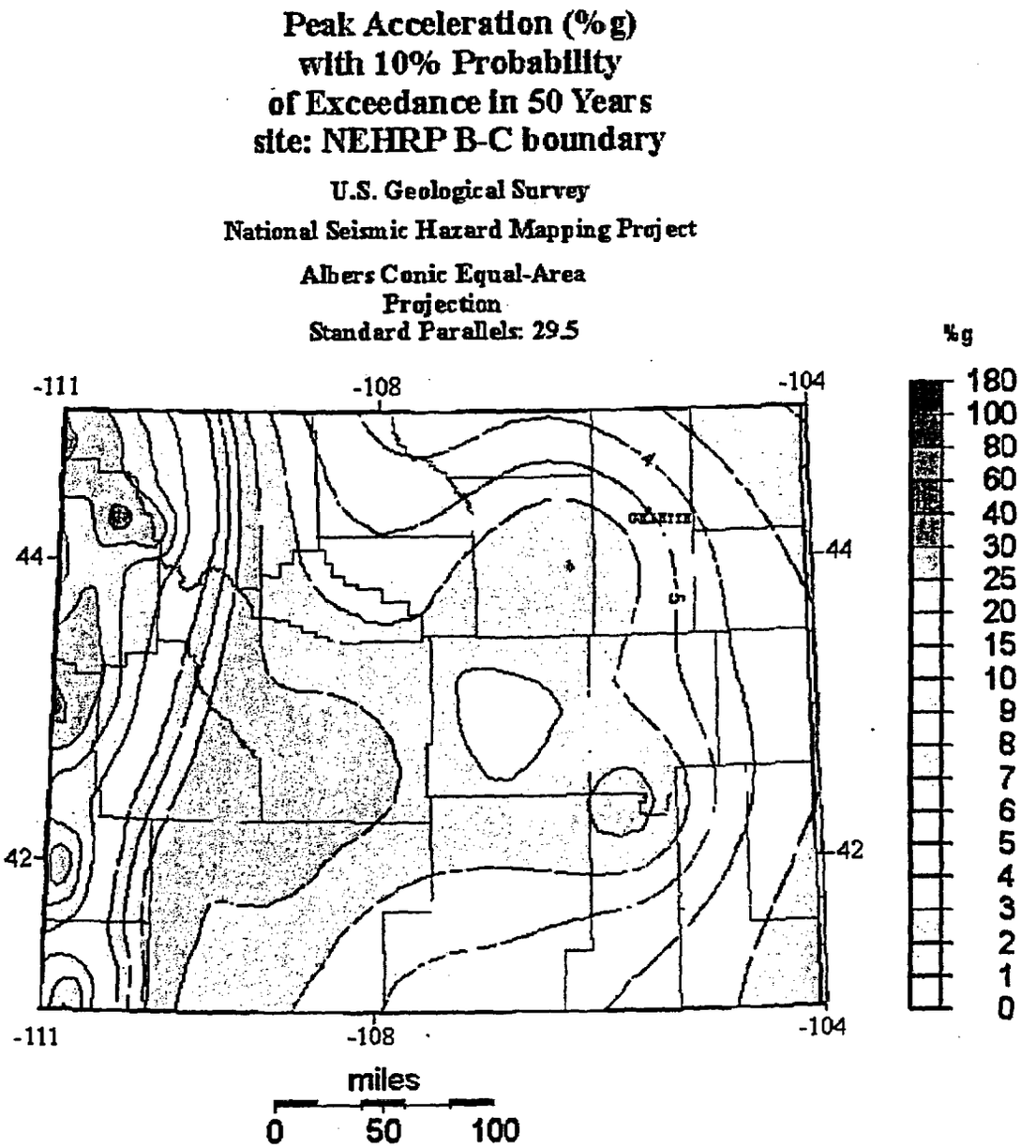


Figure 2. 500-year probabilistic acceleration map (10% probability of exceedance in 50 years).

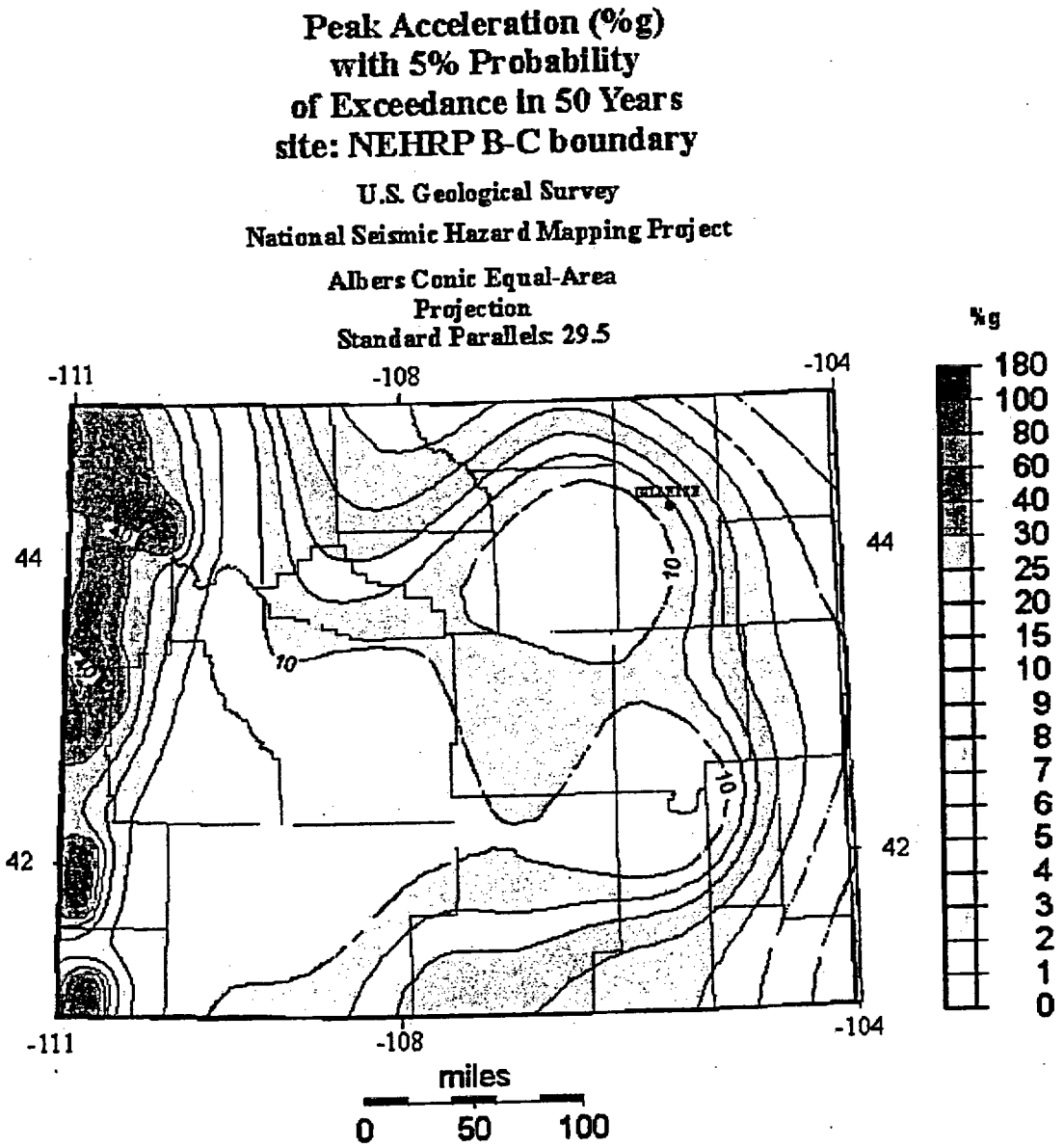


Figure 3. 1000-year probabilistic acceleration map (5% probability of exceedance in 50 years).

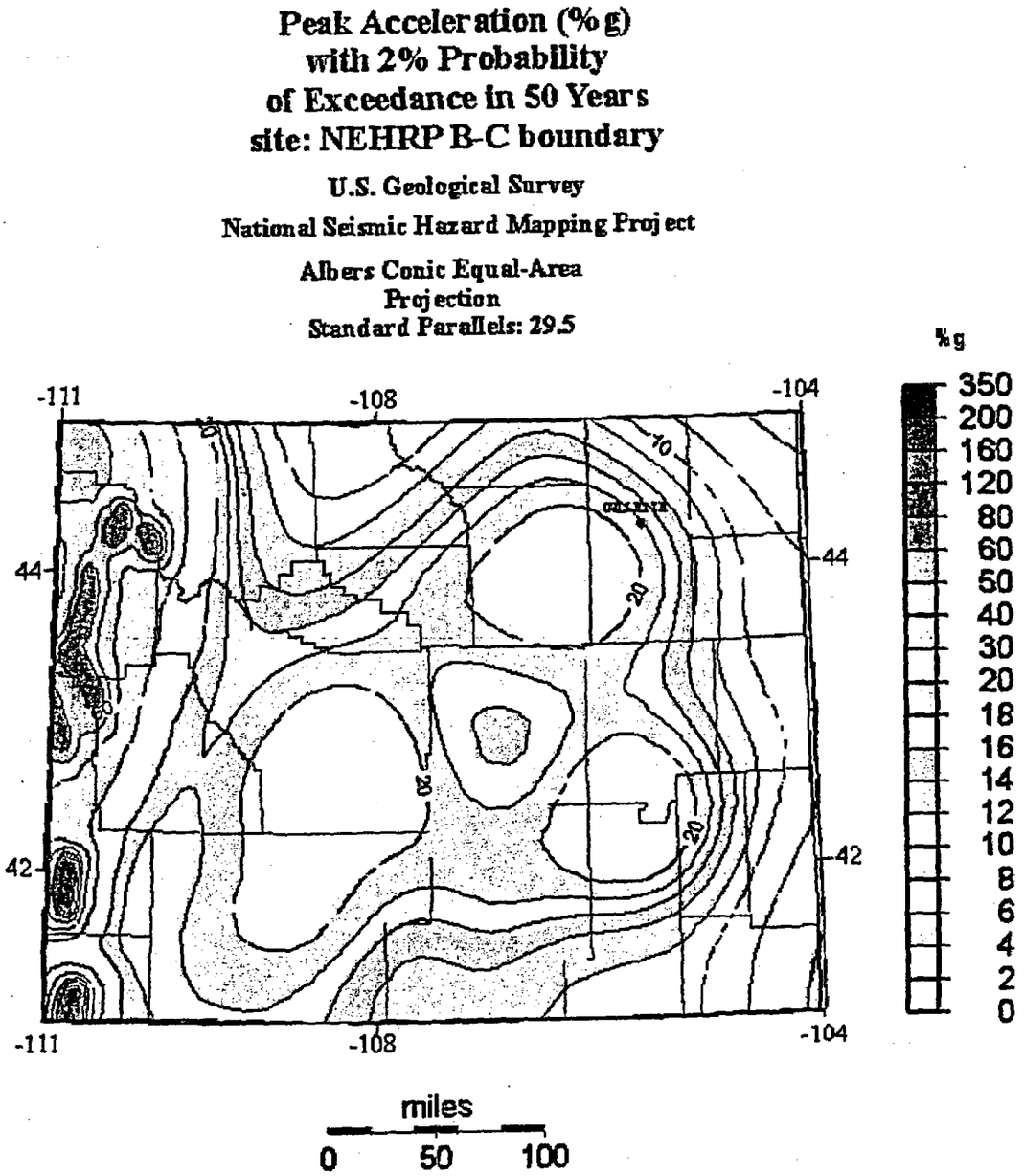


Figure 4. 2500-year probabilistic acceleration map (2% probability of exceedance in 50 years).

Summary

There have been seven historic earthquakes with a magnitude greater than 2.5 recorded in or near Campbell County. Because of the limited historic record, it is possible to underestimate the seismic hazard in Campbell County if historic earthquakes are used as the sole basis for analysis. Earthquake and ground motion probability maps give a more reasonable estimate of damage potential in areas without exposed active faults at the surface, such as Campbell County.

Current earthquake probability maps that are used in the newest building codes (2500 year maps) suggest a scenario that would result in moderate damage to buildings and their contents, with damage increasing from the northeast to the southwest. More specifically, the probability-based worst-case scenario could result in the following damage at points throughout the county:

Intensity VII Earthquake Areas

Gillette
Savageton
Wright

In intensity VII earthquakes, damage is negligible in buildings of good design and construction, slight-to-moderate in well-built ordinary structures, considerable in poorly built or badly designed structures such as unreinforced masonry buildings. Some chimneys will be broken.

Intensity VI Earthquake Areas

Recluse
Rozet
Spotted Horse
Weston

In intensity VI earthquakes, some heavy furniture can be moved. There may be some instances of fallen plaster and damaged chimneys.

Intensity V Earthquake Areas

Rockypoint

In intensity V earthquakes, dishes and windows can break and plaster can crack. Unstable objects may overturn. Tall objects such as trees and power poles can be disturbed.

References

Algermissen, S.T., Perkins, D.M., Thenhaus, P.C., Hanson, S.L., and Bender, B.L., 1982, Probabilistic estimates of maximum acceleration and velocity in rock in the contiguous United States: U.S. Geological Survey Open File Report 82-1033, 99 p., scale 1:7,500,000.

Case, J.C., 2000, Probability of damaging earthquakes in Wyoming: Wyoming State Geological Survey, Wyoming Geo-notes No. 67, p. 50-55.

Case, J.C., 1996, Historical seismicity of northeastern and east-central Wyoming: Wyoming State Geological Survey Wyoming Geo-notes Number 51, pp. 50-55.

Case, J.C., 1997, Historical seismicity of south-central and southeastern Wyoming: Wyoming State Geological Survey Wyoming Geo-notes Number 56, pp. 54-59.

Case, J.C., Larsen L.L., Boyd, C.S., and Cannia, J.C., 1997, Earthquake epicenters and suspected active faults with surficial expression in Wyoming: Wyoming State Geological Survey Geologic Hazards Section Preliminary Hazards Report 97-1, scale 1:1,000,000.

Case, J.C., 1993, Geologic Hazards in Wyoming: Wyoming State Geological Survey Wyoming Geo-notes Number 40, pp. 46-48.

Geomatrix Consultants, Inc., 1988a, Seismotectonic evaluation of the northwestern Wind River Basin: Report prepared for the U.S. Bureau of Reclamation, Contract No. 6-CS-81-07310, 116 p.

Geomatrix Consultants, Inc., 1988b, Seismotectonic evaluation of the Wyoming Basin geomorphic province: Report prepared for the U.S. Bureau of Reclamation, Contract No. 6-CS-81-07310, 167 p.

McGrew, L.W., 1961, Structure of Cenozoic rocks along the northwestern margin of the Julesburg Basin, southeastern Wyoming (abstract): Geological Society of America, Rocky Mountain Section, Annual Meeting Program, Laramie, Wyoming, May 11-13, 1961, p. 22.

Murphy, L.M., and Cloud, W.K., 1954, United States earthquakes 1952: U.S. Department of Commerce, Coast and Geodetic Survey Serial No. 773, 112p.

Stover, C.W., 1985, Preliminary isoseismal map and intensity distribution for the Laramie Mountains, Wyoming, earthquake of October 18, 1984: U.S. Geological Survey Open File report 85-137, 9 p.

Wald D.J., Quitoriano V., Heaton T.H., Kanamori H., 1999, Relationships between Peak Ground Acceleration, Peak Ground Velocity and Modified Mercalli Intensity in California, Earthquake Spectra, v. 15, no. 3, 557-564.

CHAPTER 3 - DESCRIPTION OF THE FACILITIES

The permit area for the North Butte property contains 1,039 acres. The total surface area to be affected by the proposed operation is within the permit area and will total approximately 309 acres. The wellfields, Satellite facility, evaporation ponds, and two deep disposal wells are the significant surface features associated with the uranium in situ leaching mining operations.

In association with the North Butte operations is a lined, two cell evaporation pond to assists with waste water disposal. The ponds will act as holding ponds prior to disposal to the deep injection wells. The ponds are sized to hold 40 gpm bleed stream for a 30-day time period to allow for maintenance or repair of the deep wells. The target operating parameters for each of the two deep disposal wells is 150 gpm maximum at 2000 psi maximum injection pressure.

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 1,309 acres. The areas fenced to limit access by livestock to wellfield areas will be slightly greater than that encompassed by the areas to be mined. All yellowcake processing will be conducted at the Central Processing Plant (CPP) at Smith Ranch-Highland Uranium Project (SR-HUP). North Butte will have well fields, a small office and Satellite building housing ion exchange (IX) columns, construction and maintenance shop, water treatment equipment, resin transfer facilities, pumps for injection of lixiviant, a small laboratory and employee break room.

3.1 IN SITU LEACHING PROCESS AND EQUIPMENT

The North Butte Project will use 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, and full scale operations at SR-HUP, as well as techniques and processes developed at other ISL facilities that utilize best practices and industry experience.

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/or bicarbonate 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 will be used because of its selectivity for uranium and minor reaction with the gangue minerals. Pilot tests worked well at other PRI operations, 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

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 facilities, this transfer is performed by moving the uranium loaded resin from the Satellite to the CPP using truck transport.

Deep injection wells and/or lined evaporation ponds are used to collect and dispose process wastewaters. 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.

3.1.3 Satellite Building

The Satellite building houses 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 or at headerhouses.

The location of the Satellite building and associated structures are shown on Plate 1. There is one Satellite building planned for the North Butte amendment area. The Satellite is located in the NE ¼ Section 24, T44N, R76W. The building will occupy approximately 19,000 ft^2. The layout of the Satellite is shown on Figure 3-3. The Satellite serves all wellfields at the North Butte Project and is designed to operate with a maximum through-flow of 4500 gpm and vessel pressures of 150 psi during production operations.

3.1.4 Wellfields

3.1.4.1 Ore Deposits

The ore deposits in the North Butte Project 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.

A typical stratigraphic interval to be mined by the in situ mining method is shown by the geologic cross sections of the Production Wellfields. 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.

3.1.4.2 Wellfield Areas

Wellfield areas are developed as needed to meet production requirements and are generally about 20 to 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 3.1.4.3 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.

Detailed information will be submitted on North Butte's individual mining units as delineation drilling is completed and pre-mining hydrological data is obtained.

There are currently 8 wellfields planned for the Reynolds Ranch amendment area. Anticipated locations of these wellfields are shown on Plate 1.

3.1.4.3 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 3-4). 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 3-4.

3.1.4.4 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 20 to 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 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 3-5. 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 is Mine Unit 1, which is anticipated to be the first wellfield in operation. The exact schedule for other proposed wellfields depend on future economic analyses of ore reserves and anticipated production costs.

The development schedule provided in Figure 3-5 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.

3.1.4.5 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. The Pilot holes will be large enough in diameter to provide at least three inches of annulus space.

Typical well completion schematics for production wells, injection wells, and monitor wells are shown on Figures 3-6 through 3-8, 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-inch SDR-17 (or equivalent). The PVC casing joints normally have a length of approximately 20 feet each. 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 (March 2006), all production and injection wells are planned to be constructed with SDR-17 PVC casing that utilizes the o-ring seal and nylon spline.

Casing centralizers, located approximately every 40 feet above the casing shoe, are normally run on the casing to ensure it is centered in the drill hole. Effective sealing materials shall consist of neat cement slurry, sand-cement grout, or bentonite clay mixtures meeting State requirements described in Section 6, Chapter 11 of the LQD Non Coal Rules and Regulations unless a variance is obtained from the LQD Administrator. The purpose of the cement or other sealing materials 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". Tremie pipes cannot be used to top off a well in cases where the cement return to the surface is more than 40 feet from the top. This is due to the fact that centralizers are placed every 40 feet and it is not possible to place a tremie pipe past the centralizers. In these instances, protection of groundwaters of the state is documented through mechanical integrity testing.

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.

3.1.4.6 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 125% of the maximum operating wellhead casing 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 well will be placed out of service and the casing may be repaired and the well re-tested or abandoned. The WDEQ-LQD Administration will be notified of any well that fails the MIT. If a repaired well passes the MIT, it will be employed in its intended service following approval from the LQD Administrator that the well has demonstrated mechanical integrity. 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.

3.1.4.7 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.

3.1.4.8 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 Chemical Storage Facilities

Chemical storage facilities at the North Butte will include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact safety, are stored outside. No Bulk radiological materials will be stored at the North Butte Satellite. Other non-hazardous bulk process chemicals (Oxygen, Soda Ash, Gasoline, Diesel, Carbon Dioxide, Propane or Natural Gas) that do not have the potential to impact radiological safety are stored within the Satellite facilities.

3.2.1 Process Related Chemicals

Hazardous materials, which have the potential to impact radiological safety are not stored at the Satellite facility. All outside bulk liquid storage tanks are contained within concrete curbed secondary containment structures.

Additional process-related chemicals stored in bulk at North Butte will include carbon dioxide and oxygen. Carbon dioxide is typically stored adjacent to the Satellite facilities where it is added to the lixiviant prior to leaving the IX facilities. Oxygen is also typically stored at the Satellite facilities, or within wellfield areas, where it is centrally located for addition to the injection stream in each header house. Soda Ash may also be stored in bulk in order to produce bicarbonate for leaching solution.

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 within sufficient secondary containment structures.

Sodium sulfide is currently (March 2003) used in limited amounts at the SR-HUP as a chemical reductant during ground water restoration, this may be used at North Butte. 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 will be 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. Additionally, bioremediation is also used during ground water restoration. Chemicals utilized for bioremediation may include methanol, molasses, and phosphoric acid along with bioremediation agents. 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.

3.2.2 Non-Process Related Chemicals

Non-process related chemicals that will be stored at North Butte Satellite include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of process areas 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

At the North Butte Project, 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.

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 Satellite 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

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

Leaching and Complexing

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

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)

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

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.

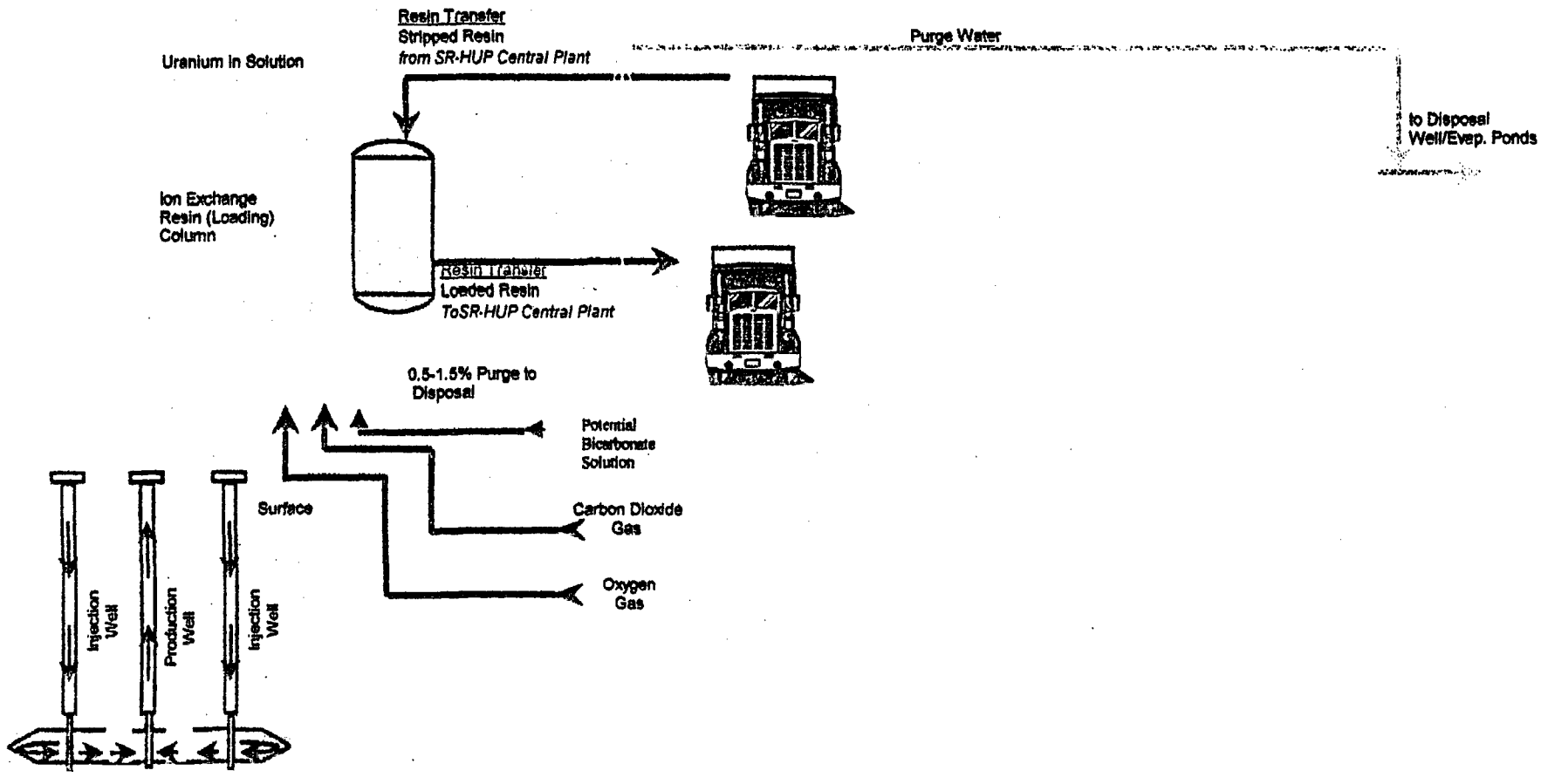
Sulfate is created by the oxidation of pyrites associated with uranium roll front geochemistry.

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

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

URANIUM EXTRACTION



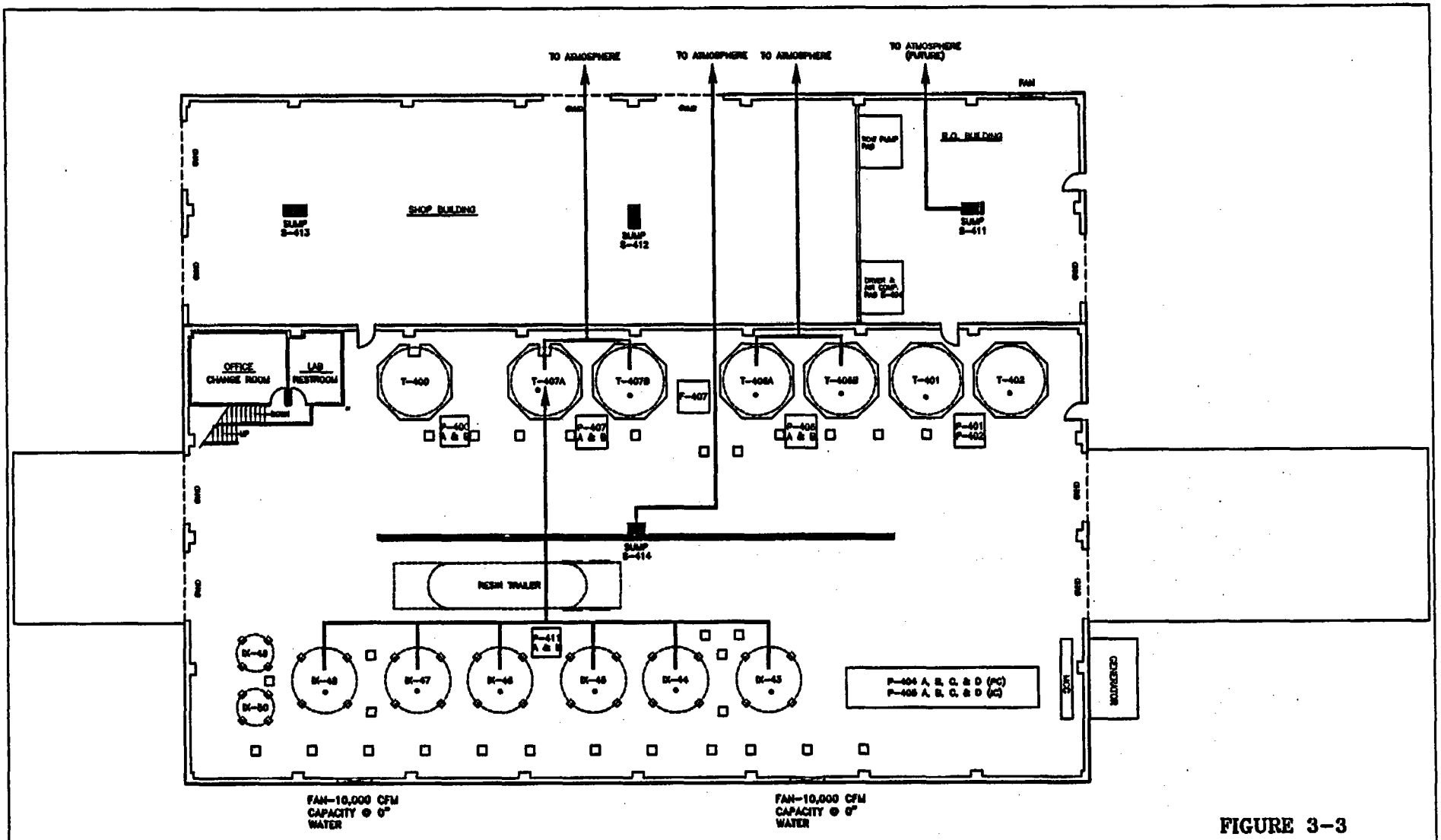


FIGURE 3-3

LEGEND

- RADON TESTING LOCATIONS
- GAMMA SURVEY LOCATIONS

POWER RESOURCES, INC.

P.O. Box 1210 Gillette, WY 82717 (307) 358-6541 (307) 235-1628

REVISIONS		
NO.	DATE	BY
1	02/06	JT
2	03/06	JT

NORTH BUTTE PROJECT

SATELLITE LAYOUT

CAMPBELL COUNTY, WYOMING

Figure 3-4
North Butte Project
Typical Wellfield Development Pattern

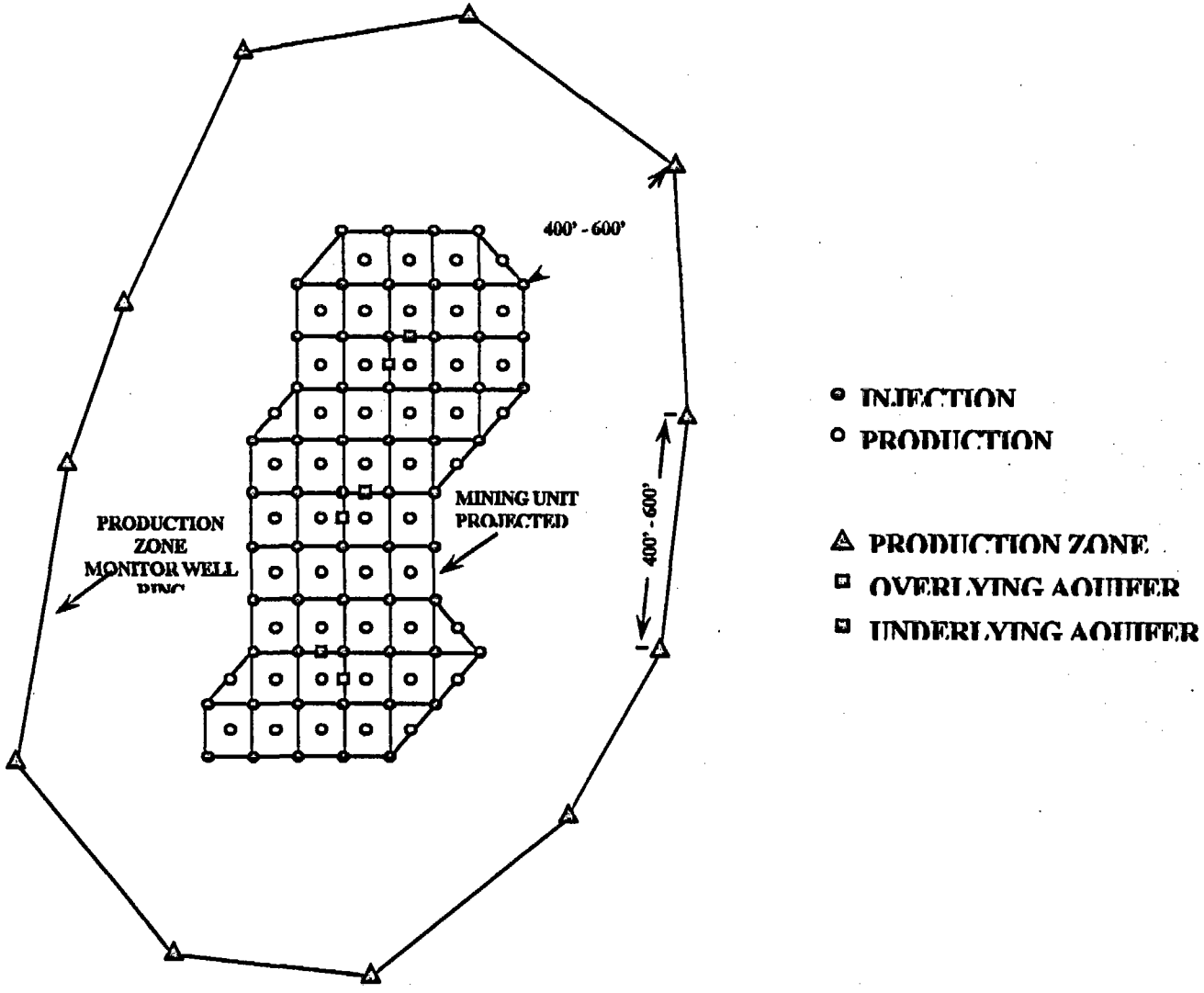
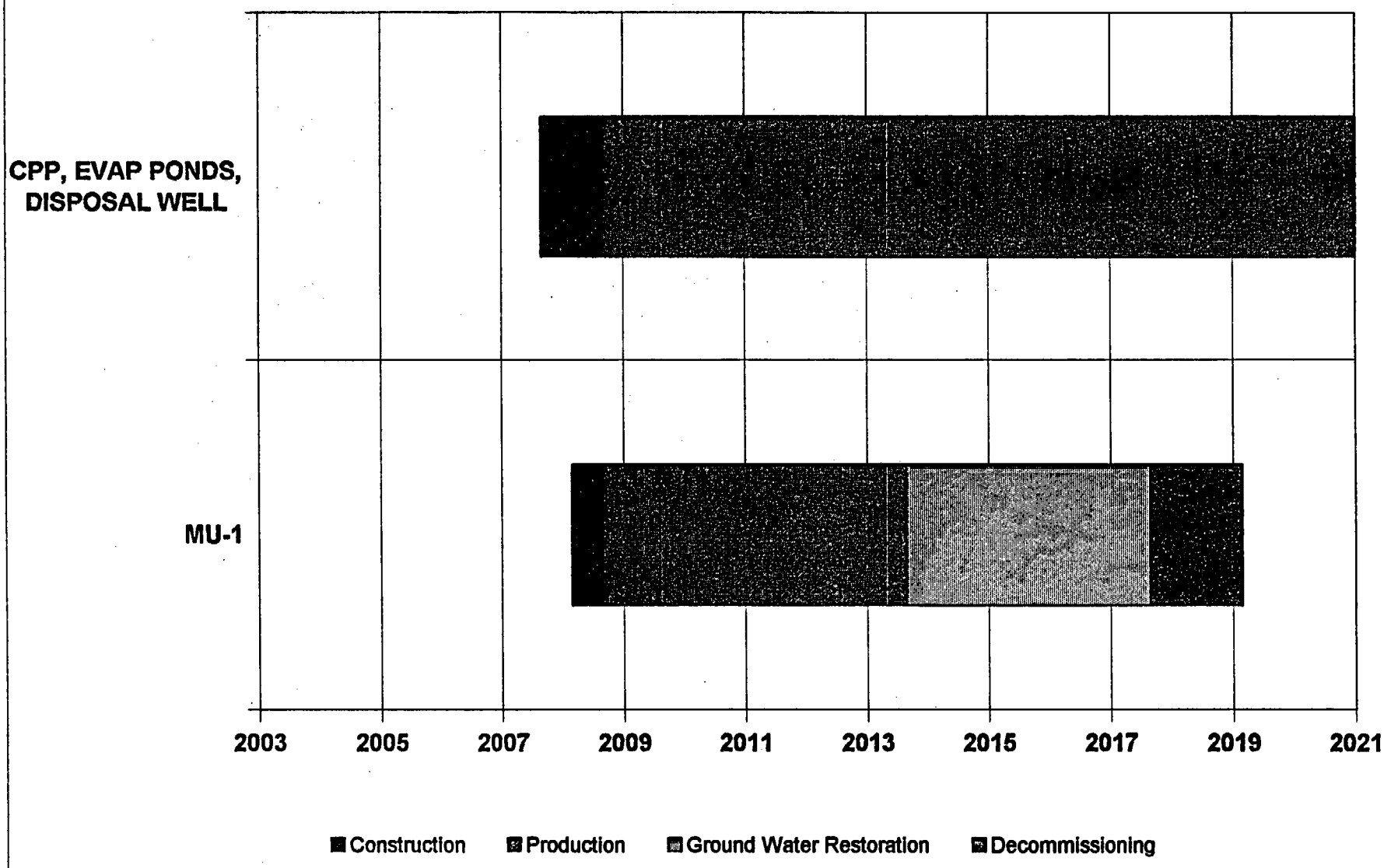


Figure 3-5
North Butte Uranium Project - Estimated Time Table of Mining Related Activities



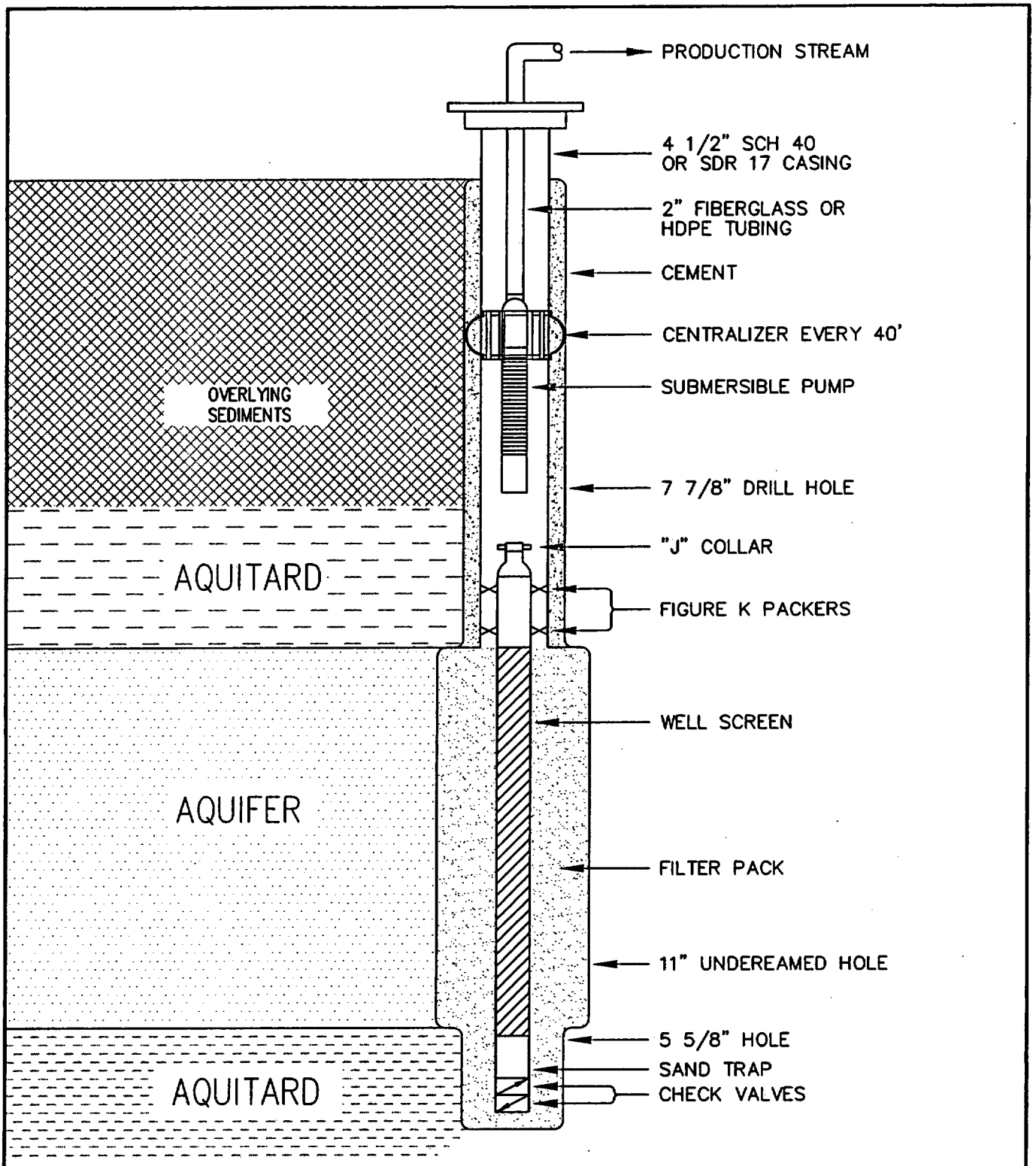


FIGURE 3-6

POWER RESOURCES, INC.

P.O. Box 1210 Glenrock, WY 82637 (307) 358-6541 (307) 235-1626

REVISIONS		
NO.	DATE	BY

NORTH BUTTE PROJECT

TYPICAL PRODUCTION WELL

CAMPBELL COUNTY, WYOMING

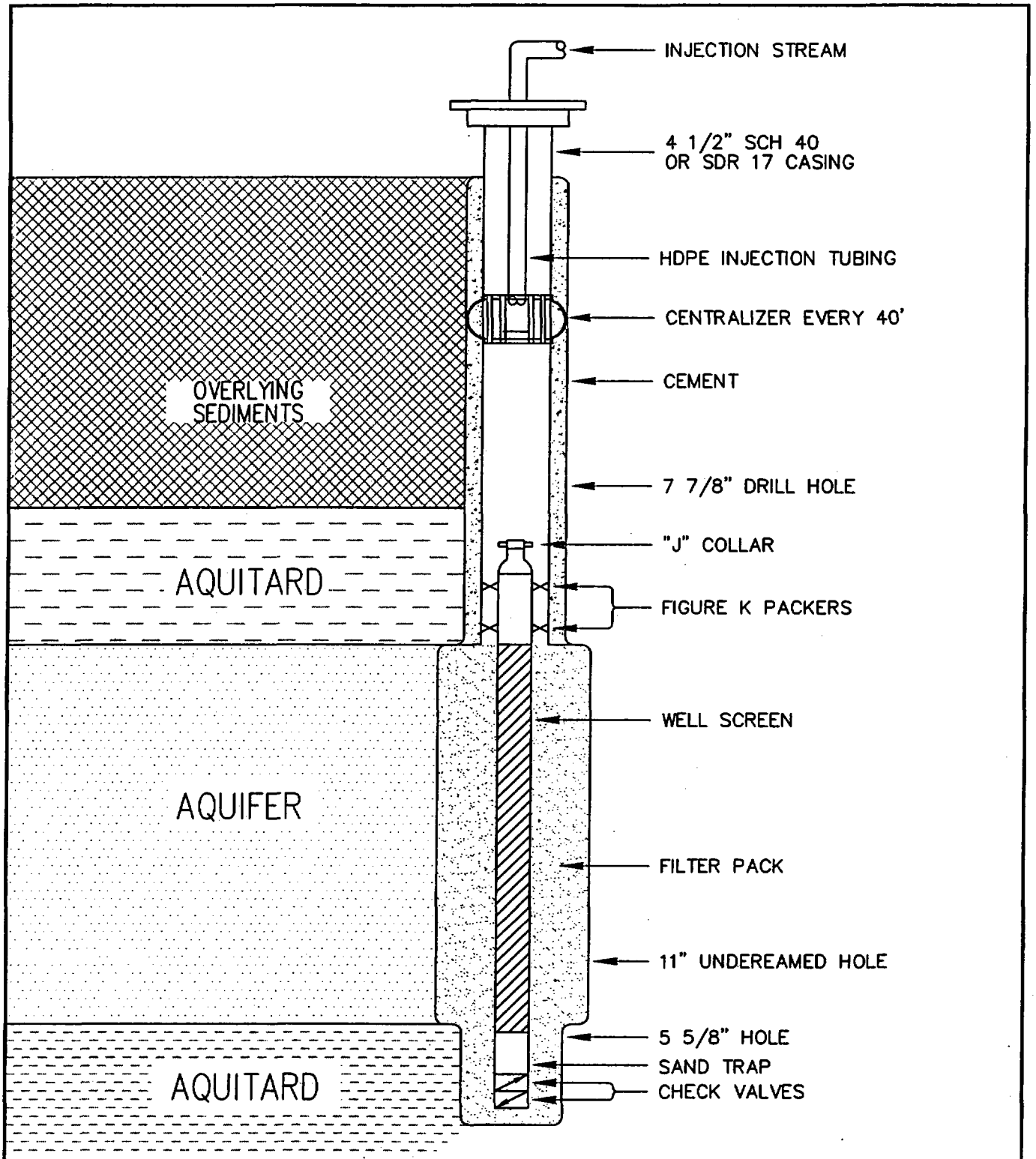


FIGURE 3-7

POWER RESOURCES, INC.

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

REVISIONS		
NO.	DATE	BY

NORTH BUTTE PROJECT

TYPICAL INJECTION WELL

CAMPBELL COUNTY, WYOMING

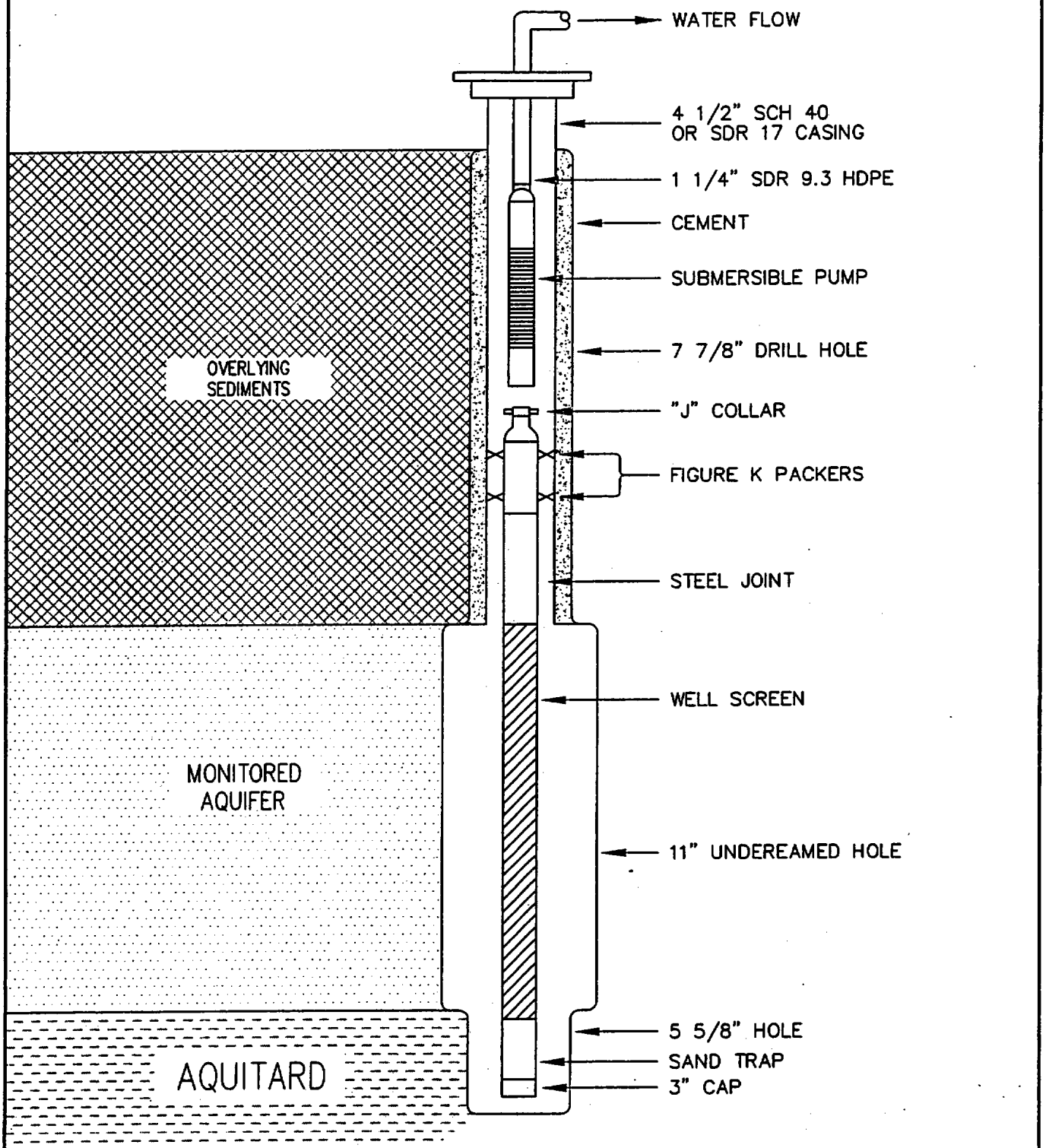


FIGURE 3-8

POWER RESOURCES, INC.

P.O. Box 1210 Glenrock, WY 82637 (307) 358-6541 (307) 235-1626

REVISIONS		
NO.	DATE	BY

NORTH BUTTE PROJECT

TYPICAL MONITOR WELL

CAMPBELL COUNTY, WYOMING

CHAPTER 4 - EFFLUENT CONTROL SYSTEMS

This section describes the effluent control systems to be used at the North Butte Satellite. Since no Central Processing Plant (CPP) will be located at North Butte effluent release from the yellowcake drying facilities and associated equipment cannot occur.

The yellowcake drying facilities are located at the SR-HUP, CPP currently in operation under WDEQ-LQD Mine Permit 633 and NRC License SUA-1548.

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. In order to alleviate potential discomfort or health problems due to the in-plant accumulation of gases and fumes, three ventilation systems are installed. A ventilation system is connected to all process vessels where significant radon-222 or process fumes could reasonably be expected to released.

4.1.1 Tank and 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 consists of an air duct or piping system connected to the top of each of the process tanks to exhaust fumes to the outside atmosphere. The venting system from all tanks and sumps consists of 4 to 6-inch PVC piping and function to vent radon gas to the outside atmosphere (see Figure 3-3 for schematic of ventilation systems for the Satellite).Air flow through any openings in the vessel are from the 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 or a sump and discharge the air with any gases and fumes to a vent placed on the outside of the building near the roof level.

4.1.2 Work Area Ventilation System

The work area ventilation system is designed to force air to circulate within the separate Satellite areas. The systems for the ion exchange area will include a minimum of two exhaust fans. The ventilation system exhausts will be located on the north or leeward side of the buildings. During favorable weather open doorways and the convection vents in the roof will provide satisfactory work area ventilation.

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, and oxygen. There will be no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.2 LIQUIDS AND SOLIDS

Liquid effluents from the operation will include the production bleed stream, plant washdown water, restoration equipment (EDR/RO) waste, restoration bleed, analytical laboratory waste, and facility sanitary waste.

The net production bleed stream is approximately 0.5% to 1.5% of the production. The bleed is taken after the ion exchange units have removed the uranium. The bleed is then commingled with the other liquid effluents and either discharged to the evaporation ponds/deep disposal injection wells as shown in Figure 4-1 the water may be routed to a reverse osmosis unit. Less than 2 gallons per minute of water will result from plant wash water. This water will be commingled with other plant waste water.

During restoration two additional liquid waste streams are expected at North Butte as shown on 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 up to 150 to 300 gallons per minute with an EDR/RO capacity of 1000 gpm (this stream will vary depending on the size and efficiency of the EDR/RO unit). This stream will be routed to a lined evaporation pond or to a deep waste disposal well.

A projected water balance for North Butte operating at 4,500 gpm with a one and one half percent production bleed is shown in Figure 4-2. The water balance represents the highest production flowrate matched with the corresponding restoration flowrate (2,000 gpm). These flowrates represent the total water balance with the Satellite. As capacity is added to the facility to meet these production and restoration levels, disposal capacity may be added in the form of additional deep disposal injection wells or future evaporation ponds. Additional reductions in wastewater volumes may be obtained by increasing the efficiency of the reverse osmosis process. Figure 4-1 provides additional detail on the individual streams of the water going to the deep disposal injection wells.

If treatment or processing can improve the water quality such that it meets Wyoming DEQ criteria for NPDES discharge or for land application and NRC radionuclide criteria for release to unrestricted areas, the water may be discharged through the water treatment plant or used for irrigation (provided regulatory approval).

The water generated during preoperational pump testing typically meets WDEQ-WQD Class IV (Livestock) standards at a minimum and has minimal potential radiological impact on soils or surface water. Therefore, water generated during preoperational pump testing is pumped onto the ground and no alternate handling or disposal method is required.

4.2.1 Deep Disposal Injection Wells

The North Butte Facility will operate two Deep Disposal Injection wells, which 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 89-275 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.

The two North Butte permitted disposal wells are designated as Federal BY-1 and Federal BY-2, and they will be located in Township 44N, Range 76W, Section 13. The description of these wells can found in submittals from the original licensee (Uranerz) to the WDEQ-LQD in June of 1989 and renewed by Power Resources in 2001. 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 2,000 psig.

4.2.2 Lined Evaporation Ponds

Power Resources Inc. (PRI) plans to utilize a combination of deep well injection, evaporation ponds and surface discharge (potentially under the WDEQ NPDES or Land Application system during restoration) to dispose of wastewater effluents that will be generated from the North Butte ISL process. Two evaporation ponds will be constructed for the temporary storage of process wastewater that will be injected into the deep disposal well. During normal operations, one of the evaporation ponds will receive relatively low-TDS water from the wellfield bleed stream. During restoration, the pond will receive the wellfield bleed stream from groundwater sweep. This water will be disposed of via one of the disposal methods discussed above.

The two evaporation ponds designed for the North Butte Project are not intended for use as a primary disposal system, i.e. sized for active evaporation of all waste streams, although their evaporation rate at maximum operating level is 5 GPM on an annual basis. Rather, the ponds are actually holding ponds, sized to store a 40 GPM bleed stream for a 30-day time period to allow for maintenance or repair of the deep disposal well. The target operating parameter of the deep injection well is 150 GPM maximum, a 2,000 psi surface injection pressure; two deep wells are permitted for the North Butte ISL project, each with a 150 GPM

capacity. PRI plans to install only one deep well initially, and operate it at a rate less than the maximum 150 GPM. One well should be more than sufficient to accommodate the maximum wastewater production of 40 GPM during operations, plus the additional brine from aquifer restoration activities. The Smith Ranch-Highland Uranium Project located 40 miles southeast of the North Butte site, has been successfully injecting wastewater into the same deep formations for the past several years.

The evaporation pond is currently planned to will be located south of the process plant site, in the NW ¼ SE ¼ of Section 24, T44N, R76W (see Figure 15.1, Volume II). Pathfinder Mines Corporation (previous owners) has conducted extensive geotechnical studies for the evaporation pond site, and has found the site to be very suitable for pond construction. The detailed engineering for the ponds, as well as geotechnical studies, were provided to Pathfinder by Western Water Consultants, Inc. of Sheridan, Wyoming. The engineering design details for the two evaporation ponds (Ponds 1 and 2), complete with on-site geotechnical analyses, are provided in Section 15.11.1 of Volume I.

In summary, PRI will construct two evaporation ponds, each lined with synthetic membrane liners underlain by leak detection systems. Two lining systems have been evaluated, a single synthetic liner system and a double synthetic liner system. Each system provides equivalent levels of environmental protection, and each is designed to meet the requirements of the NRC Regulatory Guideline 3.11 with regard to the use of synthetic and natural materials for ponds at uranium recovery facilities. The final selection of the lining system will be based on construction bid prices. The two liner system versus the single may be more cost effective if the sand for the single liner pond is too expensive due to availability and transportation charges.

4.2.3 Solid Waste

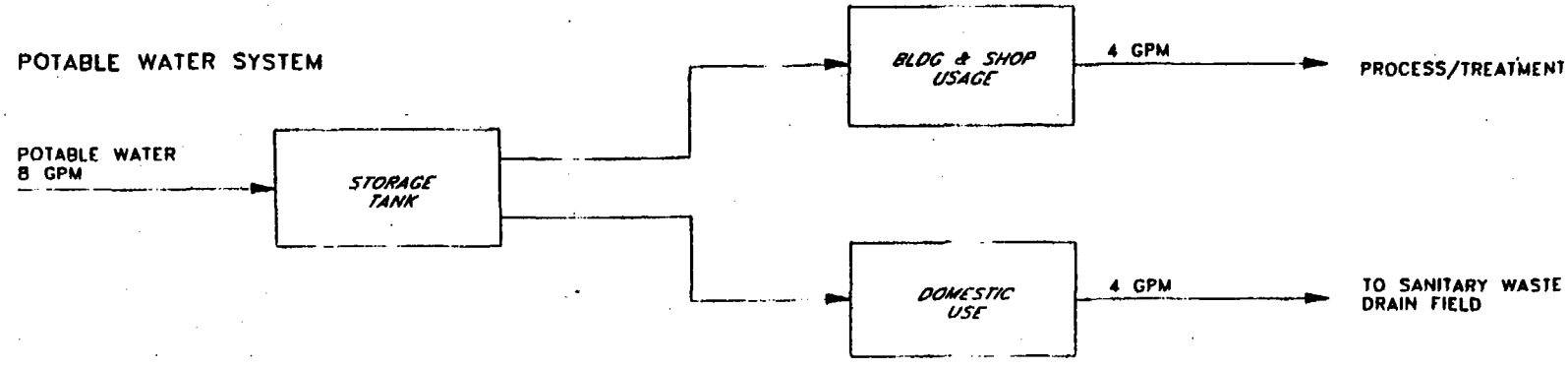
The non-radioactive wastes, such as concrete, wood, and steel, will be either buried on site in accordance with WDEQ regulations or transported off site to a municipal landfill. Other non-radioactive wastes such as office waste, packing material, and domestic trash will be collected on site and transported to a municipal landfill. No hazardous, sanitary, or radioactive contaminated wastes will be disposed of on site or at a municipal landfill. No impact to ground water is anticipated resulting from any on site burial of the items mentioned above.

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. Radioactive solid waste that has a contamination level requiring controlled disposal are isolated in drums, bins, or other suitable containers and disposed in a NRC licensed disposal facility. The operations at the North Butte will generate between approximately 50 to 150 yd^3 of radioactive contaminated waste each year. During final decommissioning of the Central Processing facilities and wellfields, the volume will increase.

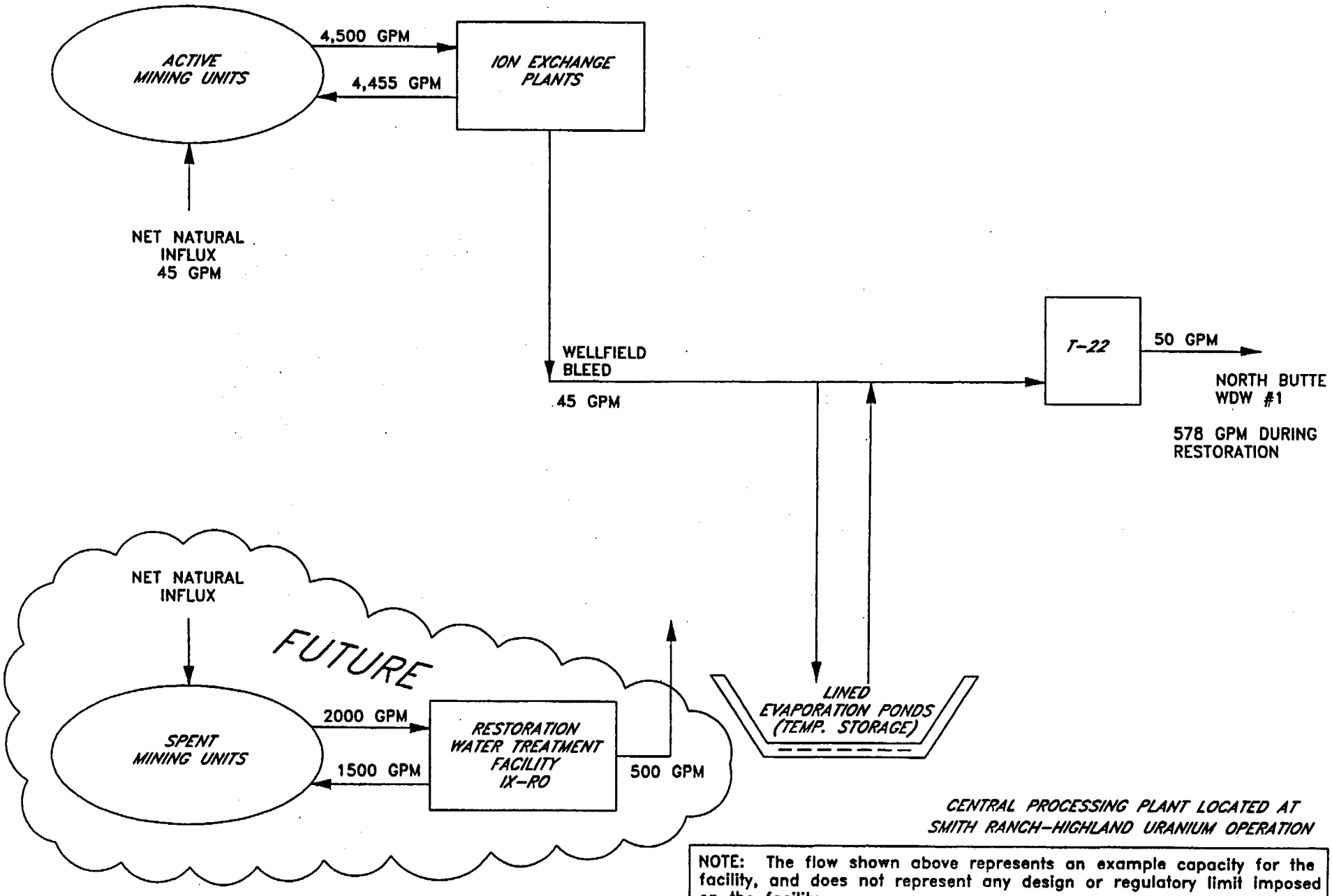
FIGURE 4-1
NORTH BUTTE SATELLITE URANIUM PROJECT



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 NORTH BUTTE PROJECT

WELLFIELD OPERATIONS AT 4,500 GPM
WITH 45 GPM PURGE (1.0% BLEED)



CENTRAL PROCESSING PLANT LOCATED AT SMITH RANCH-HIGHLAND URANIUM OPERATION

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

5.1 PRE-OPERATIONAL ASSESSMENT OF WELLFIELDS

5.1.1 General

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 that 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 4.4.6). The distance between these monitor wells for Mine Unit 1 at the North Butte Project will be no more than 400 feet on the down gradient of the wellfield, 600 feet on the sides (perpendicular to the direction of flow), and 1,000 feet up gradient side of the Wellfield. The distance between these monitor wells and the production patterns will be approximately 400 feet. The acceptable distance between the monitor wells and the production patterns was 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 took into account the demonstration that if an excursion were to occur, production fluids could be controlled within 60 days, as required by WDEQ requirements. The results of this groundwater modeling that produced the spacing estimates for the production zone monitor wells are contained in Section 16.12 of Volume I. In determining the locations of the monitor wells in future mine units the following will be considered: the proximity of the injection operation to points of withdrawal; the local geology and hydrology; the operating pressures and whether a negative pressure gradient is being maintained; the nature and volume of injection fluids, formation fluids, process by-products, and recovery fluids; and the injection well density.

Monitor wells will be installed within the overlying aquifer (F-Sand) at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data and to be used in the development of UCL's for these zones. Due to discontinuous and poorly developed nature of the underlying aquifer (L-Sand), and due to the thick and continuous nature of the lower aquitard, underlying monitor wells are not planned to used at the North Butte Project.

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 (B-Wells for Mine Unit –1) - 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 4-1) 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 4-1 and three samples for the UCL parameters chloride, total alkalinity, and conductivity. All samples are collected at least two weeks apart.

3) Overlying Zones, MO Wells (UM Wells for Mine Unit-1)- Two samples for the parameters in Table 4-1 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.

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.

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.

Noncompliances discovered through operational monitoring will be reported and corrective action plans developed in accordance with LQD Rules and Regulations, Chapter 11, Sections 12 and 13.

5.2.2 Monitoring Frequency and Reporting

The Production Zone and overlying 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. If results of the confirmatory sampling are not complete within 30 days of the initial sampling event, then the excursion will be considered confirmed for the purpose of meeting the reporting requirements described below. 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 five 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 an excursion is not controlled within 30 days following confirmation of the excursion, a sample must be collected from each of the affected monitoring wells and analyzed for the following parameters: ammonia; antimony; arsenic; barium; beryllium; bicarbonate; boron, cadmium, calcium, carbonate; chloride; chromium; conductivity; copper; fluoride; gross alpha; gross beta; iron; lead; magnesium; manganese; mercury; molybdenum; nitrate + nitrite; pH; potassium; selenium; sodium; sulfate; radium-226 and 228; thallium; TDS; uranium; vanadium; and zinc.

If the concentration of the UCL parameters detected in the monitor well(s) does not begin to decline within 60 days after the excursion is verified, injection into the production zone adjacent to the excursion will be suspended to further increase the net water withdrawals. Injection will be suspended until a declining trend in the concentration of the UCL parameters is established. Additional measures will be implemented if a declining trend does not occur in a reasonable time period. After a significant declining trend is established, normal operations will be resumed with the injection and/or production rates regulated such that net withdrawals from the area will continue. The declining trend will be maintained until the concentrations of excursion parameters in the monitor well(s) have returned to concentrations less than respective UCLs.

If an excursion is controlled, but the fluid which moved out of the production zone during the excursion has not been recovered within 60 days following confirmation of the excursion, the operator will submit within 90 days following confirmation of the excursion a plan and compliance schedule meeting the requirements of LQD Rules and Regulations, Chapter 13, Section 13(b).

A monthly report on the status of an excursion shall be submitted to the administrator beginning the first month the excursion is confirmed and continuing until the excursion is over. The monthly report shall contain the requirements described in LQD Rules and Regulations, Chapter 12, Section 12(e).

5.3 EFFLUENT AND ENVIRONMENTAL MONITORING

5.3.1 General

PRI maintains a detailed environmental and radiological program to monitor any releases from the North Butte 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 Highland Uranium Projects have shown no significant adverse impacts to the environment or any increased health risks to the public.

5.3.2 Continuous Air Particulate Monitoring

As described in Chapter 4 of this Volume, the drying of yellowcake will be done using a vacuum dryer, which eliminates the potential for discharge of uranium particulate. As a result, no radionuclide particulate emissions are expected at the North Butte site from drying operations. This has been demonstrated through operations at the SR-HUP currently operated by PRI. Review of the air particulate data from the SR-HUP shows that all radionuclide concentrations have averaged less than 5% of the respective Effluent Concentration Limits and 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 5-2, 5-3, and 5-4 summarizes the U-nat, Th-230, and Ra-226 monitoring data for these SR-HUP monitoring stations.

Since no radionuclide particulate emissions are expected, as described above, no air particulate monitoring will be conducted at the North Butte Project.

5.3.3 Passive Radon Gas Monitoring

Passive radon gas (radon-222) will be monitored at the site to assess background conditions and releases from the facilities to the environment. Radon will be monitored using Track-Etch type radon cups (detectors) provided by a contractor specializing in radon detection. The frequency of exchange of the cups will be 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 will be reported to the NRC in the Semi-Annual Report. Radon will be monitored at the Air Monitoring Stations shown on Figure 10.7, Volume II.

Radon-222 monitoring is currently conducted at the SR-HUP and radon-222 data for the period 2000 through 2004 is summarized in Table 5-5. 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. 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 at the North Butte operation.

5.3.4 Passive Gamma Radiation Monitoring

Passive gamma radiation will also be monitored at the Air Monitoring Stations shown on Figure 10.7 of Volume II and discussed in Section 14 of Volume I. Passive gamma radiation will be monitored using spherical TLD's, which are exchanged on a quarterly basis. Results of the monitoring will be reported to the NRC in the Semi-Annual Report.

Passive gamma radiation monitoring is currently conducted at the SR-HUP and data collected at the Smith Ranch Air Monitoring Stations for the period 2000 through 2004 is summarized in Table 5-5. Review of these data show that background gamma radiation levels at the respective upwind and downwind sites for each project range from 26 to 44 mRem. In comparison to the background sites, data obtained at the Restricted Area Boundaries of the Smith Ranch CPP show apparent minimal increases in gamma radiation of only 1 to 7 mRem during the period.

Similar gamma radiation conditions to that described above for SR-HUP are expected to exist at the North Butte operation.

5.3.5 Environmental Ground Water Monitoring Program

The project wide environmental ground water monitoring program will include 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. Monitoring of these wells will be conducted on a quarterly basis.

5.3.6 Environmental Surface Water Monitoring Program

The project wide environmental surface water monitoring program includes the quarterly monitoring of Willow Creek when stream flow is present as well as numerous stock ponds that are located down stream of operating wellfields. Water samples will be obtained from these sites on a quarterly basis and analyzed for uranium and radium-226 when adequate water exists to permit sampling.

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

5.3.6.1 Soil Sampling

No operational soil sampling is planned at the North Butte project, with the exception of sampling of areas that have been potentially contaminated by radiological material from unanticipated wellfield spills, pipeline leaks, etc.

Soil sampling and analysis will be performed in accordance with NRC decommissioning standards during wellfield decommissioning activities.

5.3.6.2 Vegetation Sampling

No operational monitoring of vegetation is anticipated. Vegetation sampling and analysis will be performed in accordance with NRC decommissioning standards during wellfield decommissioning activities.

5.3.7 Waste Disposal Well Monitoring

The planned Deep Disposal Well for North Butte will be monitored in accordance with the UIC permit 89-275 issued by the WDEQ-WQD. In accordance with this permit, the quality of the injected water will be monitored on a quarterly basis. Samples will be composited from the waste stream each quarter and analyzed for total dissolved solids, carbonate, bicarbonate, total uranium, and radium-226. Continuous monitoring and recording will be conducted for the annulus pressure, injection pressure, and injection volume

The permit limit for uranium is 65 mg/L. Permit limits have not been established for any of the other sample parameters. The maximum injection pressure limit is 2,000 psig and the annulus pressure must be maintained between 30 psig and 700 psig. The maximum injection volume will be 432,000 gal/day (300 gpm).

5.3.8 Evaporation Ponds

5.3.8.1 Leak Detection Monitoring

Each lined evaporation or treatment pond at the North Butte CPP will be constructed with a leak detection system as described in Section 15.11 of Volume I. The leak detection system for each pond will have collection pipes that will drain to sumps which will serve as collection points for any fluid from a pond leak. Taps will be installed in each sump to allow inspection for fluids and sampling of fluids if detected. Each tap will be checked once a week for the presence of liquid in the sumps. If liquid is present, a sample will be collected and analyzed for chloride, carbonate/bicarbonate, sodium, and uranium to determine if the source of the fluid is from an evaporation pond leak. If the

analysis confirms that a leak exists, the WDEQ and the NRC will be verbally notified by telephone or e-mail no later than the next business day and a written report will follow within seven days.

Remedial action in the event of a leak in one of the ponds is to attempt to repair the leak with the water still in the pond if the failure is at or above the water level. For leaks in the bottom of a pond, all water will be transferred to the other pond until repairs are completed. The other pond will maintain a level of at least 1 foot of freeboard below the overtopping level as the maximum operating level. Filling of a pond after repair work is completed will be carefully monitored on a daily basis to ensure the leak has been fixed.

5.3.9 Wildlife Monitoring

5.3.9.1 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 at the SR-HUP 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. Since existing big game at the North Butte area is similar to the SR-HUP area, and since ISL operations will be conducted in a similar manner, no significant impacts to big game wildlife are expected from the North Butte Project. As a result, this monitoring will not be conducted for the North Butte area.

5.3.9.2 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). Only the Blackfooted Ferret remains 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 (May 2005) 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 species 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.

5.3.9.3 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. According to baseline studies summarized in Section 13.3.4 of Volume, no raptor nests were observed within the North Butte permit area. Several nests were observed within one mile of the permit area, however, none of these nests were active during baseline studies.

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, CPP) 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.

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.

5.3.9.4 Sage Grouse Surveys

No sage grouse leks were observed within the North Butte permit area during baseline wildlife studies. There were two strutting grounds located in the near vicinity which are shown on Figure 13.1 in Volume II. These leks are known as the North Butte Lek and the Gilbertz III Leck. No sage grouse nests were observed on the permit area, but female sage grouse and their broods were observed within the permit area in the sagebrush and grassland habitat types.

Each known sage grouse lek on and within 1 mile of the permit area, plus the Gilbertz III site will be surveyed at least two times per year (once in late March, once in early April), to determine peak attendance. All potentially suitable habitats will be searched to locate new or previously unrecorded leks. Lek attendance will be recorded as numbers of males and females observed during each of the 2 surveys.

5.3.10 Cultural Resources Mitigation

As described in Section 7 of Volume 1, archeological investigations carried out on the North Butte permit area have shown considerable evidence for prehistoric

human occupation of the area. In all, 25 new archeological sites were found and recorded. Of these, three were found to contain significant subsurface remains. The remaining sites were determined to be primarily surface manifestations. As all artifacts were recovered from these sites, no additional investigation was recommended and an archeological clearance was recommended.

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.

5.3.11 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.

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 (WQD). 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 after outlier removals.

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 of the pre-mining values. If during restoration, the average concentration of a parameter in the designated production area wells of a mining unit (i.e., MP-Wells) is not reduced to the RTV within a reasonable time, a report describing the restoration method used, predicted results of additional restoration activities, and an evaluation of the impact, if any, that the higher concentration has on the ground water quality and future use of the water will be prepared and submitted

to the applicable regulatory agencies. Table 6-2 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.

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 establish reducing conditions within the mining zone. However, PRI may employ bioremediation as a reduction process.

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

Once restoration activities have returned the average concentration of restoration parameters to acceptable levels 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 WDEQ that the wellfield is restored.

6.1.3.1 Ground Water Transfer

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

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

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

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

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

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 an IX system prior to RO/EDR treatment, as part of the waste disposal system or it will be re-injected into the wellfield. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Additionally, prior to or following IX treatment, the 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, a reductant (either biological or chemical), which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone ground water reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements.

All or some portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids in the 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, 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

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 (or bicarbonate) and conductivity; and

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

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, Section 8 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 2 feet of the collar with a nonorganic well abandonment plugging fluid of neat cement or bentonite based grout mixed in the recommended proportion of 20 lbs per barrel of water, to yield an abandonment fluid with a 10 minute gel strength of at least 20 lbs/100 sq ft and a filtrate volume not to exceed 13.5 cc.
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. A steel plate shall be placed atop the sealing mixture showing the permit number, well identification, and date of plugging.
4. A cement plug is placed at the top of the casing (if cement is not within three feet of the surface), and the area is backfilled, smoothed, and leveled to blend with the natural terrain.

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

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. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the North Butte Project.

6.2.2 Surface Disturbance

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

Disturbances associated with the CPP, Main Office Complex, evaporation ponds, 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. Surface disturbance associated with development of access roads will occur at the North Butte area and topsoil will also be stripped from the road areas prior to construction and stockpiled.

6.2.3 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil is salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment 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 70 acres of topsoil will be salvaged, stockpiled, and reapplied throughout the life of the North Butte Project.

As described in Section 11 (Appendix D-7 SOILS) of Volume I and Chapter 2 of this Volume, topsoil thickness varies within the permit area from non-existent to several feet in depth. However, typical topsoil stripping depths range from 3 to 6 inches. Estimated topsoil salvage volumes for the CPP area, evaporation ponds, wellfields, access roads, and wellfield roads are shown in Tables 15.1A, 15.2A, and 15.3 of Volume I.

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).

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 and evaporation ponds, will be initiated. In decommissioning the CPP, 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 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). Post-reclamation and decommissioning

radiological survey methods for verification of soil cleanup will be designed to provide 95-percent confidence that the survey units meet cleanup guidelines.

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.

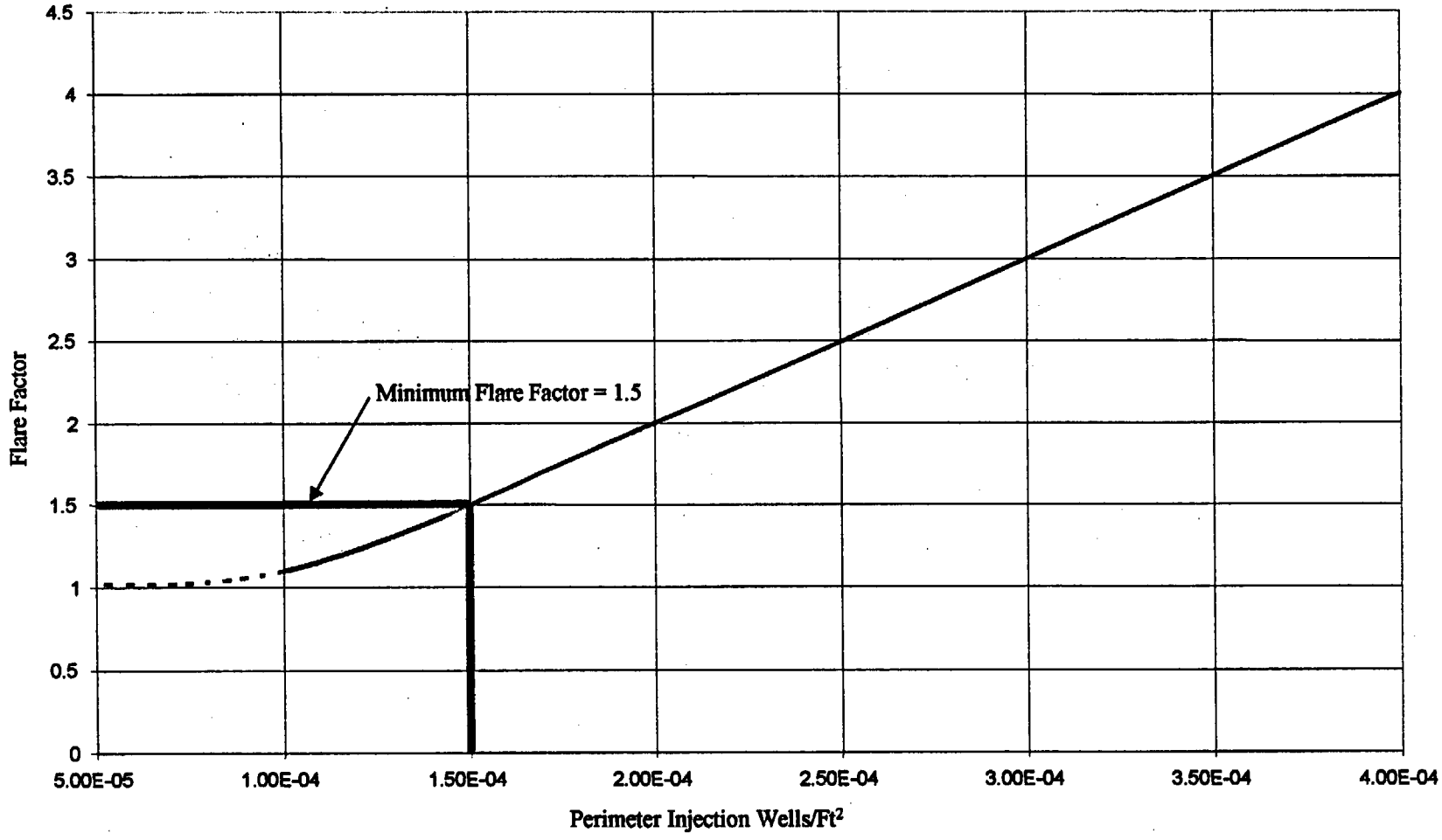
Reclamation costs for the North Butte Operation will be added to the current surety estimate (current estimate is $78,800) one year prior to construction. The estimated reclamation and restoration costs anticipated for the Satellite facility, evaporation ponds, associated Mine Unit 1 (anticipated to be the first Mine Unit in production), and the Deep Waste Disposal Well are detailed in Section 17 of Volume I. The total estimated surety for these facilities is approximately $5,125,800. which is considered a conservative estimate. The costs are based on estimates for the existing (Permit to Mine # 633) Smith Ranch CPP, existing Smith Ranch Evaporation Ponds, existing Mine Unit 4, and existing Smith Ranch Deep Waste Disposal Wells since the North Butte CPP, Mine Unit 1, and Deep Waste Disposal Well are anticipated to be similar in all aspects. A detailed breakdown of reclamation cost estimates is contained in Section 17 of Volume I.

Groundwater restoration costs are based on treatment of 1 pore volume for groundwater sweep and 5 pore volumes for reverse osmosis and bioremediation, as is predicted in the current Smith Ranch Surety Estimate. Mine Unit pore volumes are determined using the following equation:

Mine Unit Pore Volume = (Affected Ore Zone Area) x (Average Completed Thickness) x (Flare Factor) x (Porosity)

The flare factor has been determined for Smith Ranch wellfields to be approximately 1.5 to 1.7. This flare factor was estimated using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). The modeling was performed by Lewis Water Consultants in 1999, and the results were summarized in the report "Evaluation and Simulation of Wellfield Restoration and the RAMC Smith Ranch Facility." A detailed sensitivity analysis of the wellfield flare factor was also conducted as part of this work. The results of the sensitivity analyses indicate that the wellfield flare factor is a linear function of the wellfield scale, net production rate, and the ratio of horizontal to vertical hydraulic conductivity of the aquifer, as shown in Figure 6-1. Since the net production and bleed rates are similar for all wellfields, and the hydraulic conductivity of the Fort Union Formation sands are very similar (as demonstrated through aquifer test data), then the differences in flare factor between wellfields should be primarily the result of differences in wellfield scale.

FIGURE 6-1



Predicted Wellfield Flare Factor for North Butte Commercial Wellfields as a Function of Wellfield Scale

Source: Figure 3-16 in "Evaluation and Simulation of Wellfield Restoration at the RAMC Smith Ranch Facility" by Lewis Water Consultants (October 29, 1999)

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 7. This Chapter 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

Pre-operational assessment of the wellfields and environmental monitoring of effluents and environmental monitoring programs are presented in Appendix A of Volume I, and include assessment of ground water, air, radiological, soils, vegetation, wildlife, and wastes.

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 at the North Butte project has extended the operating life of the site and deferred final reclamation of SR-HUP. During this period, livestock grazing will continue to be excluded from limited areas where mining related activities will occur at North Butte.

Drilling wells and installation of pipelines result in temporary disturbance to the soils vegetation in those areas; however, as demonstrated by current practices, the impact is minimal. Topsoil is removed to one side then stockpile in accordance the State regulations, 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 results in livestock being excluded from some of the wellfield areas, however, this will vary with the grazing level land the landowner's desires.

Surface disturbances associated with the evaporation ponds, and access roads are 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 309 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 North Butte permit area, the main drainages collect surface precipitation and snowmelt in a roughly northwest to southeast direction along Willow 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 traveling 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 North Butte 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 mining, 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 roads, office buildings, pipelines, 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 and/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 production 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 2,000 acre feet of groundwater over the life of the project. Most of the water removed will be returned to the environment after treatment and discharge. The remaining water removed from the formation will be evaporated, disposed through permitted deep well injection, or discharged to the surface through a NPDES or Land Application permit during restoration (provided WDEQ approval and discharged water meets applicable standards).

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 processing plant. PRI will be 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. 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

Impacts on wildlife resources form mining activities may be classified as either short-term or long-term. Short-term impacts are those that result directly from and occur during mining operations but, assuming reclamation efforts are successful, cease after reclamation. Long-term impacts are those that persist even after successful reclamation efforts. Long term impacts usually impacts usually result indirectly from mining activities and are much more difficult to identify and evaluate. Most of the impacts identified for the North Butte ISL project area resulting from development activities are considered to be short-term in nature provided reclamation is successful.

Impacts may occur at a number of different levels of population organization ranging from the individual through herds or groups to the entire population. Since most of the anticipated impacts on the North Butte project area are of a short-term nature or are restricted to the disturbed site and immediately adjacent areas, few lasting effects are anticipated at the regional population level for most species (e.g., the partial elimination of small mammals or mammalian predators during mining activities but the full recovery to baseline population levels after successful reclamation).

The general categories of potential impact to wildlife resources expected from the development at the North Butte project and severity ratings of each impact on the wildlife components evaluated during baseline wildlife studies in the study area are presented in Table 13.4 in Volume I. Potential impacts evaluated in the table include modification of vegetation, water supply alterations, airborne emissions, direct wildlife mortality, and presence of development- associated humans and noise. Each wildlife component was compared against these potential impacts and rated as severe, moderate, slight, or unanticipated. Results show that potential impacts to all the different wildlife components either rated as slight or unanticipated.

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 are not removed with the uranium. Second, the use of modern vacuum dryers at SR-HUP 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 wellfield 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. Radiological concentrations predicted by the MILDOS model for North Butte are considered conservative since releases from a conventional dryer were considered in the model, which will not occur at the North Butte Project. Results and details of the MILDOS runs can be found in Section 19 of Volume I.

7.3.2 Background Radiation Exposures to the Population

Primary sources of radiological exposure to the population in the vicinity of the North Butte project will be 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).

7.3.3 Annual Population Doses from the Project

Annual population doses computed for the Ranches and towns in the vicinity of the North Butte Project by MILDOS-Area indicate a dose of less than 0.5 mRem/yr from mine activities to the nearest residence (Pfister Ranch). This dose is less than 0.5% of the allowable limit of 100 mRem/year. The major influence on the dose to the nearest resident at the North Butte site is the location of the local area being mined. Mining in the western area results in a dose of approximately 0.45 mRem/year (for a child) compared to a dose of 0.15 mRem/year (for a child) when the northern area is being mined.

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, one small town (Savageton) with a population of approximately 30, and a series of hypothetical receptors placed around the perimeter of the project on the permit boundary at 43 different positions. These last receptors included locations downwind of the main processing facility.

The maximum radon-222 concentration at the North Butte permit boundary was 0.84 pCi/L with a working level concentration of 8.0E-04 WL, compared to an ALC (allowable concentration) of 1.10E-03 WL.

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 North Butte Project will be limited to fugitive dust from access roads and wellfield activities.

Fugitive dust emissions will be minimal and dust suppressants will only be used if conditions warrant their use.

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 North Butte Project 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) or a WDEQ Land Application permit (provided WDEQ approval and discharged water meets applicable standards). In the event that restoration water is surface discharged, the treated water will be monitored to ensure that the 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 Satellite. 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 chemical storage 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 chemical storage tanks outside the resin building such as fuel storage tanks containing diesel or gasoline, could result in the spill of 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, if liquids escaped the containment system. All areas affected by such a failure or leak would be delineated and any contaminated soils or material requiring controlled disposal would be removed and disposed of in accordance with State requirements. Failure of outside storage tanks containing carbon dioxide or oxygen would result in the venting of gas to the atmosphere and would not result in contamination of soil or water. Therefore, there would be no long-term impact from a release of chemical or fuel storage tanks located outside the process building.

7.5.2 Pipeline Failure

The rupture of a pipeline between the 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 270,000 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 Satellite 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 Satellite the uranium will be in solution, adsorbed on ion exchange resin. 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.

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 North Butte permit area is located in Campbell County Wyoming, in which 69 tornadoes touch downs were recorded in a period from 1950 through 2003. Of those, 65 tornadoes were classified as F0 (with wind speeds of 40-72 miles per hour and described as a gale tornado) or F1 tornadoes (described as moderate with wind speeds of 73-112 miles per hour). Four of the 69 tornadoes were classified as F2 with wind speeds of 113-157 miles per hour and described as significant tornadoes. (Wyoming State Climate Office-"Wyoming Climate

Atlas"). The F scales for the tornadoes are 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 loaded resin and mining fluids have the highest radiological activity of any material processed at North Butt Project. However, since the material would be a fluid or contained on resin beeds, the potential environmental effects would be minimal. The strongest tornado recorded in Campbell 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 North Butte Project there will be no yellow cake so release by a tornado can not occur.

7.5.5 Well Casing Failure

Should a well fail due to cracks in the well casing or surrounding cement in the annulus, it is possible that the mining solutions could escape into the aquifer above the mining zone. This type of failure is most likely to occur in an injection well since it at a pressure greater than the aquifer pressure. Only the barren solutions would be involved in an injection well failure. 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. The main protection against either occurrence is correct well installation and completion and a thorough integrity testing program.

To minimize the risk of a casing failure significantly impacting the environment, should one occur, monitor wells will be completed in the aquifer overlying the production zone. The fluid levels and quality of the water in the overlying aquifer 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.

7.5.6 Leakage Through Old Exploration Holes

Beginning in November 1967, and continuing through August of 1988, approximately 2582 exploration and predevelopment holes were drilled on the North Butte property by Cleveland Cliffs Iron Company, their predecessors, and Uranerz USA, Inc. Prior to 1979, to the best of PRI's knowledge, the exploration holes were drilled with natural mud, and sealed and plugged in accordance with Wyoming regulations in effect at the time of drilling. These regulations have evolved over time and the later holes were abandoned according to specifications at the time. Starting in 1979, to the best of PRI's knowledge, all holes were drilled and abandoned according to Wyoming Statute 35-11-404.

As part of the licensing efforts for the North Butte project, two major aquifer tests were performed in 1988. These tests involved pumping a well in the ore body aquifer and monitoring drawdown in the ore body aquifer. These tests indicate that the exploration holes in the North Butte area are adequately plugged (see Section 10 of Volume I).

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 resin to the Central Processing Plant from potential future Satellite IX Facilities at nearby properties or existing PRI operations.

2) Shipments of process chemicals from suppliers to the processing facilities.

3) Shipment of By-Product Waste Materials to a licensed disposal facility.

7.5.7.1 Shipments of Resin

The operation of Satellite IX facilities or other existing operations requires that the resin used for IX operations be transferred from the Satellite facility to the Central Processing Plant at SR-HUP. 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 current operations at the SR-HUP.

7.5.7.2 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. 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.

7.5.8 Evaporation Pond Failure

The evaporation ponds will be 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 will be 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.

7.5.9 Response Procedures for Reasonably Expected System Failures

Appropriate site personnel, including mine supervisors and managers, and corporate personnel, including the Senior Vice President and President will be notified immediately if an event described in this section occurs and corrective actions will be determined and implemented in accordance with established emergency response procedures. Procedures for issuing Radiation Work Permits for workers to mitigate the effects of radiological incidents have been established and are described in Chapter 9.

7.6 SOCIOECONOMIC IMPACTS

Operation of the North Butte Project will provide jobs for about 20 company employees and 10 to 20 contract employees. 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 adequate to accommodate the projected employment. It is anticipated that the largest percentage of employees will reside in the City of Gillette or Town of Wright in Campbell County.

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 in the Hartzog Draw Field. However, exploration and production drilling for oil and gas around the permit area is aimed at pay sands at subsurface depths of 8,000 feet or more. No oil production wells are located within the permit area. The closest coal mining operation is approximately 32 miles east (Jacobs Ranch Mine). As a result, there will be no impacts to coal operations or development. Currently (April 2005), there has been some limited activity in the area for coal bed methane development. Seven coal bed methane wells exist south and north of the North Butte permit boundary, however no wells exist within the permit boundaries. These wells are shut in and no pipelines exist for these wells. Coal bed methane development and is aimed at coal seams approximately 1,200 feet or deeper, which will not be impacted by ISL operations. In the event that both ISL mining

and coal bed methane development occurs in the same area, working agreements between operations will alleviate any concerns.

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 would contain 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

Alternative sites for the process plant and access road may be considered if it is determined prior to construction that an alternative site within the permit area would be more suitable.

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 carbonate/bicarbonate 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, in combination with either biological or chemical reductant addition, 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 wellfield purge and restoration fluids are considered the best alternative to dispose of these types of wastes. The zones receiving these wastes will be 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 conjunction with storage/evaporation ponds to dispose of the treated wellfield purge fluids and fluids from groundwater restoration has proven to be the most cost effective way to dispose of this relatively good quality waste water. Disposal of groundwater restoration liquid waste via surface discharge may also be considered utilizing NPDES or Land Application permits upon approval from the WDEQ and if discharge meets applicable standards.

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 North Butte Project 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 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 North Butte Project 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 North Butte 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 or the RSO.

The Senior Vice President of Operations directly supervises the Mine Manager.

9.3.4 Mine Manager

The Mine Manager is responsible for managing the day-to-day operations at the North Butte Project, and reports directly to the Senior Vice President of Operations. The Mine Manager is responsible for ensuring that North Butte 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, 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

Reporting directly to the Mine Manager, the Manager-Health, Safety and Environmental Affairs will oversee all Radiation Protection, Health, and

Environmental Programs as stated in the EHS Management System, at the North Butte Project. 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 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 has a secondary reporting requirement to the Senior Vice President of Operations.

The position of Manager-Health, Safety and Environmental Affairs 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.

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 may supervise 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 databases 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 Manager- Health, Safety, and Environmental Affairs, but will report radiation safety items directly to the RSO.

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, the Radiation Safety Officer (RSO) is responsible for the daily supervision of the radiation safety programs at the North Butte Project. The RSO may be an individual also responsible for radiation safety programs for other company operations and not exclusively designated to the North Butte site. 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 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.

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 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 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 Mine 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 5.5.1 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 Safety and Environmental Review Panel Responsibilities

This procedure will be used for the evaluation of all major changes to the facility operations as described in Section 5.5.1 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 5.5.1 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 5.5.1. 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 5.5.3 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 5.5.1. 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

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 (Satellite Operators/Restoration Operators) will utilize NRC approved dosimeters at the North Butte Project. 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 will be performed at specified locations throughout the North Butte Satellite 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 will be posted at various locations in the Satellite, and consist of IX columns and, various tanks and filter apparatuses.

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" will be implemented and maintained at the North Butte Project.

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 Radon Daughter Monitoring

Radon daughters will be routinely monitored on a monthly basis at the North Butte Satellite. 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. Since North Butte will not have a Central Processing Plant, monitoring will be limited.

9.10.2 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.

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 North Butte Project will be 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" will be 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. Exposure to any uranium that has not been through any drying process is considered "soluble" (D-Class), which is applicable to the North Butte Project.

Routine employee exposure to radon daughters will be determined for only the Satellite Workers. Routine exposure to airborne uranium are not anticipated at North Butte since there are no drying operations. Routine exposure times are determined by annual time studies or actual occupancy times. Time studies will also be updated after any significant change in equipment, procedures, or job functions. Each Satellite Worker's routine and non-routine exposure to radon daughters will be recorded monthly and summarized annually.

Non-routine exposures to uranium and radon daughters 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 will be 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 Satellite Worker's routine and non-routine exposure to soluble and insoluble uranium will be recorded at least 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 will be utilized at the North Butte Project. From the monitoring data collected, the employees' intake of radon daughters will be 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 Radiological 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 will be set at 2.5 mg of soluble uranium for any calendar week. An administrative action level will be set at 125 DAC-hours for exposure to soluble 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 will be evaluated on a quarterly basis and an administrative action level will be 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 will also be 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 North Butte Project are associated with in situ mining activities and uranium recovery within the resin operations. The recovery portion of the process does 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 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. Satellite Operators will be 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 will be 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 will be performed monthly in Satellie Areas and weekly in designated Clean Areas. Routine surveys in the Satellite facilities will consist of both a visual inspection for obvious signs of contamination and instrument surveys to determine total alpha contamination.

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.

9.13.3 Personnel Contamination Control

Change rooms, showers and lockers for clean clothing will be provided for employee use. An operable and appropriately calibrated alpha survey meter will be made available for employee use at the exit of the Satellite facility and at the entrance to the Lunch Room at these facilities.

Employees working in process equipment maintenance and repair will be provided with appropriate protective clothing and equipment. Protective clothing

will be laundered on site or, if a disposable type, will be disposed of in a facility licensed to accept such wastes.

Employees will be instructed in the use of the survey meter, techniques for minimizing contamination, for maintaining good personal hygiene, and in basic decontamination methods. Employees will also be 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 will perform unannounced spot check surveys for alpha contamination on workers leaving the Satellite facilities. These unannounced spot check surveys will be conducted on at least a quarterly basis.

All employees with potential exposure to radioactive contaminants 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.

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, will be surveyed for contamination prior to release from the site. The survey will be conducted in accordance with regulatory limits. 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 Satellite maintenance workers who work in contaminated areas or work on equipment contaminated with uranium will be provided and required to wear protective clothing including coveralls, boots or shoe covers.

Eating, chewing, or smoking in the Satellite controlled areas is prohibited and violators are subject to disciplinary action.

9.15 MANAGEMENT AUDIT AND INSPECTION PROGRAMS

Routine inspections of the Satellite facility will be 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 will perform a Weekly Safety and Environmental Inspection that covers all major facilities at the North Butte Project, including the resin area, injection well, evaporation ponds, storage areas, and Wellfields.

In accordance with NRC requirements, an "Annual ALARA Audit" will be 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 will be 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 unauthorized removal of materials and access will be put in place at the North Butte facility. The operating facilities will be manned 24 hours per day, 7 days per week, and in controlled and/or unrestricted areas, surveillance will be maintained through the presence of the operators and workers on site. Access to the Satellite facilities by the public will be limited by the use of a locked, automatic gate. All visitors will be required to check and sign in at the office before being allowed to enter the controlled access areas of the facility.

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 that will be used at the North Butte Project. 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 will be retained on site under the direction of the RSO. To maintain the integrity of the program, the RSO and others, through the audit program, will periodically review records to ensure that they are complete and accurate, and calculations have been done properly. These types of records will be maintained on site until license termination. Critical records will be 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 will periodically conduct audits of the radiation safety and environmental monitoring programs to verify compliance with applicable rules, regulations, and license requirements and to ensure that exposures of employees, the public, and the environment are ALARA. Audit teams will be 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 will be conducted on an annual basis to assist with achieving the above objectives.

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
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 3) Notify NRC in writing within 30 days of exceeding the Action level

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:

a Nuclide	b Average	c Maximum	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

TABLE 9-3

RADIATION SURVEY AND MONITORING EQUIPMENT

Criteria	Alpha Detector	Gamma Detector	Gilair Air pump	Alpha Counter
Equipment Type	Model 3 43-5 Or Equivalent	Model 3 44-6 Or Equivalent	Basic(3) Or Equivalent	Model 2000 43-9 Or Equivalent
Calibration Frequency	ANNUAL	ANNUAL	PRIOR TO EACH USE	ANNUAL
Calibration Performed By	EPA Approved Lab	EPA Approved Lab	Bios DC_HC 1 Dry Cell Calibrator (In house)	EPA Approved Lab
Range	0-50,000 CPM	0-200 MR/HR	5-500 cc/min	0-999999 CPM
Sensitivity	Efficiency As per calibration	Typically 1200 cpm/mR/hr	N/A	Efficiency As per calibration
Availability	Available at all times	Available at all times	Available monthly Or as needed	Available monthly Or as needed
Planned Use	Personal Alpha surveys and truck surveys	Truck surveys	Monthly Radon tests or as needed	Analysis for modified Kusnetz method

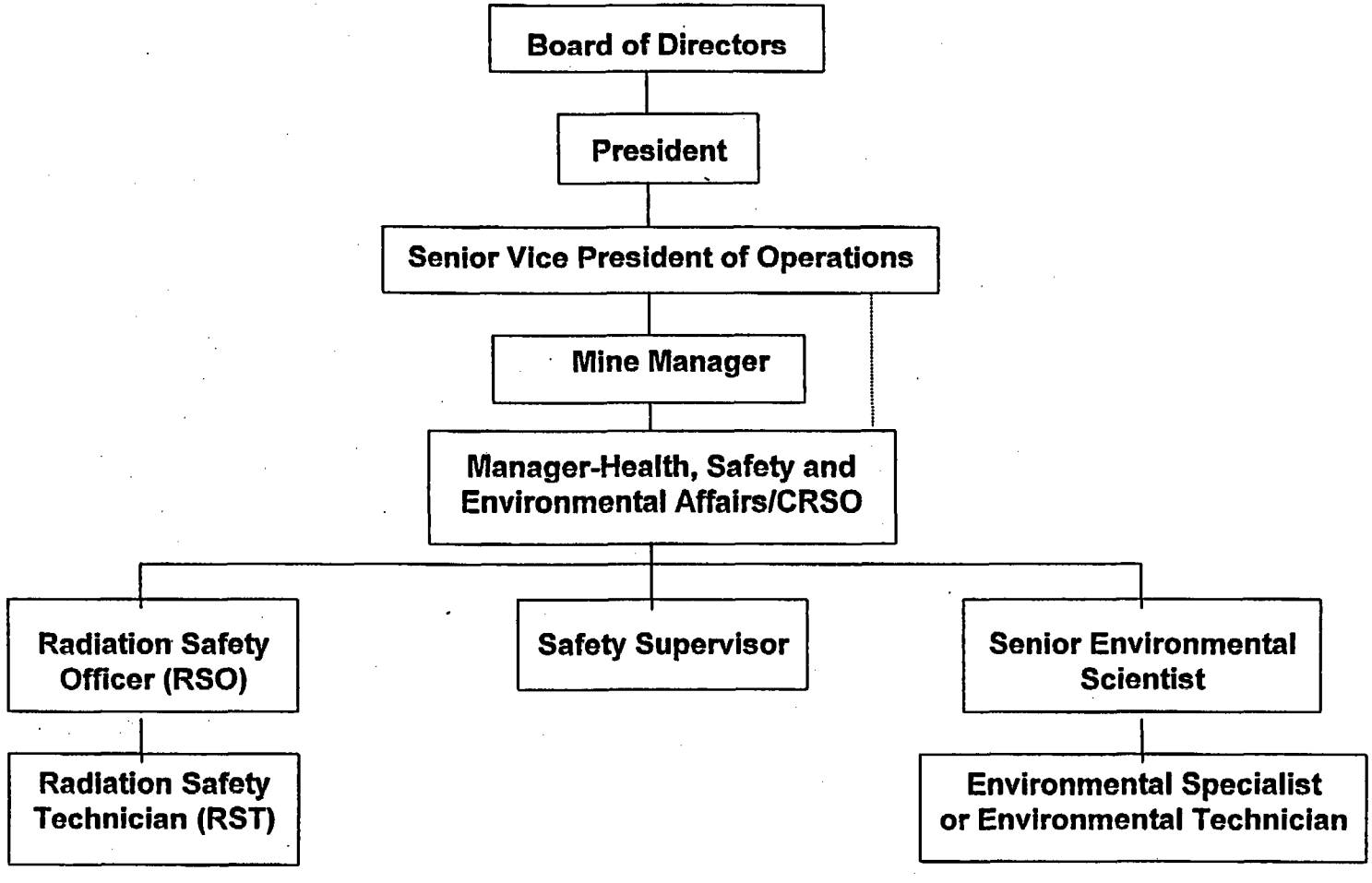


Figure 9-1: PRI Environmental, Health, and Safety Reporting Structure

CHAPTER 10 - BENEFIT-COST SUMMARY

10.1 GENERAL

The general need for uranium is as fuel for the operation of nuclear power plants. 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 North Butte Project 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 North Butte Project 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 North Butte Project, there will be 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 North Butte Project the appropriate regulatory action.

CHAPTER 11- ENVIRONMENTAL APPROVALS AND CONSULTATIONS

11.1 GENERAL

The various state and federal permits and licenses needed or in-hand, for the North Butte Project are listed in Table 10.1. Prior to the injection of chemically fortified water into the ore body aquifer, Power Resources Incorporated will have obtained all the necessary permits, licenses and approvals.

TABLE 11.1
PERMITS AND LICENSES FOR THE NORTH BUTTE ISL PROJECT

Permit or License Name	*Agency*	*Status*
Source Material License	NRC	SUA 1540 Docket No. 40-8981
Permit and License to Mine	DEQ-LQD	Permit to Mine No. 632
Permit to Appropriate GW	SEO	Existing wells are all approved New well permits will be filed prior to drilling
Permit to Construct Leach Field	DEQ-WQD	Application prior to construction
Deep Disposal Well Permit	DEQ-WQD	Approved UIC 89-275

Notes: NRC – U.S. Nuclear Regulatory Commission
DEQ-LQD – Department of Environmental Quality – Land Quality Division
DEQ-WQD – Department of Environmental Quality – Water Quality Division
DEQ-AQD – Department of Environmental Quality Air Quality Division
DEQ – Department of Environmental Quality
SEO – State Engineers Office
EPA – U.S. Environmental Protection Agency