Nichols Ranch ISR Project U.S.N.R.C Source Material License Application

Volume I

Technical Report

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NICHOLS RANCH ISR PROJECT

URANIUM SOLUTION MINE

Campbell and Johnson Counties, Wyoming

Volume I
(Technical Report)

U.S.N.R.C. Source Material License Application

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1.0 PROPOSED ACTIVITIES

1.1. INTRODUCTION

Uranerz Energy Corporation is applying for a Source Material License with the U.S. Nuclear Regulatory Commission (NRC) for in-situ recovery of uranium. The applications for operating and reclamation are being submitted to the NRC and the Wyoming Department of Environmental Quality - Land Quality Division (WDEQ-LQD).

The Nichols Ranch ISR Project is located in the Pumpkin Buttes Uranium Mining District of the Powder River Basin in the state of Wyoming in the counties of Johnson and Campbell. The Nichols Ranch ISR Project is divided into two units, the Nichols Ranch Unit and the Hank Unit. Figure 1-1 (see map pocket) shows a general map of the areas. The central processing plant will be located at the Nichols Ranch Unit, and a satellite facility will be located at the Hank Unit. The Hank Unit satellite facility is approximately six miles northeast of the central processing plant at the Nichols Ranch Unit. Uranerz desires a license that authorizes a central processing plant, satellite facility and accompanying wellfields for an in-situ recovery operation with ion exchange columns.

The current land surface ownership of the Nichols Ranch ISR Project includes approximately 3,091 acres of private ownership and approximately 280 acres of United States Government ownership administrated by Bureau of Land Management (BLM). The names and addresses of the surface and mineral owners of record within and adjacent to the project area are provided in Appendix A and B of this application. The ore zone locations are shown on Figure 1-2 (see map pocket) for the Nichols Ranch Unit and Figure 1-3 (see map pocket) for the Hank Unit.

Uranerz Energy Corporation estimates the U_3O_8 content for the Nichols Ranch Unit to be 2,521,000 pounds and the U_3O_8 content for the Hank Unit to be 1,852,000 pounds. The central processing plant at the Nichols Ranch Unit will have a nameplate capacity to produce 2,000,000 pounds per year of U_3O_8 (yellowcake). Initially the Nichols Ranch Unit will operate at a designed flow rate of 3,500 gallons per minute (gpm) and an annual production of

500,000 pounds. The satellite facility at the Hank Unit will have a designed flow rate of 2,500 gpm and an annual production of 300,000 pounds. Construction for the two units is estimated at approximately one year, but could be accelerated. The Nichols Ranch Unit should have a six month ramp up to the full annual production, and after the Nichols Ranch Unit ramp up, the Hank Unit will start a 6 month ramp up phase to the full annual production. It will take an estimated 3-4 years to extract the uranium from the Nichols Ranch Unit and an estimated 4 to 5 years to extract the uranium from the Hank Unit. The details for the operating plans are presented in Chapter 3.0.

The plans for project waste management and disposal are two fold. Uranerz plans to permit and install deep disposal wells at both the Nichols Ranch Unit and at the Hank Unit. The deep disposal wells will receive liquid waste. Uranerz will also have an agreement with an approved waste disposal facility for 11e (2) byproduct material. The details of the groundwater restoration, decommissioning, and land reclamation are discussed in Chapter 6.0. There is a detailed Gantt chart showing production schedules, groundwater restorations plans, and decommissioning/reclamation plans in Chapter 3.0.

The Wyoming Department of Environmental Quality will hold Reclamation Performance Bonds that cover facility decommissioning and groundwater and surface reclamation. Uranerz will update the bonds on an annual basis according to the Annual Surety Estimate Revision. The annual revisions are reviewed and approved by the U.S. Nuclear Regulatory Commission and Wyoming Department of Environmental Quality. The annual updates account for new areas that are disturbed or areas that have been reclaimed. Uranerz will also be applying for an Aquifer Exemption and Deep Disposal Well permits with the Wyoming Department of Environmental Quality.

1.2 GENERAL SOLUTION MINING PROCESS

The solution extraction process that Uranerz will use for the Nichols Ranch ISR Project is the general in situ recovery process for solution mining. This process, involving the dissolution of the water soluble uranium compound from the mineralized host sandstone rock at neutral pH

ranges, consists of two steps. First, the uranium is oxidized from the tetravalent to the hexavalent state with an oxidant such as oxygen or hydrogen peroxide. Second, a chemical compound such as a sodium bicarbonate ($NaHCO_3$) is used to complex the uranium in the solution if needed. The uranium rich solution is transferred from the series of production wells to the processing facility nearby for uranium concentration with ion exchange resin. The solution is then re-injected and refortified to further recover uranium.

1.3 ADVANTAGES OF ISR URANIUM MINING

The proposed uranium in-situ recovery (ISR) process has been successfully tested at the Ruth R & D project and on a commercial scale at other uranium ISR extraction properties in Wyoming including the nearby Christensen Ranch Mine, and at properties in Texas. There are numerous environmental advantages to ISR extraction versus conventional mining. The advantages include; minimal air quality disturbance, considerably less surface disturbance, no tailings ponds or groundwater contamination, less heavy equipment, fewer people, most other contaminants are not disturbed underground, and aquifers remain in tact.

1.4 ORE AMENABILITY OF ISR URANIUM MINING

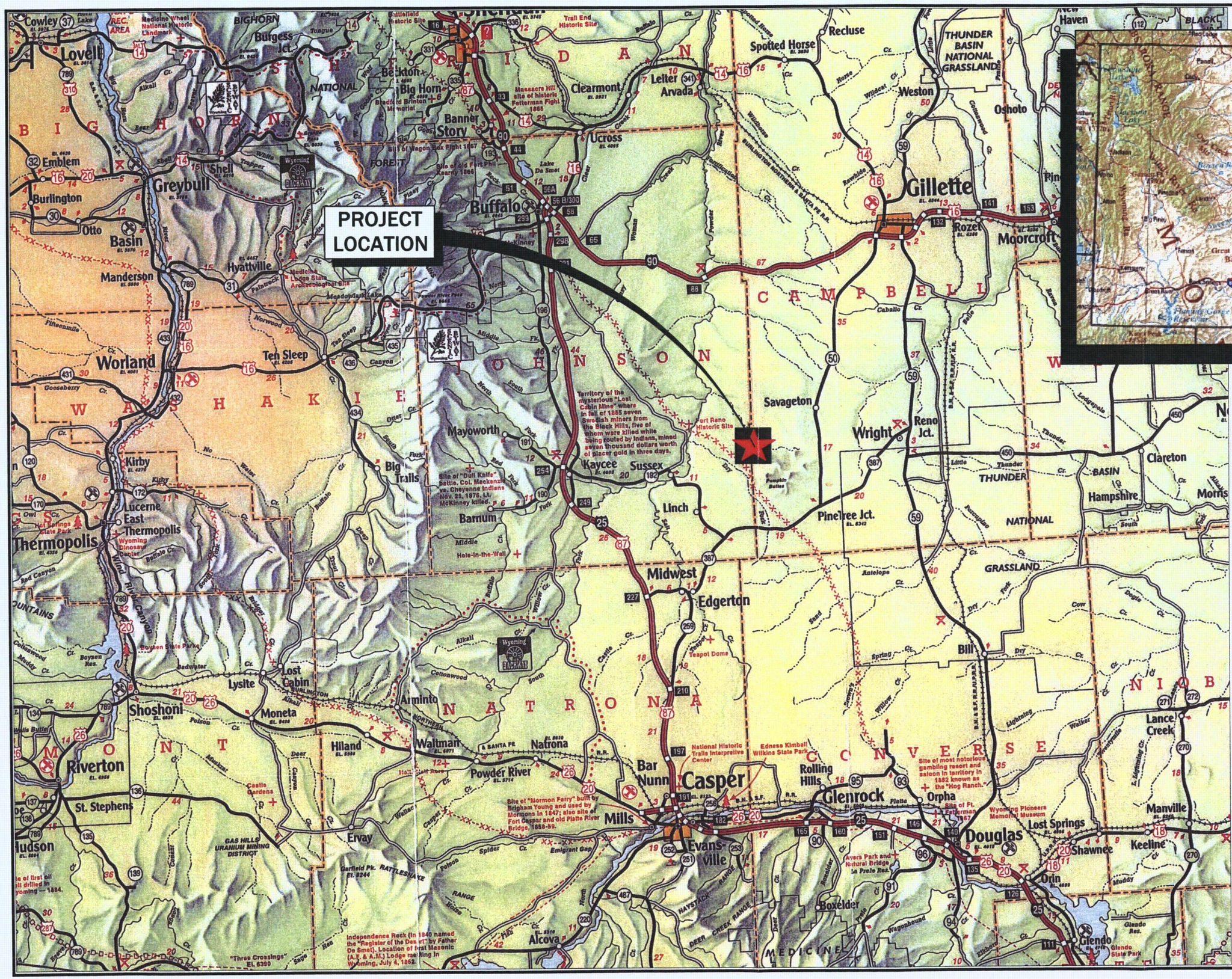
The uranium deposits in the Nichols Ranch ISR Project area have shown amenability to ISR extraction from core samples, two pilot tests, one commercial operation at near by Christensen Ranch, and one licensed facility at North Butte.

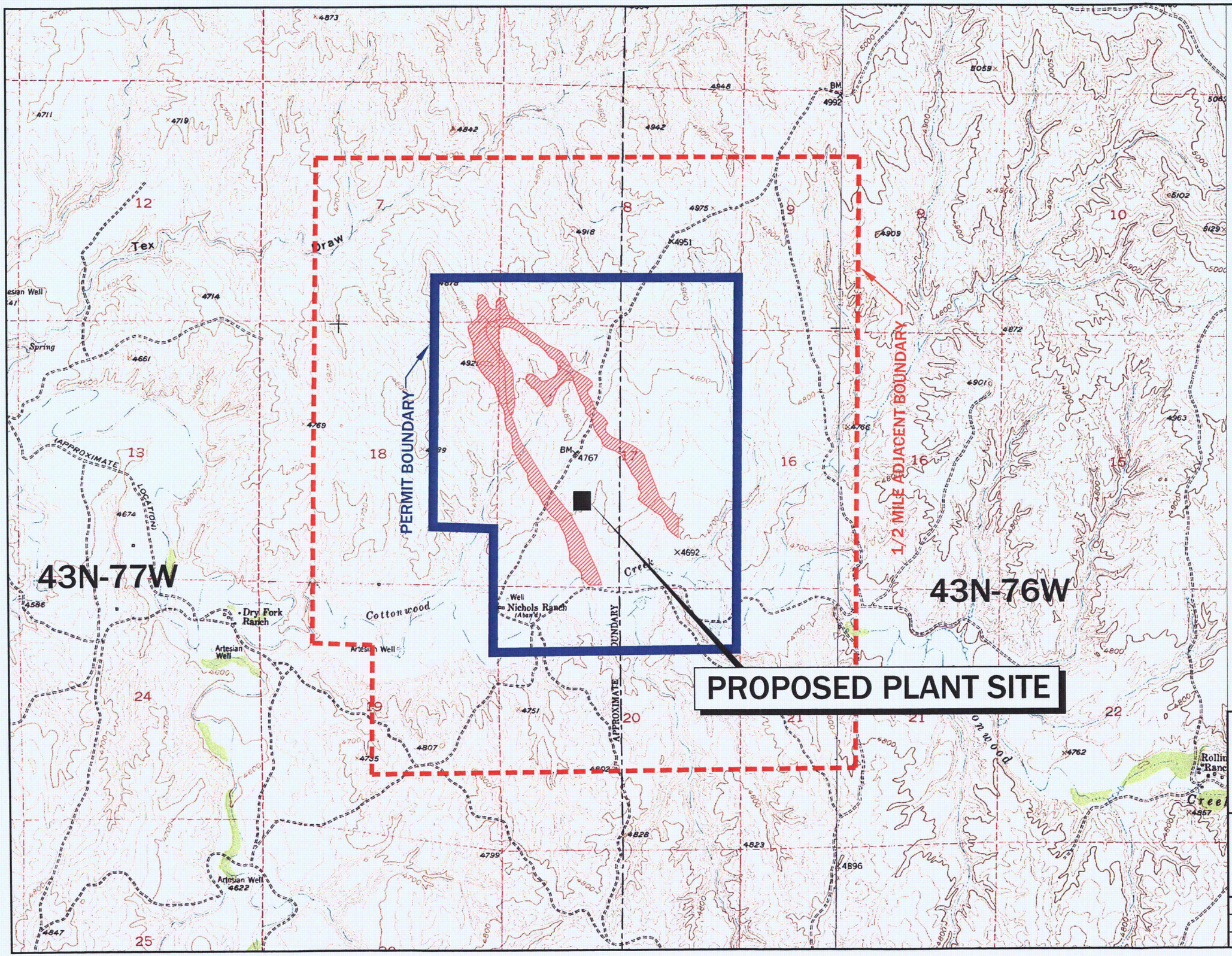
The North Rolling Pin pilot test was located within approximately 2.0 mi of the Nichols Ranch ISR Project, and the Collins Draw pilot test was about 3.0 mi from the Nichols Ranch ISR Project. The Wyoming Department of Environmental Quality, Land Quality Division (WDEQ-LQD) issued license 3RD for the Collins Draw site, and the Nuclear Regulatory Commission (NRC) granted a source license in late 1979 for the same site. Approval was granted in 1974 (SUA-1199) for research and development activities on North Rolling Pin. Figure 1-4 (see map pocket) shows Christensen Ranch, North Butte, Collins Draw Pilot, North Rolling Pin Pilot, and the proposed the Nichols Ranch Unit and the Hank Unit locations.

Core sample results were confirmed by the two pilot test projects. The Collins Draw project was conducted at depths of 450 ft (+/-50 ft) and used an oxidized carbonate leach solution. Recovery operations at Collins Draw lasted from May 1980 to July 1981. Hydrologic tests resulted in an average transmissivity of 185 gpd/ft. A conclusion from the Collins Draw pilot test indicated that the technology developed at Collins Draw would be applicable to other ore bodies in the Powder River Basin. The pilot test for North Rolling Pin was approximately 125 ft deep and was conducted using an oxidized carbonate leach solution. The two pilot tests were successfully able to recover uranium using the in situ recovery method followed by groundwater restoration.

The Christensen Ranch commercial ISR mine owned by AREVA, is located about 5.0 to 6.0 mi north of the Nichols Ranch ISR Project. Christensen Ranch has produced millions of pounds of U_3O_8. Christensen Ranch ISR mine is on the same geological formation and sand horizons that the Uranerz Nichols Ranch ISR Project will use to extract the uranium. Christensen Ranch is currently on stand-by, but AREVA possibly has plans to restart the facility. The Power Resources Incorporated (PRI) North Butte project is also licensed in this area. This facility is not constructed, but is licensed and permitted by the NRC and WDEQ respectively.

The two pilot test and the two NRC licensed facilities demonstrate the amenability of ISR extraction in this area of the Powder River Basin. The ISR extraction method provides for minimal surface disturbance, short-term environmental impacts and no significant risks to public safety or health. Uranerz Energy Corporation desires to proceed with requests for an NRC Source Material License for the Nichols Ranch ISR Project, including the Nichols Ranch Unit central processing plant and the Hank Unit satellite facility.


PROJECT LOCATION
Cowley
Lovell
Burgess Jct.
Beckton
Big Horn
Banner
Story
Clearmont
Leiter
Arvada
Spotted Horse
Recluse
Weston
Oshoto
Gillette
Rozet
Moorcroft
Emblem
Shell
Greybull
Burlington
Otto
Basin
Manderson
Hyattville
Buffalo
Ucross
Lake De Smet
Worland
Ten Sleep
Kirby
Lucerne
East Thermopolis
Thermopolis
Mayoworth
Big Trails
Barnum
Kaycee
Sussex
Linch
Savageton
Wright
Reno Jct.
Pine Tree Jct.
Midwest
Edgerton
Bill
Lost Cabin
Lysite
Shoshoni
Moneta
Arminto
Hiland
Waltman
Natrona
Powder River
Riverton
St. Stephens
Hudson
Ervay
Mills
Bar Nunn
Casper
Evansville
Alcova
Rolling Hills
Glenrock
Orpha
Douglas
Lost Springs
Shawnee
Orin
Glendo
Boxelder
Lance Creek
Manville
Keeline
Clareton
Hampshire
Morris
THUNDER BASIN NATIONAL GRASSLAND
BIGHORN NATIONAL FOREST
WASHAKIE
HOT SPRINGS
BIG HORN
CAMPBELL
JOHNSON
NATRONA
CONVERSE
NIOBRARA
MOUNTAINS
MEDICINE
GAS HILLS URANIUM MINING DISTRICT
Medicine Wheel National Historic Landmark
Trail End Historic Site
Massacre Hill site of historic Fetterman Fight 1866
Site of old Fort Phil Kearny 1866
Site of Wagon Box Fight 1867
Medicine Lodge State Archaeological Site
Fort Reno Historic Site
Site of "Dull Knife" battle, Col. Mackenzie vs. Cheyenne Indians Nov. 25, 1876. Lt. McKinney killed.
Teapot Dome
National Historic Trails Interpretive Center
Edness Kimball Wilkins State Park
Site of most notorious gambling resort and saloon in territory in 1882 known as the "Hog Ranch."
Site of Ft. Fetterman 1867
Wyoming Pioneers Memorial Museum
Avers Park and Natural Bridge
La Prele Res.
Site of "Mormon Ferry" built by Brigham Young and used by Mormons in 1847; also site of Fort Caspar and old Platte River Bridge, 1858-59.
Independence Rock (in 1840 named the "Register of the Desert" by Father De Smet). Location of first Masonic (A.F. & A.M.) Lodge meeting in Wyoming, July 4, 1852.
"Three Crossings" El. 6390
Emigrant Gap
Territory of the mysterious "Lost Cabin Mine" where in fall of 1885 seven Swedish miners from the Black Hills, five of whom were killed while being routed by Indians, mined seven thousand dollars worth of placer gold in three days.
Wyoming Dinosaur Center
Hot Springs State Park
Boysen State Park
Boysen Res.
Castle Gardens
Glendo Res.
Glendo State Park
Wyoming Scenic Byway
Wyoming Backway
NOT TO SCALE
WYOMING
Cheyenne
Laramie
Casper
Great Divide Basin
Rawlins
Lander
Riverton
Cody
Yellowstone National Park
Jackson
Pinedale
Rock Springs
Green River
Evanston
Kemmerer
Afton
Thermopolis
Sheridan
Buffalo
Douglas
Torrington
Newcastle
Lusk
Wind River Range
Bighorn Mts.
Medicine Bow Mts.
Laramie Mts.
Sierra Madre
Wind River Res.
Pathfinder Reservoir
Seminoe Reservoir
Alcova Reservoir
Glendo Reservoir
Guernsey Res.
Heart Mtn.
Shoshone Nat. Forest
Bridger Nat. Forest
Medicine Bow Nat. Forest
Thunder Basin Nat. Grassland
Black Hills Nat. Forest
Bighorn Nat. Forest
Big Piney
Pinedale
Kemmerer
Lyman
Mountain View
Evanston
Green River
Rock Springs
Wamsutter
Baggs
Saratoga
Encampment
Rawlins
Medicine Bow
Hanna
Glenrock
Douglas
Lusk
Newcastle
Upton
Moorcroft
Sundance
Hulett
Aladdin
Beulah
Devils Tower
Cowley
Lovell
Deaver
Frannie
Meeteetse
Ten Sleep
Worland
Manderson
Greybull
Shell
Cody
Powell
Ralston
Deaver
Lovell
Cowley



SCALE: 1"=2000'

0 1000 2000 feet

LEGEND

PROJECTED WELLFIELD

EXISTING ROADS

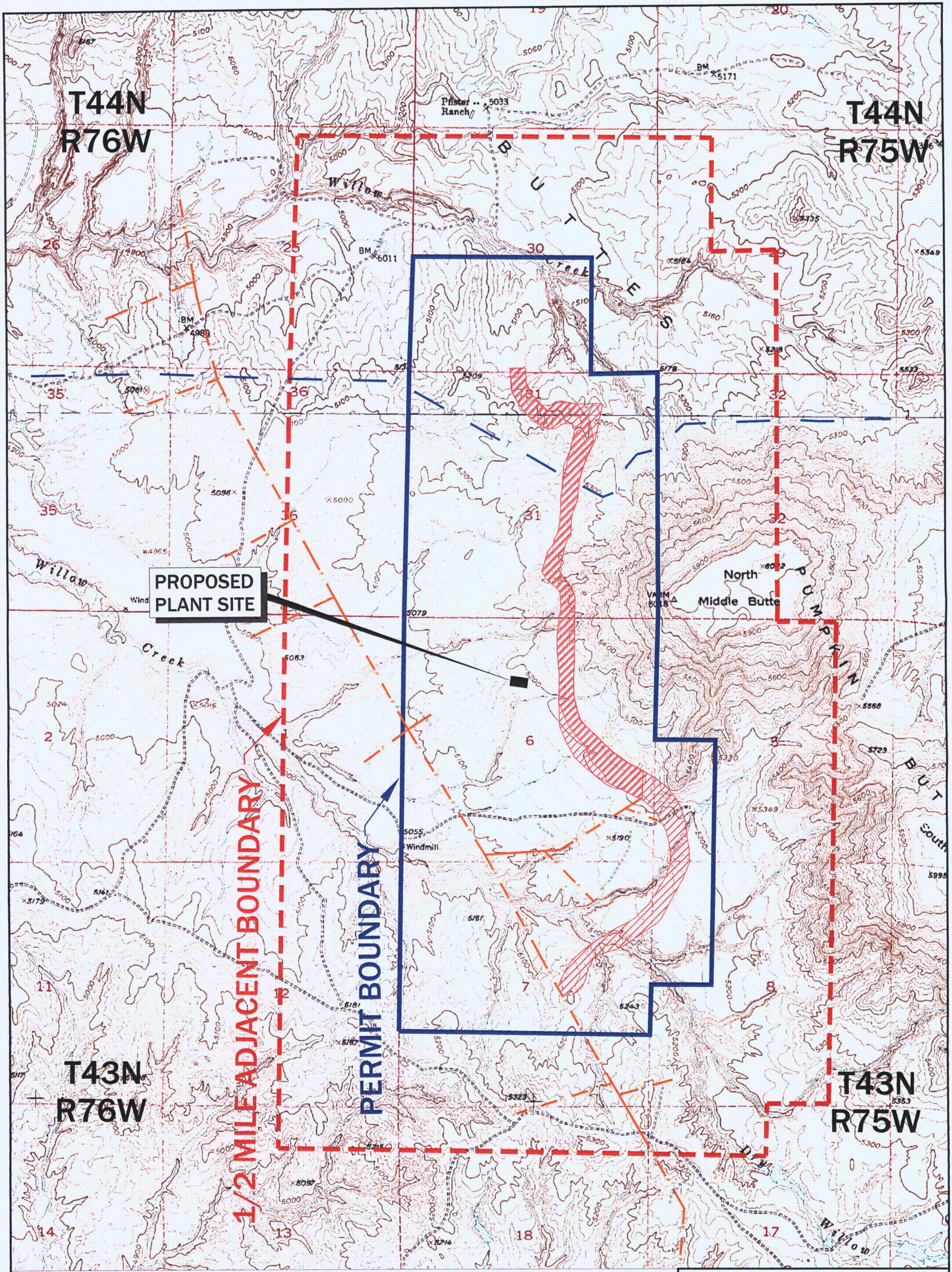
Uranerz ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

NICHOLS RANCH ISR PROJECT

FIGURE 1-2

NICHOLS RANCH UNIT CONTOUR MAP

By: S.M.F.	Date: 10/29/2007
Contour Interval: 20 FEET	Revision Date:
Scale: 1"=2000'	DATUM: NAD 27 UTM 13



LEGEND

- PROJECTED WELLFIELD
- EXISTING MOUNTAIN STATES TELEPHONE AND TELEGRAPH COMPANY 16' RIGHT-OF-WAY
- EXISTING POWDER RIVER ENERGY CORPORATION 30' RIGHT-OF-WAY
- EXISTING ROAD

SCALE: 1"=2000'

0 2000 ft. 4000 ft.

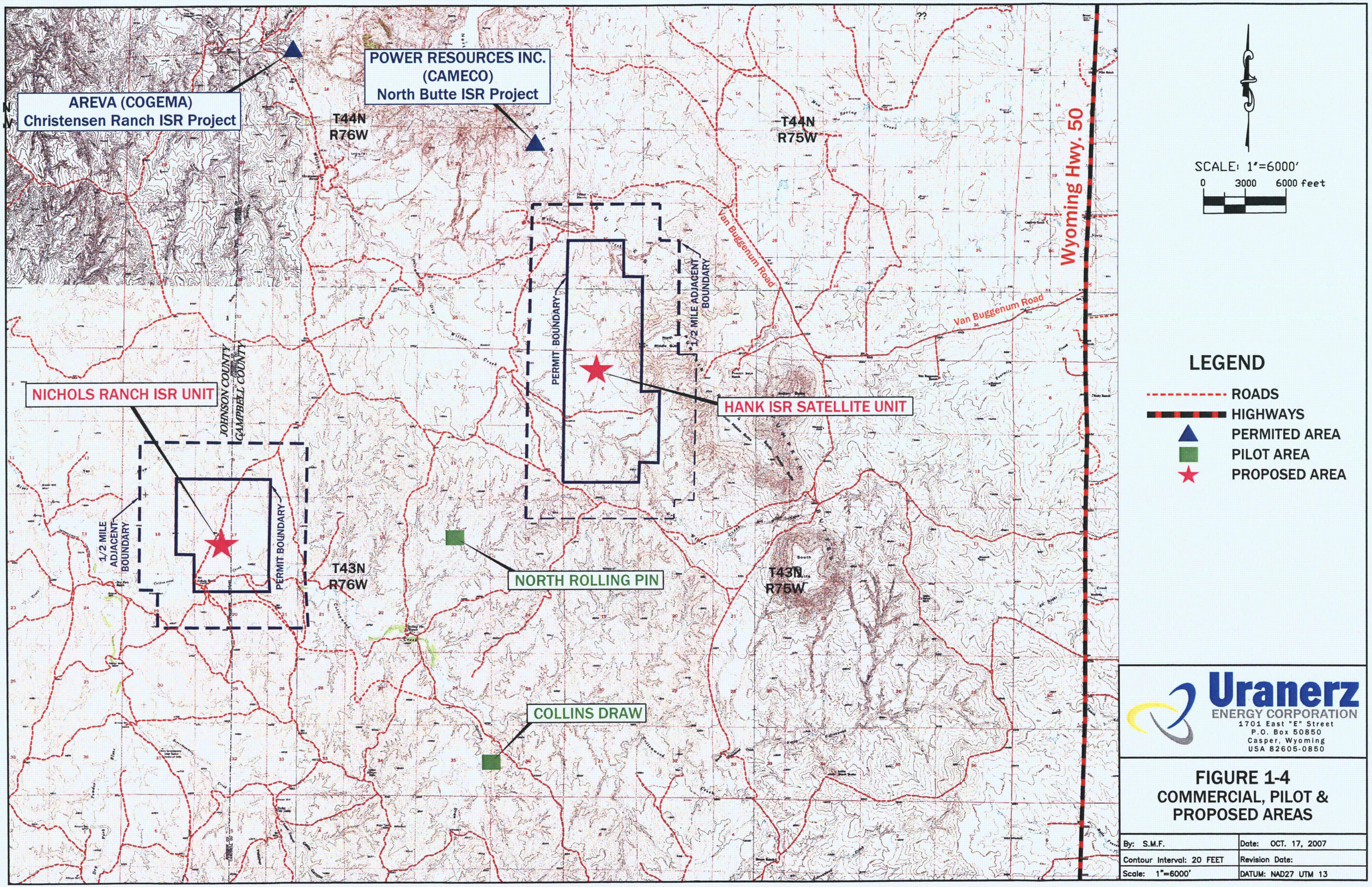
Uranerz ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

NICHOLS RANCH ISR PROJECT

FIGURE 1-3

HANK UNIT CONTOUR MAP

By: S.M.F.	Date: OCTOBER 29, 2007
Contour Interval: 20 FEET	Revision Date:
Scale: 1"=2000'	DATUM: NAD27 UTM 13



Uranerz
ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

FIGURE 1-4
COMMERCIAL, PILOT & PROPOSED AREAS

By: S.M.F.	Date: OCT. 17, 2007
Contour Interval: 20 FEET	Revision Date:
Scale: 1"=6000'	DATUM: NAD27 UTM 13

2.0 SITE CHARACTERIZATION

2.1 SITE LOCATION AND LAYOUT

The Nichols Ranch ISR Project is located in the Pumpkin Buttes Mining District of the Powder River Basin in Johnson and Campbell Counties Wyoming. The project is divided into two project units, the Nichols Ranch Unit and the Hank Unit. The Nichols Ranch Unit encompasses approximately 1,120 acres of land located in Township 43 North Range 76 West, Sections 7, 8, 17, 18, and 20. The Hank Unit encompasses approximately 2,250.53 acres of land located in Township 44 North Range 75 West, Sections 30 and 31 and Township 43 North Range 75 West, Sections 5, 6, 7, and 8. The Nichols Ranch Unit will be the site of the main processing facility consisting of the central processing plant (CPP), main office building, and a maintenance building. The Hank Unit will be a satellite operation consisting of a satellite ion exchange plant, an office building, and a maintenance building. Access to the Nichols Ranch ISR Project site is either via Wyoming State Highway 50 to Van Buggenum Road to T-Chair Livestock ranch roads, or from U.S. Highway 387 north on T-Chair Livestock ranch roads. Figure 2-1 (see map pocket) shows the general location and access to the project areas.

The current land surface ownership of the Nichols Ranch ISR Project includes approximately 3,090.53 acres of private ownership, mainly by the T-Chair Livestock Company, and approximately 280 acres of United States Government ownership administrated by the Bureau of Land Management (BLM).

Names and addresses of the surface and mineral owners of record within and adjacent (within 0.5 mi of each unit) to the project are provided in Appendix A and B of this application. Appendix A lists all surface and mineral owners located within the two project units. Appendix B lists all surface and mineral owners for lands located within 0.5 mi of the project units. The legal descriptions of the project units are contained in Appendix C including tabulations of all lands in the project units and tabulation of No Right to Mine lands.

2.2 USES OF ADJACENT LANDS AND WATERS

2.2.1 General

The lands within the Nichols Ranch ISR Project have historically been used for cattle grazing and wildlife habitat. Presently the lands are used for a variety of purposes. Livestock grazing, oil and gas extraction, coal bed methane extraction, and uranium recovery activities are all currently taking place on or near the project area. The immediate future land use for the project area and adjacent areas will be continued livestock grazing, in situ uranium recovery, coal bed methane extraction, and oil and gas extraction.

No residential sites are located within the two Unit permit areas. Two ranches are located near the Unit permit areas. The Pfister Ranch is located approximately 0.6 mi north of the Hank Unit in Township 44 North Range 75 West, Southwest Quarter of Section 19. The Dry Fork Ranch lies approximately 0.9 mi to the west of the Nichols Ranch Unit in Township 42 North Range 76 West, Northeast Quarter of Section 24. Other residential sites that are located near the Nichols Ranch ISR Project are listed in Table 2-1. All of these residents are located outside the Nichols Ranch ISR Project area. Figure D1-2 (see map pocket) of the attached Appendix D1 – Land Use shows the location of the residents listed in Table 2-1 in relation to the Nichols Ranch ISR Project.

Three NRC licensed in situ uranium recovery facilities are located within 50 mi of the Nichols Ranch ISR Project. COGEMA's Christensen Ranch ISR facility is located approximately 6.0 mi north of the Nichols Ranch Unit and approximately 4.0 mi to the northwest of the Hank Unit. Power Resources Inc. (PRI) licensed North Butte amendment area lays approximately 2.0 mi to the north of the Hank Unit and 5.0 mi to the northeast of the Nichols Ranch Unit. PRI's Smith-Highlands Ranch (SR-HUP) ISR facility is located approximately 45 mi to the southeast of the Nichols Ranch ISR Project. Two of the licensed facilities, Christensen Ranch and SR-HUP, currently have existing yellowcake processing plants with the SR-HUP being in operation. The current Christensen Ranch plant is currently idle, but is expected to be back in production in the near future. PRI's North Butte amendment area does not have any current

Table 2-1 Nearest Residents.

Nearest Residences	Number of Inhabitants	Nearest Permit Area	Distance From Permit Area (mi)	Direction
T-Chair (Rolling Pin) Ranch*	5	Nichols Ranch, Hank	1.9, 2.9	E, SW
Pfister Ranch	3	Hank	0.6	N
Pumpkin Buttes Ranch	2	Hank	1.1	E
Van Buggenum Ranch	0	Hank	4	E
Ruby Ranch	2	Hank	6.1	E
Dry Fork Ranch	3	Nichols	0.9	W
Christensen Ranch	1	Hank	3.5	NW

* T-Chair Ranch sits between the Nichols Ranch and Hank Unit areas.

processing or wellfield facilities. Figure 1-4 (see map pocket) of Chapter 1.0, Proposed Activities, shows the location of each facility in relation to Uranerz Energy Corporation's Nichols Ranch ISR Project.

After mining activities are completed, the land will be returned to the pre-mining land use of wildlife habitat and livestock grazing. Decommission and reclamation activities of the affected areas resulting from the uranium recovery activities are detailed in Chapter 6.0 of this application.

2.2.2 Agricultural

Livestock grazing is the main activity on the project area and adjacent lands. No known sources of mass food production for human consumption exist within 10 km of the project area. Hay was grown in the past on approximately 127.8 acres of the southern part of the Nichols Ranch Unit, but because of drought conditions over the last seven years, this crop has not been produced. The National Resources Conservation Service (NRCS) stocking rate for the Nichols Ranch ISR Project ranges from 1.0 to 3.0 animal units per acre, per month on range that varies from average to excellent as listed in the NRCS Technical Guides for the Northern Plains.

2.2.3 Recreation

Recreational activities within a 50-mi radius of the Nichols Ranch ISR Project are mainly outdoor activities such as camping, hiking, fishing, and hunting. Almost all of the land on and adjacent to the Nichols Ranch ISR Project area is private with limited access, but public lands such as the Thunder Basin National Grassland, located approximately 24 mi to the east/southeast of the Hank Unit, and the Bighorn Mountains, approximately 27 mi to the west, provide areas for recreational activities. The Powder River, located approximately 9.0 mi to the west of the project area, also provides recreational opportunities for public use.

2.2.4 Water Rights

Surface and groundwater rights on, adjacent to, and within 3.0 mi of the Nichols Ranch ISR Project are listed in Appendix D-6 (Hydrology) of this application. No adjudicated surface water rights are located in or adjacent (within 0.5 mi of the permit boundary) to the Nichols Ranch ISR Project. The surface water rights that do exist within the proposed Nichols Ranch ISR Project area are limited to stock/storage ponds and ephemeral creeks. Groundwater rights in the Nichols Ranch ISR Project area are mainly associated with old monitoring wells and stock wells. No other adjudicated water rights are in the project area and lands adjacent to the project area according to the Wyoming State Engineer's Office. Uranerz Energy Corporation also does not hold any adjudicated water rights in the project area. Most wells that are located within the Nichols Ranch ISR Project area were installed by prior uranium exploration companies, the T-Chair Livestock Company, or coal bed methane companies. Several additional wells have been completed in the project area by Uranerz Energy Corporation for use in collecting baseline groundwater quality data.

Wells in the area of the proposed Nichols Ranch ISR Project area are uniformly distributed over the area excluding monitoring/sampling wells that are permitted by Uranerz Energy Corporation. Most of the wells are used for livestock watering through the use of windmills or electric well pumps. Well depths vary from 180 ft to 1,000 ft in depth, most of which are completed in sands other than the ore zone sands. Those wells which are completed in the ore zone sand will either

be abandoned using acceptable WDEQ methods will have the ore zone interval isolated, or will be used as monitoring wells if not completed in multiple sands. No wells in or adjacent to the project area are used for domestic water consumption. A domestic water supply well is found on the Pfister Ranch, located approximately 0.6 mi north of the northern boundary of the Hank Unit. This well is completed at a depth that is stratigraphically below the zones planned for the ISR extraction. Additionally, the well is located at a distant from any planned wellfields and in sandstone units that do not contain any uranium mineralization of economic significance. Any extraction activities that take place in the area are very unlikely to affect this well because the well is completed in a sandstone unit that is separated from the ore zone sandstone by an aquiclude consisting of mudstone. The extensive groundwater monitoring program utilized during the extraction phase should detect any problems prior to this well being adversely affected.

Any water wells that Uranerz Energy Corporation constructs in the project area will be completed in sands that are stratigraphically below or above the ore zone. The purpose of the wells will be for providing process and wash down water to the plant facilities along with supplying water for lavatories, safety showers, and change house shower water. Bottled water will be provided for drinking water.

Appendix D6, Hydrology, of this license application contains detailed hydrologic information for the Nichols Ranch ISR Project.

2.2.5 Industrial

2.2.5.1 General/Oil/Gas

Coal bed methane and oil and gas development have and will be taking place in the proposed project area and on the lands adjacent to the Nichols Ranch ISR Project area. The Hank Unit lies within the Hartzog/Pumpkin Buttes Oil Fields. Presently six oil/gas wells exist on the lands within and adjacent to the Hank Unit. No oil/gas wells are located within or adjacent to the Nichols Ranch Unit. According to the Wyoming Oil and Gas Conservation Commission, no

further oil and gas development will take place in the Nichols Ranch ISR Project. The locations of the oil/gas wells for the Hank Unit are shown in Exhibit D6-5 (see map pocket) of the attached Appendix D6- Hydrology. Table 2A-1 of Addendum 2A lists all oil/gas wells found within a 3.0 mi radius of the project area.

The oil/gas wells located in the Hank Unit should not cause any issues with the proposed extraction activities. The location of the wells and the depths that they are drilled to (< 9,000 ft deep) will not interfere with the ISR extractions since the ore zone is much shallower than the oil/gas wells. None of the oil/gas wells penetrate the ore zones. Additionally the completion techniques used by the oil/gas companies are such that the wells will not cause any potential excursions to occur. The oil and gas wells in the project area are typically cemented from at least 1,000 ft deep to the surface. This amount of cement is sufficient to protect the oil/gas wells from acting as a conduit for any uranium recovery fluids. Pressure monitoring on the oil/gas wells also ensures that the oil/gas wells are working properly and that the wells integrity is intact.

2.2.5.2 Coal Bed Methane

Coal bed methane (CBM) activity is widespread throughout the Powder River Basin. The methane is produced at a depth of approximately 1,000 ft and greater which is approximately 400 ft deeper than the uranium mineralization found in the Nichols Ranch and Hank Units. Since the CBM activity and uranium mineralization are stratigraphically separated with layers of sandstone, mudstone, and clay, it is very unlikely that any of the CBM wells will be impacted by the extraction activity and vice versa.

Currently there are 24 permitted and completed CBM wells located in or adjacent to the Nichols Ranch Unit. Thirty-three permitted and completed CBM wells are found in the lands in and adjacent to the Hank Unit. The Nichols Ranch ISR Project will not impact any of the current or proposed CBM wells as none of the existing or purposed CBM wells are or will be located within the planned wellfield areas. Communication between the CBM producers and Uranerz Energy Corporation has been established with all parties working together to avoid conflicts. Maps of the CBM producers proposed well sites, access roads, water and gas pipeline routes, and

utility corridors have been provided to Uranerz Energy Corporation for use in developing extraction activities.

CBM discharge water will not be impacted by extraction activities in the Nichols Ranch ISR Project area. Both CBM producers on the Nichols Ranch and Hank Units will be piping water produced by CBM drilling to locations out of the project area and adjacent lands. The CBM produced water will then be either discharged on the surface or stored in large storage tanks, pumped some thirty miles away, and then re-injected into the ground.

Exhibits D6-3 and D6-4 (see map pockets) of the attached Appendix D6 – Hydrology show all CBM wells on, adjacent to, and within three miles of the Nichols Ranch and Hank Units. Tables 2A-2 through 2A-3 of Addendum 2A detail all CBM wells that are permitted and completed in the project area. Table 2A-6 of Addendum 2A defines the abbreviations used in Tables 2A-1 through 2A-5.

2.3 POPULATION DISTRIBUTION

The population within 50 mi (~80 km) of the Nichols Ranch ISR Project consists mainly of rural areas. The community of Gillette, Wyoming is the closest major urban area to the mine site located approximately 46 air mi away. Casper, Wyoming is the next closet major urban area to the mine site located approximately 61 air mi away. These two communities provide the major locations of public services such as schools, churches, medical care facilities, public parks, and commodities. Wright and Buffalo, Wyoming also provide public services near the mining site. Table 2-2 lists the cities located within a 50 mi (~80 km) radius of the Nichols Ranch ISR Project area. Table 2-3 also lists the estimated populations of all major towns and cities within Campbell, Johnson, and Natrona Counties. Figure 2-2 (see map pocket) shows the location of towns and cities within 50 mi (~80 kilometers) of the project area.

Table 2-2 Cities Within a 50-mi Radius of the Nichols Ranch ISR Project Area.

City	Population[1]	Distance From Permit Area (mi)	Direction
Gillette	22,685	46	Northeast
Buffalo[2]	4,290	57	Northwest
Kaycee	273	35	West
Midwest	431	25	Southwest
Edgerton	173	23	Southwest
Wright	1,425	22	East
Casper[2]	51,738	61	Southwest

[1] Source: U.S. Census Bureau Population Division (2006).
[2] Major Wyoming cities just beyond 50 mi.

Casper, Wyoming is the County Seat of Natrona County and the second largest city in Wyoming. The city serves as the economic center of central Wyoming servicing a 150-mi radius that encompasses all or part of seven counties. Oil and gas, mining, and retail services are all found in the city. Casper also is home to the Casper Events Center which hosts many public events such as concerts, trade shows, and sporting events. The population of Casper is in an upward trend with the recent resurgence in oil and gas development and uranium mining. According to the U.S. Census Bureau, the estimated population in Casper has increased 4.0% from April 2000 to July 2005. The population of Casper is expected to continue to follow an upward trend with an average growth rate comparable to the state growth rate of 2.58%.

Gillette, Wyoming is the County Seat of Campbell County. The city has been experiencing major growth over the last few years. Coal bed methane, oil and gas development, and coal mining have played significant roles in expanding the cities population by almost 12% from April 2000 through July 2005. According to the Campbell County Economic Development Corporation, Campbell County Housing Needs Assessment of January 2005, Campbell County is projected to grow at a consistent pace between 7% and 11% for the next 15 years due to the expansion of the work force and natural population growth. With the influx of industry, Gillette also serves a regional center for oil and gas, mining, and CBM support services.

Table 2-3 Wyoming Population Data Campbell, Johnson, and Natrona Counties.

Place	Census 2000 Population	April 1, 2000 Population Estimates Base	July 1, 2001 Population	July 1, 2002 Population	July 1, 2003 Population	July 1, 2004 Population	July 1, 2005 Population	% Change July, 2004 to July, 2005	% Change April, 2000 to July, 2005
Wyoming	**493,782**	**493,782**	**494,045**	**499,045**	**501,915**	**505,887**	**509,294**	**0.7**	**3.1**
Campbell County	**33,698**	**33,698**	**34,670**	**36,155**	**36,423**	**36,654**	**37,405**	**2.0**	**11.0**
Gillette city	19,646	20,271	20,870	21,819	22,053	22,174	22,685	2.3	11.9
Wright town	1,347	1,347	1,379	1,426	1,418	1,408	1,425	1.2	5.8
Balance of Campbell County	12,705	12,080	12,421	12,910	12,952	13,072	13,295	1.7	10.1
Johnson County	**7,075**	**7,075**	**7,171**	**7,413**	**7,537**	**7,606**	**7,721**	**1.5**	**9.1**
Buffalo city	3,900	3,902	3,956	4,100	4,212	4,230	4,290	1.4	9.9
Kaycee town	249	249	253	261	265	269	273	1.5	9.6
Balance of Johnson County	2,926	2,924	2,962	3,052	3,060	3,107	3,158	1.6	8.0
Natrona County	**66,533**	**66,533**	**66,909**	**67,519**	**68,238**	**68,988**	**69,799**	**1.2**	**4.9**
Bar Nunn town	936	936	944	955	970	1,139	1,292	13.4	38.0
Casper city	49,644	49,737	49,867	50,236	50,770	51,223	51,738	1.0	4.0
Edgerton town	169	169	169	170	171	172	173	0.6	2.4
Evansville town	2,255	2,255	2,269	2,285	2,297	2,304	2,328	1.0	3.2
Midwest town	408	408	408	411	417	427	431	0.9	5.6
Mills town	2,591	2,632	2,739	2,830	2,866	2,873	2,898	0.9	10.1
Balance of Natrona County	10,530	10,396	10,513	10,632	10,747	10,850	10,939	0.8	5.2

Note: The April 1, 2000 Population Estimates Base reflects modifications to the Census 2000 population as documented in the Count Question Resolution program, updates from the Boundary and Annexation Survey, and geographic program revisions. An "(X)" in the Census 2000 field indicates a locality that was formed or incorporated after Census 2000 or was erroneously omitted from Census 2000. Additional information on these localities can be found in the Geographic Change Notes (see "boundary changes" under the Geographic Topics section of the Estimates page). Dash (-) represents zero or rounds to zero.

Source: Population Division, U.S. Census Bureau Release Date: June 21, 2006

Wright, Wyoming is the closest town to the project area located approximately 22 mi away. Like most towns in Wyoming, Wright has continued to grow with the development of coal bed methane, oil and gas, and coal mining in Campbell County. The town has experienced an estimated 5.8% growth from April 2000 to July 2005.

Several small communities exist in Johnson County, Wyoming. The county seat, Buffalo, is the largest town in Johnson County. Buffalo is located approximately 57 air mi to the northwest of the Nichols Ranch ISR Project area and houses the Bureau of Land Management office that oversees all federal land in Northeast Wyoming. The population of Johnson County is expected to grow at a rate of 1.5% to 1.7% from 2005 to 2012 according the Johnson County Comprehensive Land Use Plan of 2005. Much of the population growth is expected to come from the development of coal bed methane in Johnson County.

Several ranches are found within five miles of the Nichols Ranch ISR Project area. The closest inhabited dwelling is the Pfister Ranch. This ranch is located approximately 0.6 mi north of the Hank Unit. Currently three people reside at the ranch. The next closest inhabited dwelling is the Dry Fork Ranch located 0.9 mi to the West of the Nichols Ranch Unit. Three people also reside at this ranch. Four other ranches lie within 5.0 mi of the Nichols Ranch ISR Project area. The name of the ranches and the number of inhabitants are listed in Table 2-1. All together, the six ranches results in a total of 14 people residing within 5.0 mi of the Nichols Ranch ISR Project area. This results in an occupational density of 0.31 persons per square mile for the area within five miles of the project area. Figure 2-3 (see map pocket) shows the population density for Wyoming and for a 50 mi (~80 km area) surrounding the project area.

Because of the remote location of the Nichols Ranch ISR Project, visitation to the project location will be limited mainly to vendors, contractors, regulatory agency personnel, coal bed methane employees, and pre-arranged public tours.

Figures 2-4 through 2-6 (see map pockets) provides detailed information regarding the county profiles of Campbell, Johnson, and Natrona County. Included in this information are details about minority population's, county employment statistics, and landowners in the counties. Table 2-4 contains information on the minority populations in Campbell, Johnson, and Natrona Counties.

Table 2-4 Population By Place, By Minority: 1990 and 2000.

	Total			Non-Hispanic White			Total Minority					Hispanic/Latino		
										% of Total				
AREA NAME	1990	2000	% Chg	1990	2000	% Chg	1990	2000	% Chg	1990	2000	1990	2000	% Chg
Wyoming	**453,588**	**493,782**	**8.9**	**412,711**	**438,799**	**6.3**	**40,877**	**54,983**	**34.5**	**9.0**	**11.1**	**25,751**	**31,669**	**23.0**
COUNTY														
Campbell	29,370	33,698	14.7	28,074	31,701	12.9	1,296	1,997	54.1	4.4	5.9	882	1,191	35.0
Johnson	6,145	7,075	15.1	6,004	6,771	12.8	141	304	115.6	2.3	4.3	78	148	89.7
Natrona	61,226	66,533	8.7	57,888	61,023	5.4	3,338	5,510	65.1	5.5	8.3	2,252	3,257	44.6
PLACE														
Buffalo city	3,302	3,900	18.1	3,236	3,715	14.8	66	185	180.3	2.0	4.7	27	71	163.0
Casper city	46,742	49,644	6.2	44,002	45,334	3.0	2,740	4,310	57.3	5.9	8.7	1,843	2,656	44.1
Evansville town	1,403	2,255	60.7	1,335	1,964	47.1	68	291	327.9	4.8	12.9	55	190	245.5
Gillette city	17,635	19,646	11.4	16,802	18,350	9.2	833	1,296	55.6	4.7	6.6	558	774	38.7
Mills town	1,574	2,591	64.6	1,456	2,394	64.4	118	197	66.9	7.5	7.6	76	102	34.2
Wright town	1,236	1,347	9.0	1,169	1,298	11.0	67	49	-26.9	5.4	3.6	51	31	-39.2

Source: U.S. Census Bureau

2.4 HISTORIC, SCENIC, AND CULTURAL RESOURCES

2.4.1 General

The following reports attached as Addendum 2B and Addendum 2C and Exhibit 2-1 contain information that is considered confidential information under 10 CFR 2.390. This information must be withheld from public disclosure.

2.4.2 Cultural Resources

Class I Literature Search for Uranerz Energy Corporation's Nichols Ranch ISR Project Permit

A file search (Nos. 20980 and 20981) was conducted on November 19, 2007, through the Cultural Records Office of the Wyoming State Historic Preservation Office (SHPO) for Sections 7, 8, 17, 18, and 20, T43N, R76W; Sections 30 and 31, T44N, R75W; and Sections 5-8, T43N, R75W. Uranerz Energy Corporation's proposed Nichols Ranch ISR Project occurs within these legal descriptions.

Ten projects have been conducted within the sections for seven block and three block/linear surveys; they were completed for five mine blocks, three well pads and access roads, and two well pads (Table 2-5). A few recent projects have yet to be approved by the Bureau of Land Management (BLM) and have not been accessioned into the SHPO database; therefore, they are not included in Table 2-5. Fifty sites, however, have been recorded in the sections. Of these, 43 are prehistoric sites, five are historic sites, and two are multicomponent prehistoric/historic sites. The sites are summarized in Table 2-6 and presented in Exhibit 2-1 (confidential binder). Of the prehistoric sites, 16 are eligible for listing on the National Register of Historic Places (NRHP), 19 are not eligible, seven are not eligible with SHPO concurrence, and one is unevaluated with SHPO concurrence. Of the historic sites, one is eligible and four are not eligible. One multicomponent site is eligible for the NRHP and one is not eligible with SHPO concurrence.

Table 2-5 Previous Cultural Resource Inventories Within or near Uranerz Energy Corporation's Nichols Ranch ISR Project Permit Area.

Accession No.	Project Name	Contractor [1]	Type [2]	Legal Location
76-352-0	Brown's Ranch Uranium Mine	OWSA	B	Section 6, T43N, R75W
77-1-0	Brown's Ranch Uranium Mine	OWSA	B	Section 30, T44N, R75W
79-680-0	Brown's Ranch Uranium Mine	PE	B/L	Section 6, T43N, R75W
80-1209-0	Fed BZ 1	AS	B/L	Section 7, T43N, R76W
81-2054-0	Fed B-R-1	AC	B	Section 6, T43N, R75W
81-2054-0	Parker Fed 34-6 Testing	AEC	B	Section 17, T48N, R71W
4-2191-0	East Bullwhacker CBM POD	SWCA	B	Section 20, T43N, R76W
6-1350-0	Dry Willow CBM POD #1	SWCA	B	Section 31, T44N, R75W
6-1350-2	Dry Willow POD 1 Supplement	SWCA	B	Section 31, T44N, R75W
6-1465-0	Dry Willow POD Block Survey	Arcadis	B	Section 20, T43N, R76W

1 AC = Archeo Consultants; Arcadis = Arcadis U.S. Inc.; AEC = Archaeological Energy Consulting; AS = Archaeological Services; OWSA = Office of the Wyoming State Archaeologist; PE = Powers Elevation.
2 B = block; B/L = combination block/linear.

Table 2-6 Previously Recorded Sites Within or near Uranerz Energy Corporation's Nichols Ranch ISR Project Permit Area.

	Legal Location							
Site No.	Township	Range	Section	Site Type	Landowner	NRHP Eligibility Status [1]	Time Period [2]	Accession No. [3]
48CA379	44N	75W	31	Lithic scatter	Private	NE/SHPO	P	6-1350
48CA5386	43N	76W	8	Lithic scatter	Private	NE	P	--
48CA5390	43N	76W	17	Lithic scatter	Private	E	P	--
48CA5391	43N	76W	17	Lithic scatter	Private	E	P	--
48CA5393	43N	76W	20	Inscription	Private	NE	P	--
48CA5406	43N	76W	17	Lithic scatter	Private	NE	P	--
48CA6146	44N	75W	31	Open camp	BLM	NE/SHPO	P	6-1350
48CA6147	44N	75W	31	Open camp/trash scatter	BLM	NE/SHPO	P/H	6-1350
48CA6148	44N	75W	31	Lithic scatter	BLM	NE/SHPO	P	6-1350
48CA6149	44N	75W	31	Lithic scatter	BLM	NE/SHPO	P	6-1350
48CA6150	44N	75W	30	Lithic scatter	Private	NE/SHPO	P	6-1350

Table 2-6 (Continued)

Site No.	Legal Location Township	Range	Section	Site Type	Landowner	NRHP Eligibility Status [1]	Time Period [2]	Accession No. [3]
48CA6151	44N	75W	30	Lithic scatter	Private	NE/SHPO	P	6-1350
48CA6153	44N	75W	30	Open camp	Private	U/SHPO	P	6-1350
48CA6155	44N	75W	30	Lithic scatter	Private	NE/SHPO	P	6-1350
48CA6342	43N	75W	6	Open camp	BLM	NE	P	--
48CA6343	43N	75W	6	Open camp	BLM	NE	P	--
48CA6344	43N	75W	6	Open camp	BLM	NE	P	--
48CA6345	43N	75W	6	Open camp	BLM	NE	P	--
48CA6474	43N	75W	8	Rockshelter	Private	E	P	--
48CA6475	43N	75W	7	Open camp	Private	E	P	--
48CA6476	43N	75W	8	Open camp	Private	E	P	--
48CA6477	43N	75W	7	Lithic scatter	Private	NE	P	--
48CA6478	43N	75W	8	Open camp	Private	E	P	--
48CA6479	43N	75W	8	Open camp	Private	E	P	--
48CA6480	43N	75W	8	Open camp	Private	E	P	--
48CA6481	43N	75W	8	Open camp	Private	E	P	--
48CA6489	43N	75W	8	Open camp	Private	E	P	--
48CA6490	43N	75W	6, 7	Open camp	Private	E	P	--
48CA6491	43N	75W	7	Lithic scatter	Private	NE	P	--
48CA6498	43N	75W	8	Lithic scatter	Private	NE	P	--
48CA6499	43N	75W	6, 7	Lithic scatter	Private	NE	P	--
48CA6748	43N	75W	6	Open camp	BLM	E	P	--
48CA6749	43N	75W	6	Lithic scatter	Private	NE	P	--
48CA6750	44N	75W	31	Lithic scatter	BLM	NE	P	--
48CA6751	44N	75W	31	Open camp	BLM	E	P	--
48CA6752	44N	75W	31	Open camp	BLM	NE	P	--
48CA6753	44N	75W	31	Open camp	BLM	E	P	--
48CA6754	44N	75W	31	Lithic scatter	BLM	E	P	--
48JO2944	43N	76W	8	Trash scatter	Private	NE	H	--
48JO2945	43N	76W	8	Trash scatter	Private	NE	H	--
48JO2946	43N	76W	7, 8	Open camp	Private	E	P	--
48JO2947	43N	76W	7	Lithic scatter	Private	NE	P	--
48JO2948	43N	76W	17	Lithic scatter	Private	NE	P	--

Table 2-6 (Continued)

Site No.	Legal Location			Site Type	Landowner	NRHP Eligibility Status [1]	Time Period [2]	Accession No. [3]
	Township	Range	Section					
48JO2949	43N	76W	17	Trash scatter	Private	NE	H	--
48JO2950	43N	76W	17	Trash scatter	Private	NE	H	--
48JO2951	43N	76W	18	Homestead	Private	E	H	--
48JO2953	43N	76W	20	Lithic scatter/ building remains	Private	E	P/H	--
48JO2957	43N	76W	17	Lithic scatter	Private	NE	P	--
48JO2959	43N	76W	18	Lithic scatter	Private	NE	P	--
48JO2960	43N	76W	18	Lithic scatter	Private	NE	P	--

1 E = eligible; NE = not eligible; NE/SHPO = not eligible with SHPO concurrence; U/SHPO = unevaluated with SHPO concurrence.
2 H = historic; P = prehistoric; P/H = multicomponent prehistoric/historic.
3 -- = sites that are not yet accessioned with projects, sites associated with projects that have not yet been accessioned in the cultural records office, and sites with projects that do not extend into this section.

The entire area encompassed by the Nichols Ranch Unit permit boundary (within Sections 7, 8, 17, 18, and 20, T43N, R76W) was inventoried at the Class III level by Western Land Services, Sheridan, Wyoming, for the Tex Draw CBM POD, which has not been analyzed by the BLM (personal communication, November 21, 2007, with Clint Crago, Archaeologist, BLM Buffalo Field Office).

Within the Hank Unit permit boundary, all of Section 30 and all but the SENE, NESE, and SESE of Section 31 were inventoried for the Dry Willow 1 POD, which has been approved by BLM (personal communication, November 21, 2007, with Clint Crago, Archaeologist, BLM Buffalo Field Office). The SENE, NESE, and SESE of Section 31 were inventoried in 2007 for the Uranerz Energy Corporation's Hank In-situ Uranium Project, but it has not been reviewed by BLM. All of Sections 6-8 T43N, R75W, were inventoried at the Class III level in 2006 by Arcadis U.S., Inc. for the Dry Willow Phase 4 POD (report in progress). Only the WSW (80 acres) of Section 5, T43N, R75W, remains to be inventoried at the Class III level (personal communication, November 27, 2007, with Adam Graves, Archaeologist, Arcadis U.S. Inc.).

Traditional Cultural Property Site 48CA268

The Hank Unit within Uranerz Energy Corporation's Nichols Ranch ISR Project permit area occurs adjacent to the west side and lower slopes of Pumpkin Buttes. In 2004, the entire summit area of Pumpkin Buttes (North, North Middle, South Middle, and South buttes) was recommended as a Rural Historic Landscape (RHL) with a contributing Traditional Cultural Property (TCP) (Site 48CA268) (Seletstewa et al. 2004). This recommended designation followed Native American consultation with affected Native American tribes. A Memorandum of Agreement was signed September 25, 2006, between Native American tribes and participating agencies and Site 48CA268 was determined to qualify as a TCP but not a RHL (personal communication, November 29, 2007, with Clint Crago, Archaeologist, BLM Buffalo Field Office). The final 2006 report and site form have, to date, not been accessioned by SHPO. The site boundary of the TCP follows the elevation contour of 5,500 ft above mean sea level (1,676 m) that corresponds to the average summit elevation of the four buttes that comprise Pumpkin Buttes. Therefore, due to the immediate proximity of the Hank Unit permit boundary, any ground disturbance within the permit boundary would constitute an adverse effect to the setting of the TCP, which is eligible for listing on the NRHP. Further, if ground disturbance is proposed within the boundary of the TCP, such activity would constitute an adverse effect to the TCP and would require Native American consultation and a subsequent Memorandum of Agreement between all affected participants.

2.4.3 Paleontological Resources

A Paleontological survey was conducted for the Nichols Ranch ISR Project. From the survey performed, the Nichols Ranch ISR Project was concluded to have no major impact to significant fossil remains because of the geology and poor exposures of fossil bearing sediments. One recommendation from the survey is to have a monitor present to oversee any major ground disturbing events when more than a few feet of surface are removed. Uranerz Energy Corporation will comply with this recommendation when conducting any construction that will involve the removal of several feet of soil. Additionally, if any fossil remains are found during

any construction activities, Uranerz Energy Corporation will immediately contact the appropriate state and federal agencies.

The complete paleontological survey is attached as Addendum 2C.

2.4.4 Cultural Resource Mitigation

Uranerz Energy Corporation will comply with the following cultural resource mitigation measures.

1. Uranerz will not conduct any ground disturbing work in areas that have not been previously inventoried and cleared for cultural resources.

2. Uranerz will protect all cultural properties that have been determined eligible to the National Register of Historic Places within the permit area from ground disturbing activities until appropriate cultural resource mitigation measures can be implemented as part of an approved mining and reclamation plan unless modified by mutual agreement in consultation with the SHPO and other regulatory agencies.

3. To protect a previously identified traditional cultural property, Uranerz will also not conduct any ground disturbing activities above the 5,500 foot elevation within the Hank Unit.

4. If cultural resources are discovered during operations, Uranerz will immediately stop ground disturbing activities in the area of the discovery and will immediately notify the WDEQ-LQD, the BLM, the SHPO, and any other appropriate regulatory agency.

2.4.5 Scenic Resources

Because the Nichols Ranch ISR Project is located almost entirely on private land in a remote location, the operations aesthetic impact is limited to only the landowner and those that have

permission to be on the landowner's property. The 280 acres of BLM land near the Hank Unit is landlocked by private land limiting access to the land.

The Nichols Ranch Unit will be the site for central processing facility (CPP) along with an office building and a maintenance building. The plant and buildings would be the prominent features of the landscape since the area where they are to be located is mostly flat with little to no other cover. Even though the plant and buildings will stand out, their existence will not be seen by the public.

The Hank Unit will be the site of a satellite plant along with one maintenance building. These facilities will sit to the west of the Pumpkin Buttes on private land. Several oil/gas wells exist in the region, so the Hank Unit satellite plant will not be the only prominent feature in the area. Several transmission towers are completed outside of the Hank Unit permit boundary on top of South Middle Butte. Additionally coal bed methane development has and will take place in the Hank Unit area. Coal bed methane well houses will be present in the area. The Hank Unit will not be visible from the main T-Chair Livestock Company ranch road, but will be visible from the top of the Pumpkin Buttes. The Pumpkin Buttes have been recognized as a potential Traditional Cultural Property (TCP) by the Bureau of Land Management (BLM). Visual concerns from coal bed methane development and coal bed methane development in general were addressed in Environmental Assessments for Anadarko Petroleum Corporation Dry Willow Phase I and Dry Willow Phase II. These environmental assessments detail the agreement that was reached between the Bureau of Land Management and Anadarko Petroleum Corporation in regards to what mitigation steps would be taken to minimize the visual effects of coal bed methane in regards to the Pumpkin Buttes as a potential TCP. The main concerns that were voiced were to avoid development on the tops and sides of the Pumpkin Buttes, bury pipelines, power lines, etc, and to paint structures so that they will blend into the natural landscape. Uranerz Energy Corporation plans on doing these measures for both the Hank and Nichols Ranch plant sites. Pipelines running to and from the wellfield to the plants will be buried not only to mitigate a visual impact, but for freeze protection of the pipelines. No extraction activities will take place on top of North and South Middle Butte, and buildings, well head covers, and header houses will be painted a color that will allow the structures to blend in with the existing landscape. The

following is an excerpt from the Dry Willow Phase II Environmental Assessment on the visual resource impact regarding the coal bed methane development in the same area that the Nichols Ranch ISR Project will take place in. Much of what is observed will be the same for the proposed Nichols Ranch ISR Project with the exception that the Hank Unit will sit at the base of North and South Middle Buttes. The Nichols Ranch Unit central processing plant will be located approximately 6.0 mi to the west of the Buttes.

"Recently constructed oil and gas related facilities are visible from the base of the Buttes to approximately 15 miles westward. Modern visual distractions include conventional gas and oil wells, well pads, pump jacks, access roads (both crowned and ditched and two track), pipeline scars, reservoirs, fence lines, power lines, a large water storage facility, uranium mine facilities, ranch buildings and dust from vehicle traffic. The setting of the Pumpkin Buttes as they face the project area is nearly dominated by modern visual distractions.

As excerpted from *Pumpkin Buttes Visual Assessment* by Gary D. Long, Outdoor Recreation Planner for the Wyoming BLM State Office:

Roads and Trails: Roads were readily visible at distances up to five miles. Roads were most visible where located in darker, sagebrush-dominated landscapes. This was because of the contrast created by a light colored linear feature in a dark colored landscape that was devoid of similar natural linear features.

Coal Bed Natural Gas Development (CBM): While this could be seen, the structures associated with CBM are not readily seen at distances over one mile. What is seen are the roads and well site locations, particularly when cleared in sagebrush-dominated landscapes.

Reservoirs: Reservoirs were readily seen at distances equal to or exceeding two miles.

Power Lines: Several single pole power lines were noted. They could be seen but at distances exceeding a mile would not attract the attention of the casual observer.

A few proposed wells and accesses are within 2 and 1/2 miles of North Middle and South Middle Buttes. The project area can be viewed from all the Buttes. At distances over two miles, the frost boxes associated with CBM wells will be painted to blend into the background and will not be visible. All major access roads (crowned and ditched roads) associated with the project are already constructed and are visible from the Buttes. Construction of pipelines

and parallel two track roads accessing wells are over two miles away, will re-vegetate and will not be visible from the Buttes. There is very little sage in the project area (mostly grass) and the construction and reclamation of new accesses or pipelines will not create a vegetation contrast. There are not any reservoirs or other large production related facilities associated with the project. The majority of the power lines associated with the project will be buried.

Overhead lines associated with the project will be well over 2 miles from the buttes.

It does not appear that the construction of the Dry Willow II POD will add visual distractions to the setting of Pumpkin Buttes, especially considering the existing developments that attract the viewers' attention. Additionally, the setting of the buttes is nearly compromised by modern oil and gas related activities. Construction of the project will result in "no effect" to Pumpkin Buttes (48CA268)."

2.5 METEOROLOGY

2.5.1 General

The Nichols Ranch ISR Project area is located in Northeastern Wyoming, where climate is generally classified as semiarid and cool. The climate in this area is dry due to the effective barrier to moisture from the Pacific Ocean offered by the Cascades, Sierra Nevada, and the Rocky Mountains where the winds are from the West and Northwest. The topography in this portion of Wyoming tends to restrict the passage of storms and thereby restrict precipitation in the western portion of Wyoming (Martner 1986).

The nearest meteorological station to the Nichols Ranch ISR Project area is National Weather Service--Midwest 1SW weather station--which is located approximately 27 mi Southwest of the project area. This station was used to document temperature and precipitation near the Nichols Ranch ISR Project area. The nearest meteorological station measuring wind data is located at the Natrona County International Airport (NCIA) near Casper, Wyoming, approximately 60 air mi south-southwest of the project area.

2.5.2 Temperature

Based on weather data collected from 1971 to 2000 the annual average maximum temperature was 60.1°F and the annual average minimum temperature was 31.2°F (Curtis and Grimes 2004). On average, summer temperatures reached 90°F or above about 48 times per year, while winter temperatures fell to 0°F or below about 18 times per year (Martner 1986). On average, there were 100-125 frost-free days a year in the Nichols Ranch Project area, with the length of frost-free days decreasing with increasing elevation (Martner 1986).

2.5.3 Precipitation

During the 1971 to 2000 report period, the reporting weather station received an average of 13.67 inches of precipitation, the average maximum precipitation occurred during the month of May, and the average minimum precipitation occurs during the month of January (Curtis and Grimes 2004). In winter, the mean annual snowfall totals varied between 45 and 53 inches (Curtis and Grimes 2004). The average number of days with snowfall totals of 1 inch or more is 16 to 26 days for the area, with the highest average monthly snowfall occurring from February to April (Martner 1986).

2.5.4 Wind

As previously mentioned, the nearest meteorological station measuring wind data is located at the NCIA near Casper, Wyoming and both the NCIA and the Nichols Ranch ISR project area are located in rolling hill country east of the Continental Divide. The NCIA weather station is slightly higher than the Nichols Ranch ISR permit area. The NCIA is located at an elevation of 5,338 ft above mean sea level (AMSL) and topography of the Hank Unit ranges from 5,055 to 5,209 ft AMSL and 4,670 to 4,900 ft AMSL in the Nichols Ranch Unit. Wind data from the NCIA weather station are reasonably representative of the climate in the general area and are consequently used as the basis for the following discussion.

2.5.4.1 Wind Speed

In Figure 2-7, mean hourly wind speed by month for NCIA from 1961-1990 reveals that the weakest winds occur in the mornings and the strongest winds occur in early to mid-afternoon, although the time of year for these extremes to occur is different (Curtis and Grimes 2004).

2.5.4.2 Wind Speed Frequency

In Figure 2-8, the January wind roses for Casper from 1961-1990 are depicted and these data show prevailing (strongest) winds from the southwest. In addition, January is generally the windiest month for this location (Curtis and Grimes 2004).

2.5.4.3 Wind Direction

Figure 2-9 illustrates the wind directions by hour and month at the NCIA (1950-1990). Although different sample averaging and periods are used, the effects of topography (mountain-valley) winds are suggested. For the NCIA, during the spring and summer, early evening winds are generally out of the south-southeast while, during the day, the winds are out of the south-southwest (Curtis and Grimes 2004).

2.5.4.4 Wind Direction Frequency

In Figure 2-10, the wind direction frequency by month for the NCIA from 1961-1990 shows the maximum frequency is 230 degrees (southwest) and the maximum frequencies occur in December (Curtis and Grimes 2004).

2.5.5 Lake Evaporation and Evapotransportation

Average annual lake evaporation for the project area is estimated to be 45 inches, and annual potential evapotranspiration is estimated to be 23 to 24 inches (Martner 1986).

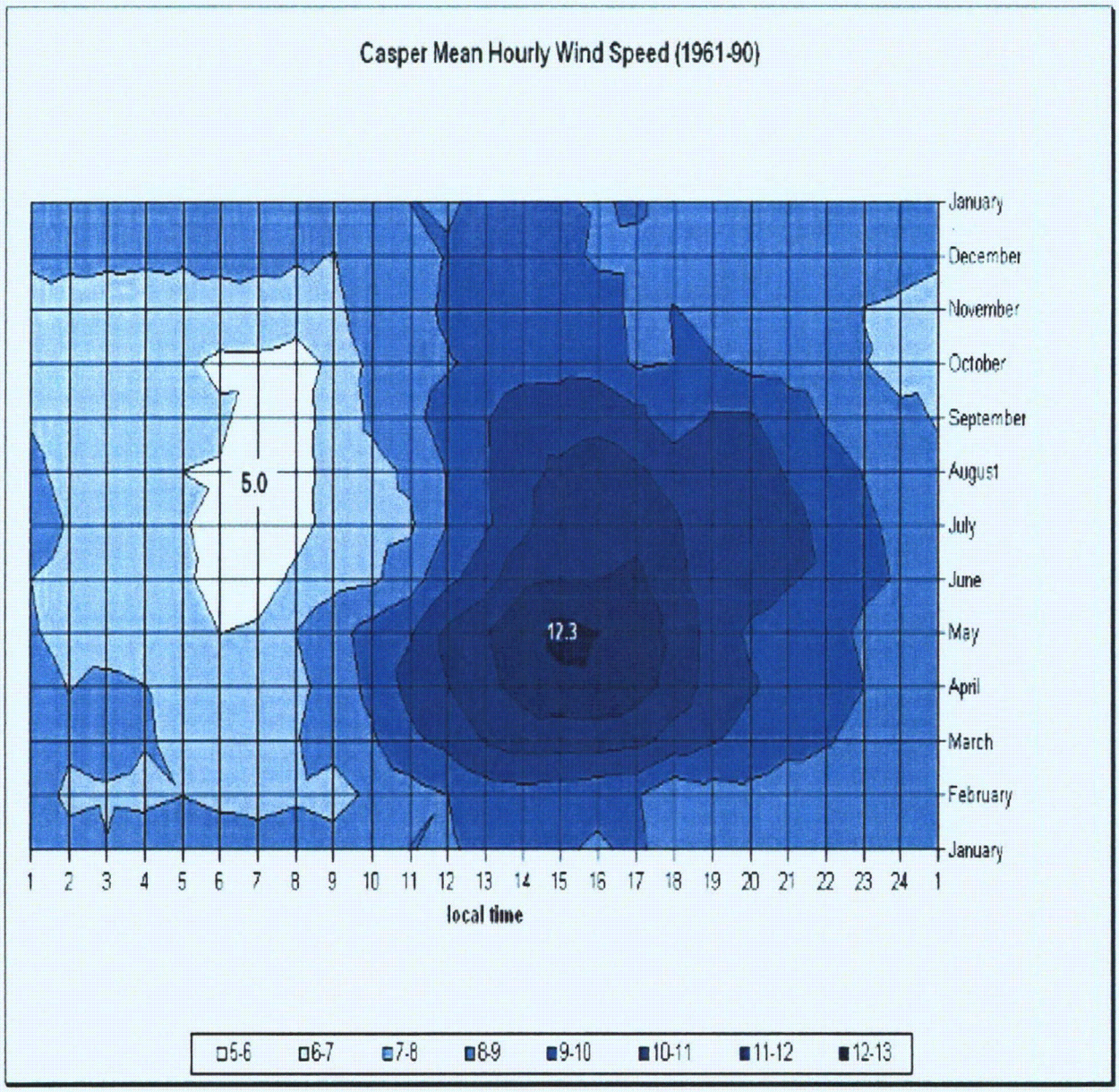


Figure 2-7 Mean Hourly Wind Speed (mph) Based Upon Observations Taken Between 1961 and 1990 at the NCIA. Extreme Annual Values are Depicted.

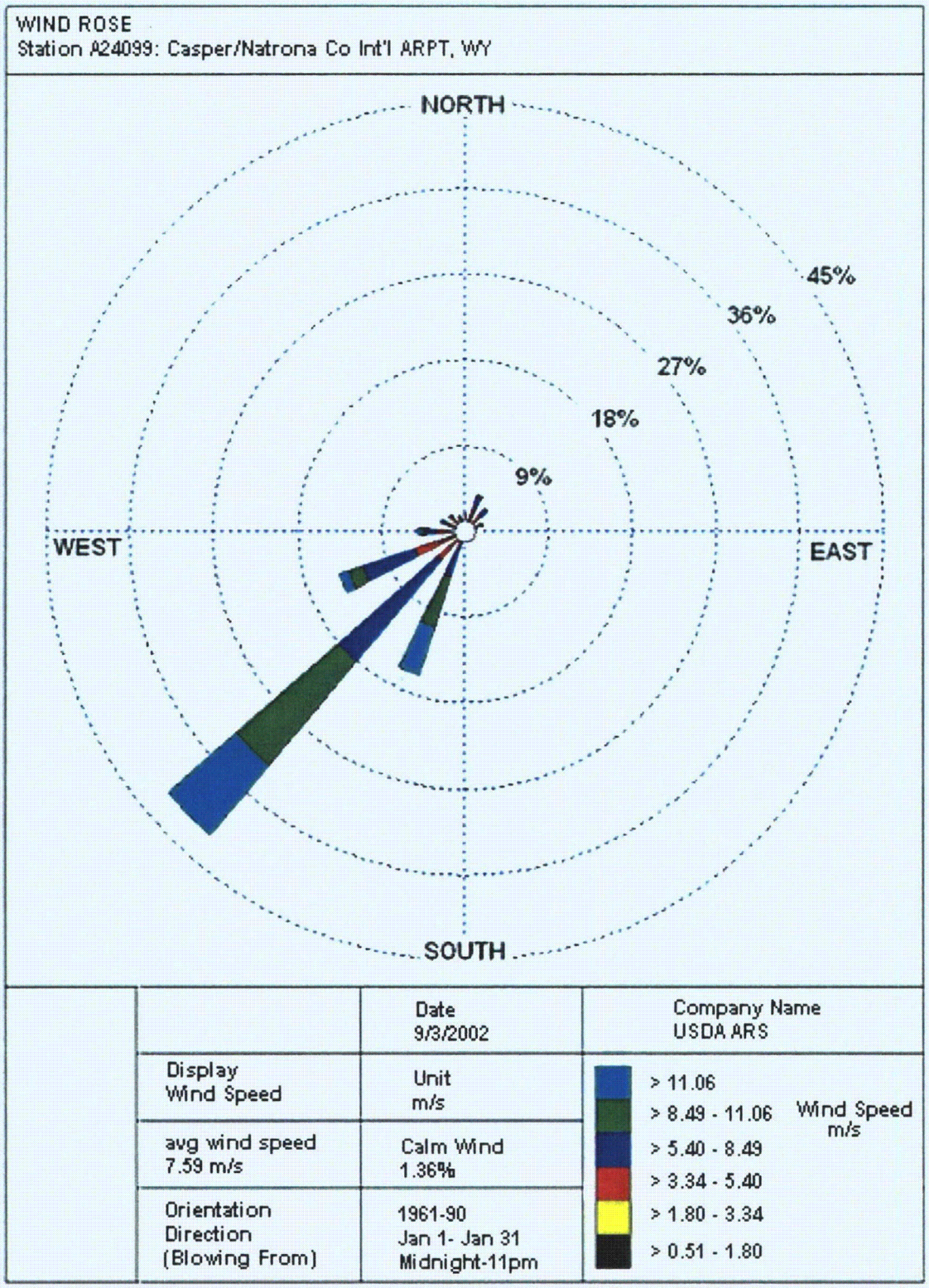


Figure 2-8 January Wind Rose Based Upon Observations Taken Between 1961-90 at the NCIA.

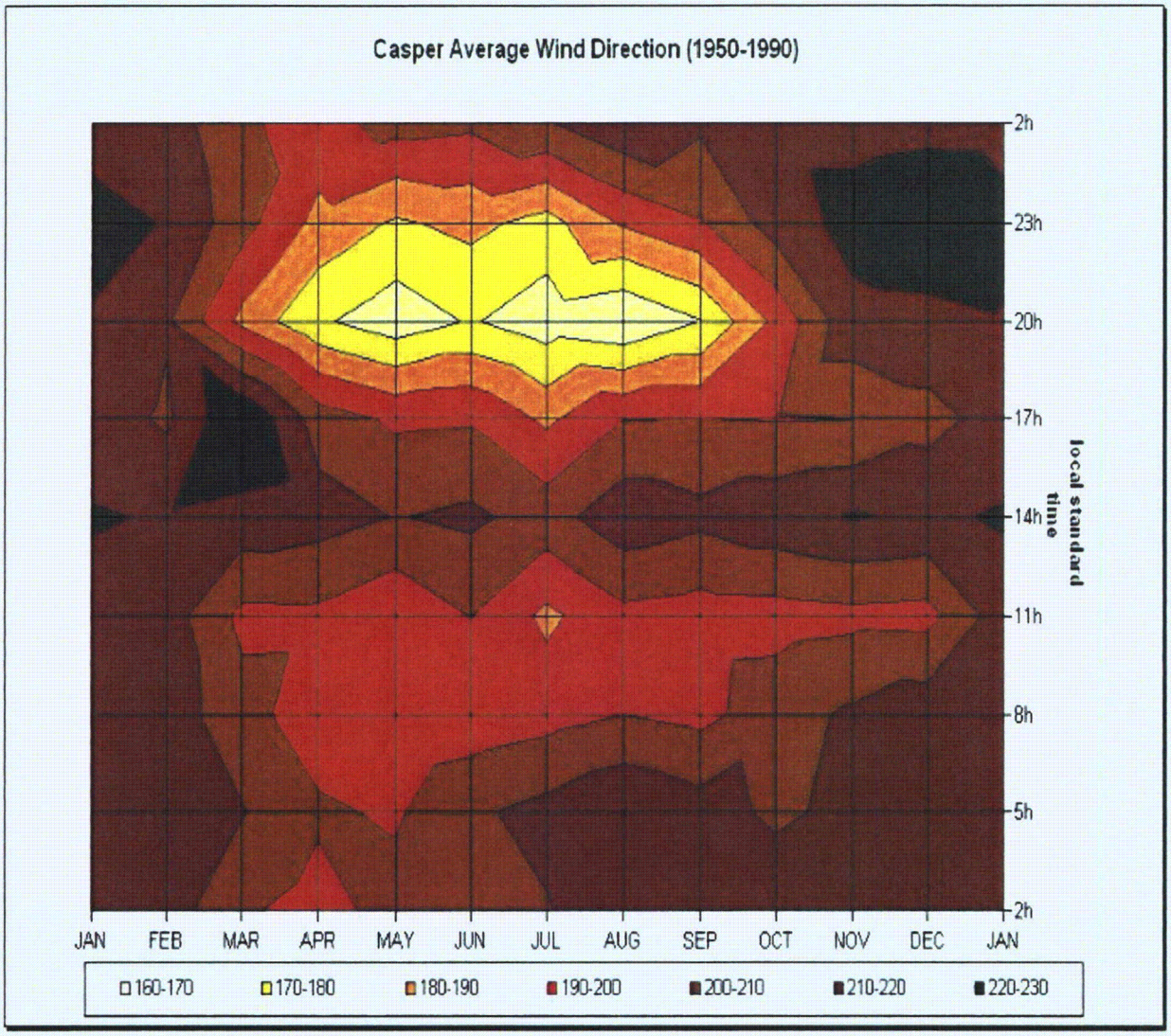


Figure 2-9 3-Hour Average Wind Direction by Month at the NCIA (1950-1990).

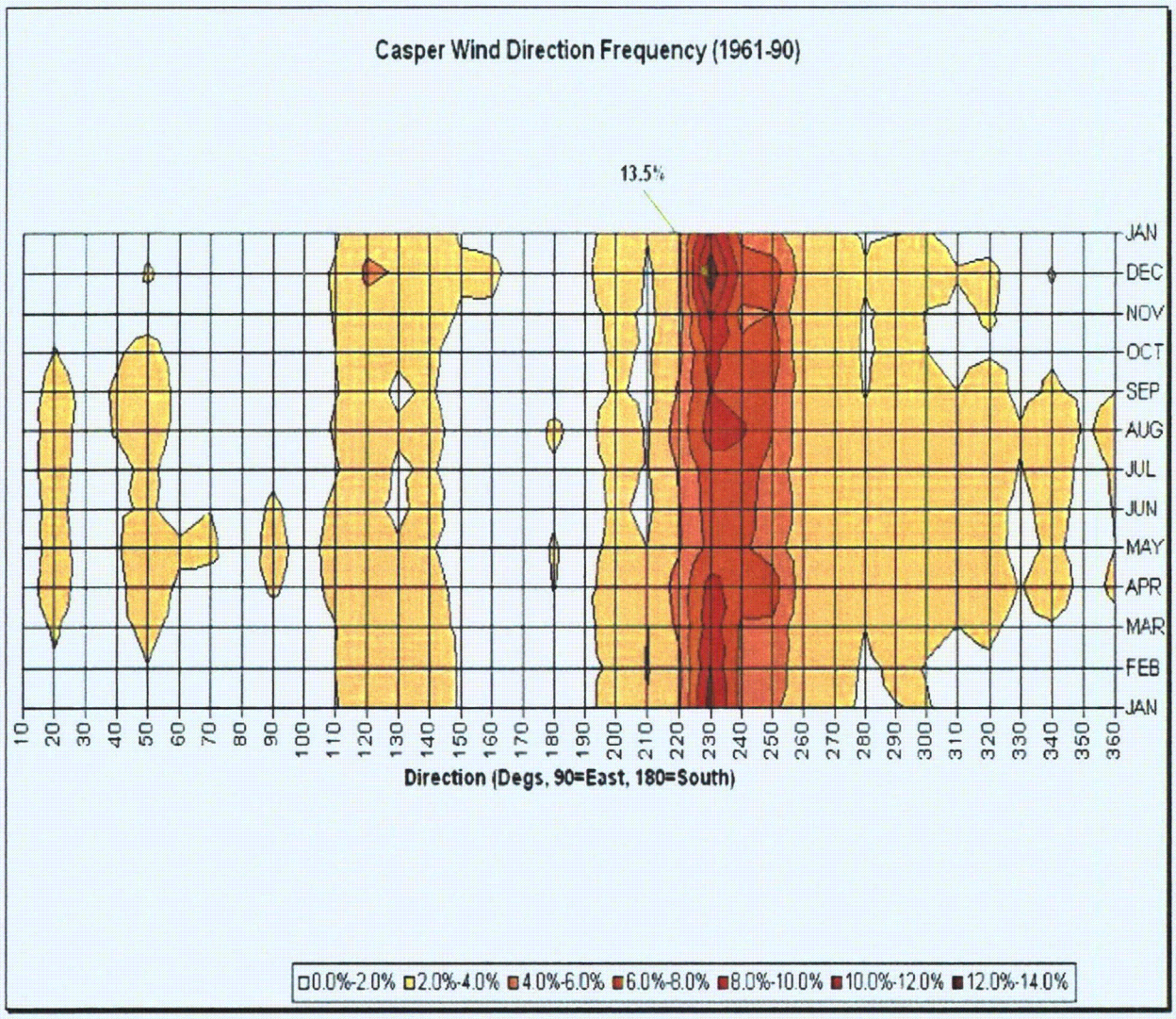


Figure 2-10 Wind Direction Frequency Based Upon Hourly Observations Taken Between 1961 and 1990 at the NCIA. The Maximum Annual Frequency is Depicted.

2.5.6 Air Quality

2.5.6.1 General

There is no known air quality permits required for the Nichols Ranch ISR Project area, and there are no known air quality permits near the project area. A meeting between Uranerz Energy Corporation and the Wyoming Department of Land Quality – Air Quality Division (WDEQ-AQD) was held to discuss the potential air quality permits that may be required for the Nichols Ranch ISR Project. After discussing the Nichols Ranch ISR Project, Uranerz Energy Corporation agreed to submit an emission inventory to the WDEQ-AQD in order to establish if any air quality permits are needed. Because of the minimal amount of emissions produced by the plant operations and the minimal surface disturbance and vehicular traffic associated with the operation Uranerz Energy Corporation believes that no air quality permits will be required. If any air quality permits are required by the WDEQ-AQD, then these permits will be obtained prior to beginning any construction activities for the Nichols Ranch ISR Project.

2.5.6.2 Impacts

Impacts on air quality associated with the operations of the Nichols Ranch ISR Project will be very minimal. Access to the project area will be via 8.5 mi of Campbell County maintained gravel road, then 8.5 mi of gravel ranch roads if accessing the project area from Wyoming Highway 50, or approximately 22.3 mi of gravel ranch roads if accessing the property from U.S. Highway 387. Both the county and ranch roads are currently used by numerous oil/gas and coal bed methane companies that are active in the region. These roads have been developed and range from 18 to 24 ft wide crowned-and-ditch roads. The closest residence to the access route is the Pfister Ranch located approximately less than a 0.25 mi to the west of the route and approximately 0.6 mi to the North of the Hank Unit. With the prevailing wind direction out of the southwest, dust produced by the mining operations and vehicular traffic will generally be blown to the northeast which should not affect ranching operations.

Particulate emissions associated with the Nichols Ranch ISR Project will also be minimal. Of the 3,370.53 acres within the project area, only approximately 300 acres or less of lands will be disturbed with stripping of topsoil occurring approximately 100 acres or less. In order to reduce particulate emissions in the wellfield by drilling equipment and wellfield maintenance vehicles, access roads will be maintained via motorized patrol. Natural vegetation will also be left un-disturbed whenever possible to prevent wind erosion.

Vehicle traffic entering the Nichols Ranch ISR Project is estimated at eight passenger vehicles per day per week along with six tractor trailers per week. Fugitive dust emissions from this traffic are estimated at approximately 135.9 tons per year using the longer of the two access routes as a basis for the fugitive dust calculations. Wellfield fugitive dust emissions were not considered in calculating the overall fugitive dust emissions since the wellfield is not considered a major source of emissions. Estimated fugitive dust emissions during construction of the facilities of the Nichols Ranch ISR Project were also not included in the fugitive dust emission calculation since the amount of vehicular activity that will be taking place during the construction will be similar to the traffic of the actual operation. Figure 2-11 outlines the methods used to calculate the fugitive dust emissions.

From the above calculations, it is estimated that an emission rate of 135.9 tons per year can be expected for the Nichols Ranch ISR Project. As this is below the 250 tons per year threshold for PSD review, an analysis to determine air quality impact is considered unnecessary.

All other emissions from the Nichols Ranch ISR Project are minimal. Table 2-5 details the other potential operation emissions and their potential emission quantity.

Assumptions:

1. For the purpose of calculating fugitive dust emissions, the well field was not considered a significant emitting source.

2. Estimated daily vehicle traffic includes eight passenger/truck vehicles entering the Nichols Ranch ISR Project. Approximately six tractor trailers will also travel to the permit area per week.

3. Estimated disturbance within the 3370.53 acre Nichols Ranch ISR Project permit area is 300 acres or less.

4. All fugitive dust calculations were based on EPA AP-42 Chapter 13.2.2.

5. Calculation Data Givens:
   Wyoming Unpaved Road Surface Material Surface Silt Content = 4.2% (Source AP-42)
   Access road vehicle speed = 30 mph
   Access road length = 15 mi

Calculations:

<u>Access Road Vehicle Miles per Day</u>

$$\frac{8\ vehicles}{day} \times 15\ miles = \frac{120\ miles}{day}$$

$$\frac{0.86\ semi's}{day} \times 15\ miles = \frac{12.9\ miles}{day}$$

<u>Vehicle Miles per Year</u>

$$Passenger\ \ Vehicles \Rightarrow \frac{120\ miles}{day} \times \frac{7\ days}{week} \times \frac{52\ weeks}{year} = \frac{43{,}680\ miles}{year}$$

$$Semi's \Rightarrow \frac{12.9\ miles}{day} \times \frac{7\ days}{week} \times \frac{52\ weeks}{year} = \frac{4{,}695.6\ miles}{year}$$

Figure 2-11 Fugitive Dust Calculations (1 of 3).

Emissions for Unpaved Roads

$$E = \frac{\left[k \left(\frac{s}{12} \right)^{a} \left(\frac{S}{30} \right)^{b} \right]}{\left(\frac{M}{0.5} \right)^{c}} - C$$

Where:

E = size specific emission factor (lbs/vehicle mile traveled)
s = surface material silt content (%) from AP 42 Tables
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
C = emission factor from AP 42 Tables

For PM-10:

k, a, b, and c are constants derived from AP 42 13.2.2
k = 1.5
a = 0.9
b = 0.45
c = N/A or 1

Correcting For Natural Mitigation:

$$E = \left[\frac{\left[k \left(\frac{s}{12} \right)^{a} \left(\frac{S}{30} \right)^{b} \right]}{\left(\frac{M}{0.5} \right)^{c}} - C \right] \left[\frac{(365 - P)}{365} \right]$$

Where: P = number of days in a year with at least 0.01 inches of precipitation from AP 42 charts

Figure 2-11 Fugitive Dust Calculations (2 of 3).

Therefore, using the following inputs:

s = 4.2
a = 0.9
b = 0.45
c = 1
S = 30 mph
M = 0.5
C = 0.0047
P = 100

E = 0.420 lbs/vehicle miles traveled

Total Fugitive Dust Emissions

Total Vehicle Miles Traveled Per Year = 47,375.6 mi per vehicle

9 vehicles total, so

$$\left(9 \text{ vehicles}\right) \times \left(47375.6 \text{ miles per year}\right) \times \left(0.42 \text{ lbs per VMT}\right) = 179{,}079.8 \text{ lbs per year or } 89.5 \text{ tons per year}$$

This is below the 250 tons per year standard established for PSD.

From the above calculations, it is estimated that an emission rate of 135.9 tons per year can be expected for the Nichols Ranch ISR Project. As this is below the 250 tons per year threshold for PSD review, an analysis to determine air quality impact is considered unnecessary.

Figure 2-11 Fugitive Dust Calculations (3 of 3).

Table 2-7 Emissions Inventory.

Emission	Estimated Emission (tons/yr)
CO_2	353.70
HCL	0.017
H_2O_2	0.003
NaOH	0.0003
Fugitive Dust	135.9

2.6 GEOLOGY AND SEISMOLOGY

2.6.1 Regional Geology

The Nichols Ranch ISR Project is located in the Powder River Basin (PRB) which 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 PRB is an asymmetrical syncline with its axis closely paralleling the western basin margin. During sedimentary deposition, the structural axis (the line of greatest material accumulation) shifted westward resulting in the basin's asymmetrical shape. On the eastern flank of the PRB, 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 with the dip increasing as distance increases westward from the axis. The Nichols Ranch ISR Project site location within the PRB is shown in Figure 2-12 (see map pocket), Structural Map of Wyoming.

The PRB hosts a sedimentary rock sequence that has a maximum thickness of about 15,000 ft 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. Geologically, the PRB is a closed depression in what was, for a long geologic time period, 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 uplift on its margins. By late Tertiary- Paleocene time, marked uplift of inland masses surrounding the Powder River Basin resulted in accelerated subsidence in the southern portion of the basin with thick sequences of arkosic (containing feldspar) 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. Near the end of Eocene time, northward tilting and deep weathering with minor erosion took place in the basin. Subsidence resumed in the late Oligocene and continued through the Miocene and into the 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 PRB began with the Pliocene uplift and continues to the present.

Of particular interest in the project area are the Tertiary-age formations:

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

The White River Formation is the youngest Tertiary unit that still exists in the PRB. Locally, its only known remnants are found on top of the Pumpkin Buttes. Elsewhere the unit consists of thick sequences of buff colored tuffaceous sediments interspersed with lenses of fine sand and siltstone. A basal conglomerate forms the resistant cap rock on top of the buttes. This formation is not known to contain significant uranium resources in this area.

The Wasatch Formation consists of interbedded mudstones, carbonaceous shales, silty sandstones, and relatively clean sandstones. In the vicinity of the Pumpkin Buttes, the Wasatch Formation is known to be 1,575 ft thick (Sharp and Gibbons, 1964). The interbedded mudstones, 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 mudstones to fissile shales. The Wasatch contains significant uranium resources and hosts the ore bodies for which this application is subject to.

The Fort Union Formation in the PRB is lithologically similar to the Wasatch Formation. The Fort Union includes interbedded silty claystones, sandy siltstones, relatively clean sandstones, claystones, and coal. The degree of lithification is quite variable, ranging from virtually un-cemented sands to moderately well cemented siltstones and sandstones. The total thickness of the Fort Union in this area is approximately 3,000 ft. The Fort Union contains significant uranium mineralization at various locations in the basin. The Fort Union is also the target formation for Coal Bed Methane (CBM) extraction activities. CBM target depths in the Nichols Ranch Unit are about 1,000 ft and 1,200 ft at the Hank Unit. A minimum of 300 ft of primarily mudstones and impermeable shales interspersed with fine-grained sands and siltstones separate the proposed uranium mining from CBM production horizons at both Nichols Ranch and Hank. Since CBM wells have their casings cemented to the surface, no interference, water loss, or water invasion is anticipated.

2.6.2 Site Geology

The Nichols Ranch Unit site is located in the Eocene Wasatch Formation about eight miles west of the South Pumpkin Butte and straddles the Johnson and Campbell County lines. The mineralized sand horizons are in the lower part of the Wasatch, at an approximate average depth of 550 ft. The host sands are primarily arkosic in composition, friable, and contain trace amounts of carbonaceous material and organic debris. There are locally sandy mudstone/siltstone intervals within the sands and the sands may thicken or thin to the point of removal in some areas.

The Hank Unit site is also located in the Eocene Wasatch Formation about five miles east-northeast of the Nichols Ranch Unit central processing plant in Campbell County. The mineralized sand horizons are in the lower part of the Wasatch, at an approximate average depth of 365 ft. The host sands are similar in composition and material make-up to those found at Nichols Ranch.

There are three primary Wasatch Formation sand members in the Nichols Ranch Unit and one minor sand unit. The sand members have been identified as F, B, and A Sands and the 1 (one) Sand unit. The F Sand member is the shallowest and the 1 Sand unit is the deepest. The principle uranium ore zone sand member is the A Sand and is 60 to 100 ft thick. Within the Nichols Ranch Unit, all the sands have separating aquicludes.

There are four primary Wasatch Formation sand members at the Hank Unit and two minor sand units. The sand members have been identified as F, C, B, and A Sands and the G and H Sand units. The H Sand unit is the shallowest and the A Sand member is the deepest. The principle uranium ore zone sand member at Hank is the F Sand and it is 75 ft thick. Within the Hank Unit, all the sands have separating aquicludes.

The Nichols Ranch Unit A Sand ore zone is bounded above and below by impermeable layers. The upper and lower aquicludes are composed of shales or mudstones, silty shales and shaley lignite horizons. The B Sand has been designated the overlaying aquifer and the 1 Sand the underlying aquifer.

The Hank Unit F Sand ore zone is bounded above and below by impermeable layers. The upper and lower aquicludes are composed of shales or mudstones, silty shales and shaley lignite horizons. The G Sand has been designated the overlaying aquifer and the C or B Sand the underlying aquifer.

The ore zones at the Nichols Ranch and Hank Units are typical Powder River Basin roll front deposits. Uranium ore, where present, is found at the interface of a naturally occurring chemical boundary between reduced and oxidized sandstone facies. Due to the nature of fluvial sandstone

deposition, an individual sand member may have several vertically superimposed subsidiary roll fronts. This is due to small differences in sandstone permeability or the occasional vertical contact between sand members resulting in development of multiple roll fronts which overlay each other in complex patterns.

The Nichols Ranch and Hank Unit ore zones have uranium mineralization composed of amorphous uranium oxide, sooty pitchblende, and coffinite. The uranium is deposited upon individual detrital sand grains and within authigenic clays in the void spaces. The host sandstones are composed of quartz, feldspar, accessory biotite and muscovite mica, and locally occurring carbon fragments. Grain size ranges from very fine-grained sand to conglomerate. The sandstones are weakly to moderately cemented and friable. Pyrite and calcite are associated with the sands in the reduced facies. Hematite or limonite stain from pyrite, are common oxidation products in the oxidized facies. Montmorillonite and kaolinite clays from oxidized feldspars are also present in the oxidized facies. Figure 2-13 (see map pocket) details a typical stratigraphic column of the Nichols Ranch ISR Project area.

2.6.3 Seismology

The area of central Wyoming where the Nichols Ranch ISR Project site is located lies in a relatively minor seismic region of the United States. Although distant earthquakes (such as the western Wyoming area) may produce shocks strong enough to be felt in the Powder River Basin, the region is ranked as a one (1) seismic risk as shown in Figure 2-14 (see map pocket). 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 mi in depth, and normal faulting. Part of this seismic belt extends along the Wyoming-Idaho border, more than 350 km (approximately 200 mi) west of the Nichols Ranch ISR Project area. More detailed information can be found in the reports "Basic Seismological Characterization for Campbell County, Wyoming and Basic Seismological Characterization for Johnson County, Wyoming" by the Wyoming State Geological Survey, which is contained in Addendum 2D.

Table 2-8 lists the largest recorded earthquakes (greater than 4.0 magnitude on the Richter Scale) that have occurred within 200 km (120 mi) of the Nichols Ranch ISR Project sites and gives the maximum ground acceleration that could be realized at the site as a result of these disturbances from the period 1873 through 2006 (Sources – Wyoming State Geological Survey, 2002 and USGS, 2007). The earthquake of highest intensity recorded during that time interval was the Casper, Wyoming earthquake of 1897. This earthquake has been assigned a probable maximum Mercalli shaking intensity of VI -VII (5.7 on the Richter scale) based on accounts of damage incurred.

No surface faulting or fault traces in the project area has been reported, nor is any faulting evident from geophysical log interpretations. Based on historic data, the ground accelerations reported in Table 2-8 (.01g to .04g) are not considered to be of a magnitude that would disturb the operations or facilities in the event that an earthquake occurred.

Table 2-8 Maximum Expected Earthquakes Intensities and Ground Accelerations at the Nichols Ranch ISR Project Site.

Earthquake Location and Year	Epicenter Intensity (Mercalli)	Magnitude (Richter)	Distance From Nichols Ranch ISR Project	Ground Acceleration at Nichols Ranch ISR Project
Casper (1894)	V	4.5	65	0.01g
Casper (1897)	VI-VII	5.7	64	0.04g
Kaycee (1965)	V	4.7	30	0.02g
Pine Tree Jct. (1967)	V	4.8	10	0.04g
West of Gillette (1976)	IV-V	4.3	38	0.02g
SW of Gillette (1976)	V	4.8	18	0.03g
Bar Nunn (1978)	V	4.6	56	0.01g
West of Kaycee (1983)	V	4.8	65	0.01g
West of Gillette (1984)	V	5.1	30	0.03g
West of Gillette (1984)	V	5	28	0.03g
Laramie Mtns (1984)	VI	5.5	95	0.01g
Mayoworth (1992)	V-VI	5.2	52	0.02g
W Convers Co. (1996)	IV-V	4.2	54	0.01g

2.7 HYDROLOGY

2.7.1 Surface Water

The addendums referenced in this section are presented in the attached Appendix D6 Hydrology text.

2.7.1.1 Drainage Basin Description

The Nichols Ranch ISR Project areas exist in the Cottonwood and Willow Creek drainage areas. The Nichols Ranch Unit is located in the Cottonwood Creek drainage while the Hank Unit is located in the Willow Creek drainage.

The Nichols Ranch Unit is located near the confluence of the Cottonwood Creek drainage with the Dry Fork of the Powder River. Figure 2-15 (see map pocket) shows the Cottonwood drainage area. The majority of the Nichols Unit drains directly to Cottonwood Creek while a portion of the northern part of the area drains to Tex Draw which is a tributary to the Dry Fork of the Powder River. Cottonwood Creek is a tributary to the Dry Fork of the Powder River and its confluence is located approximately 0.5 mi downstream of the project area. Tex Draw also enters the Dry Fork of the Powder River approximately 2.0 mi downstream of the project area.

Area of the Cottonwood Creek drainage basin is 80.2 sq mi. Dry Fork of the Powder River is a tributary to Powder River which is a tributary to the Yellowstone River, which is a part of the Missouri River drainage basin. Land surface elevation in Cottonwood Creek drainage varies from 5,974 to 4,590 ft-msl at the mouth. The channel elevation varies from 4,622 to 4,660 ft-msl in the project area. Cottonwood Creek channel is flat at a gradient of approximately 0.003 ft/ft.

The Tex Draw drainage area is 5.2 sq mi and its elevation varies from a peak of 5,085 to an elevation of 4,540 ft-msl at its confluence with the Dry Fork of the Powder River. None of the Tex Draw channel exists within the Nichols Ranch Unit area but the northwestern portion of the

project area drains to Tex Draw. Tex Draw has a much steeper gradient due to being a smaller ephemeral channel and has an approximate gradient of 0.01 ft/ft just north of the project area.

The Hank Unit is located in the Dry Willow and Willow Creek drainages. Dry Willow is a tributary to Willow Creek which is a tributary of the Powder River. Dry Willow and a portion of Willow Creek drainage upstream of the Dry Willow confluence are shown in Figure 2-15 (see map pocket). The Hank Unit is roughly 16 mi upstream of the confluence of Willow Creek and the Powder River. Willow Creek is oriented in a westerly direction through the northern end of the unit.

The area of the Willow Creek drainage basin above the Dry Willow Creek confluence is approximately 13.2 sq mi. Elevation in the Willow Creek drainage varies from 6,052 to 4,795 ft--msl at the confluence of Dry Willow Creek. The short reach of the Willow Creek channel within the unit boundary, ranges in elevation from 5,015 to 5,040 ft-msl. The gradient of the stream channel within the Hank Unit is about 0.008 ft/ft, and the active stream channel width varies from a few feet to several tens of feet.

The drainage area of Dry Willow Creek is 12.2 sq mi. The maximum elevation in this drainage basin is 6,018 ft and the elevation at the confluence is 4,795 ft. The elevation of the channel in the Hank Unit area of Dry Willow Creek varies from 4,995 ft to 5,085 ft-msl. The stream channel in this area has a gradient slightly greater than 0.01 ft/ft.

2.7.1.2 Surface-Water Flow

Dry Willow, Willow and Cottonwood Creeks and Tex Draw are classified as ephemeral streams in the project area. Stream flows only occur in response to heavy snow melt and to large rainstorms. Runoff flows are typically intermittent in the spring and early summer and the stream channels are dry the remainder of the year except during major thunderstorms in the area.

The estimated peak flows for various recurrence intervals for Cottonwood, Tex, Dry Willow and Willow Creek drainages are presented in Table 2-9. The technique that was used to estimate the peak flows is presented in Lowham (1976).

Table 2-9 Surface Drainage Properties, Estimated Peak Flows, and Velocities.

SITE	DRAINAGE AREA (sq. mi)	ESTIMATED PEAK FLOWS (CFS) RECURRENCE INTERVAL (YRS)					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Cottonwood Creek	80.2	454	1220	2150	3760	5420	7500
Tex Draw	5.2	170	456	782	1370	1970	2720
Dry Willow Creek	12.2	231	620	1070	1870	2700	3730
Willow Creek	13.2	237	638	1100	1930	2780	3840

10-YEAR VELOCITIES

Channel Station (ft)	Base Width (ft)	Side Slope (?H:1V)	Bottom Slope (ft/ft)	Discharge (cfs)	Normal Flow Depth (ft)	Flow Area (ft^2)
CTW CRK	100	2	0.0030	2150	3.425	366.0
Tex DRW	10	2	0.0100	782	4.314	80.3
DRY WIL	20	2	0.0100	1070	3.853	106.7
WIL CRK	20	2	0.0080	1100	4.158	117.7

Channel Station (ft)	Wetted Perimeter (ft)	Hydraulic Radius (ft)	Flow Velocity (fps)	Top Width (ft)	Froude Number	Average Unit Discharge (cfs/ft)
CTW CRK	115.32	3.17	5.87	113.70	0.58	20.12
Tex DRW	29.29	2.74	9.73	27.25	1.00	41.98
DRY WIL	37.23	2.87	10.02	35.41	1.02	38.62
WIL CRK	38.59	3.05	9.34	36.63	0.92	38.85

The predicted peak flows in Table 2-9 vary from 454 cubic ft per second (cfs) for a two-year recurrence interval to 7,500 cfs for a hundred year recurrence interval for Cottonwood Creek drainage. The peak flows for Tex Draw vary from 170 to 2,720 cfs for the two and 100 year recurrence intervals.

The predicted peak flows for the Dry Willow Creek and Willow Creek above Dry Willow Creek vary from a low of 231 cfs for the two year recurrence interval for Dry Willow up to a peak of 3,840 for the 100 year recurrence interval. The estimates for Dry Willow and Willow Creak are very similar due to similarity in drainage area.

The flow velocities for the 10-year peak discharges are calculated to present an estimate of the channel velocities during a significant runoff event. The bottom half of Table 2-19 presents the calculation of the flow velocities based on typical channel slope and the 10-yr peak discharge. The 10-year peak discharge was selected as representing a reasonable design period for the life of this operation. These 10-year peaks are calculated for the confluence of the drainages and therefore are a very conservative representation of the peak at the project location. The peak velocities for Cottonwood Creek are smaller due to the wide flood plane and the milder channel slope. Cottonwood Creek does have an incised pilot channel which has been dammed and, therefore, runoff flow during any significant event will be spread over a very significant width of the flood plane. The velocities in Tex Draw, Dry Willow and Willow Creek will be much greater due to the steeper channel slope and are near 10 ft/sec.

2.7.1.3 Surface-Water Quality

The surface water quality from the Cottonwood, Tex, Dry Willow and Willow Creek drainages is generally very good in the upper channel reaches of these areas. A typical TDS is 200 mg/l. Water quality generally deteriorates as the surface water flows further down stream and is in contact with the streambed for longer periods of time.

The U. S. Geological Survey has monitored the Dead Horse Creek drainage which is approximately 30 mi north of the confluence of the Dry Fork with the Powder River and roughly

20 mi north of the confluence of Willow Creek with the Powder River. Dead Horse Creek drainage area is 151 square mi, which is significantly greater than the local drainages of the mining area. Limited water quality data from this gauging station shows that ion concentrations are significant with conductivity of greater than 2,000 umhos/cm.

Table D6A.1-1 in Addendum D6A in Appendix D6 presents water quality data available from surface water samples within the drainages in the project. The Dry Willow Reservoir which is upstream of the Hank Unit had a TDS of 174 mg/l. The Brown Water Pond also had a very low TDS due to the pond proximity to the drainage divide. This pond captures water after it has moved only a relatively short distance. The Dry Willow Reservoir and Brown Water Pond were dry in September of 2007. Additional samples on Dry Willow Creek and Cottonwood Creek show that the TDS can exceed 2,000 mg/l in the surface runoff. Surface runoff water quality is generally dominated by bicarbonate concentrates but increase concentrations of calcium and sulfate are observed with increasing exposure time in channels.

2.7.2 Groundwater Hydrology

2.7.2.1 Geologic Setting and Well Construction

The Nichols Ranch ISR Project is located in the outcrop of the Wasatch Formation. The stratigraphy of the Wasatch at this site consists of alternating layers of sand and shale with lignite marker beds. The mineable ore exists in two sand members, designated as the A Sand at the Nichols Ranch Unit and F Sand at the Hank Unit. These two sand members are typically separated by the B and C Sands and adjacent aquitards.

The aquifer and aquitard sequence at the project area is shown in Figure 2-16 (see map pocket). This shows labeled sands from the 1, A, B, C, F, G, and H Sands. This figure also shows the aquitards that exist between the different sands and those aquitards are labeled as by the combination of labels for the two adjacent sands. These sands are the same names that are used at Power Resources North Butte permit which exists just north of the Hank Unit site.

The majority of the wells completed in the Nichols Ranch Unit are completed in the A Sand because this is the ore bearing sand in this area. Figure 2-17 (see map pocket) shows the locations of the Nichols Ranch Unit wells and Exhibit D6-1 in Appendix D6 shows the locations of wells within three miles of the Nichols Ranch Unit. Table 2-10 presents the tabulation of the well data for the Nichols Unit wells. This table shows that eleven of the wells have been completed in the A Sand with one well completed in each of the 1, B and C sands while two wells have been completed in the F Sand and one well in the Cottonwood alluvium. Wells MN-1, MN-2, URZNB-1 and URZN1-2 are completed as open-hole completions while the remaining have well screens in their completion interval.

Table 2-11 presents the basic well data for the Hank Unit wells while Figure 2-18 (see map pocket) shows the location of the Hank Unit wells. Exhibit D6-2 (see map pocket) in Appendix D6 shows the locations of wells within 3.0 mi of the Hank Unit. Eleven of these wells are completed in the F Sand because this is the ore bearing sand in this area. Four of the wells are completed in the overlying G Sand while one of the wells is completed in the underlying C Sand. In areas where the C Sand does not exist, the B Sand is the underlying aquifer and seven of the wells in this area are completed in the B Sand. Additionally, four existing stock wells are completed across a combination of the sands.

2.7.2.2 Summary of Aquifer and Aquitard Properties

Numerous single-well pump tests and multi-well pump tests were conducted at the Nichols Ranch and Hank Units to define the aquifer properties. The detailed hydrologic analyses and supporting data are contained in Addendums D6B and D6C in Appendix D6 for Nichols Ranch Unit and Hank Unit respectively. Three multi-well pump tests were conducted at the Nichols Unit site and are referred to in this report as the MN-1, MN-2 and MN-6 tests. Three multi-well tests were performed at the Hank Unit site. These tests are referred to as the URZHF-1, URZHF-5 and SS1F tests. Tables 2-10 and 2-11 present the basic well data for wells used to define the aquifer properties for the Nichols Ranch and Hank Units respectively. Addendum D6J presents the aquifer test theory used to analyze the pump tests.

Table 2-10 Basic Well Data for Nichols Ranch Unit Wells.

Sample Point	North Coordinate	East Coordinate	MP Elevation (ft-msl)	Casing Diameter (in)	Stick-up Above LSD	Well Depth (ft-mp)	Date	Depth (ft-mp)	Elevation (ft-msl)	Screen Interval (ft-lsd)	Aquifer
20-9	1102911	275410	4664.08	5.00	0.9	740	---	---	---	495 - 615	A
	1102911	275410	4664.08	5.00	0.9	740	---	---	---	635 - 655	A
CALVING #1	1100015	289109	4824	5.00	1.6	560	---	---	---	390 - 420	A
	1100015	289109	4824	5.00	1.6	560	---	---	---	440 - 500	A
Dry Fork #3	1100675	273123	4720		---	360	---	---	---	-	C
DW-4L	1112331	276856	4969.73	5.00	0.4	795	12/20/2006	311.48	4658.25	726 - 795	A
DW-4M	1112331	276769	4970.17	5.00	0.3	441	10/4/2007	286.14	4684.03	389 - 441	C
DW-4U	1111406	276812	4966.75	5.00	0.3	310	10/4/2007	230.24	4736.51	256 - 309	F
GARDEN	---	---	---		---	---	---	---	---	-	A
MN-1	1105710	273118	4715.14	4.50	1.3	556	10/4/2007	49.83	4665.31	479 - 556	A
MN-2	1108147	273844	4771	4.50	0.7	670	10/4/2007	179	4592	560 - 670	A
MN-3	1106960	275167	4764.64	4.50	0.7	585	10/4/2007	96.65	4667.99	479 - 585	A
MN-4	1109835	272220	4800.36	4.50	2.2	623	10/4/2007	146.75	4653.61	520 - 623	A
MN-5	1108755	272120	4883.28	4.50	2.3	727	10/4/2007	228.1	4655.18	628 - 727	A
MN-6	1107478	272220	4761.18	4.50	2.2	593	10/4/2007	103.85	4657.33	485 - 593	A
N1, 11894	1102532	269925	4622.33	2.00	0	310	---	---	---	191 - 310	F
Nichols #1	1107430	272265	4758.88	5.00	1.2	620	10/4/2007	101.25	4657.63	550 - 565	A
Pats #1	1102872	279812	4690		---	405	---	---	---	375 - 405	B
Pug #1	1102383	275338	4685		---	370	---	---	---	340 - 370	C
Red Spring A#1	1111694	269021	4710	6.00	2.9	740	---	---	---	-	A
URZN1-2	1105691	273081	4714.31	4.50	1.1	645	10/4/2007	63.78	4650.53	600 - 645	1
URZNB-1	1105725	273149	4716.36	4.50	1.3	375	10/4/2007	62.14	4654.22	330 - 375	B
URZNF-3	1105992	273707	4728.87	4.00	2.3	173	10/4/2007	89.2	4639.67	153 - 173	F
URZNQ-4	1103219	272397	4638.44	4.00	1.5	35	10/4/2007	9.33	4629.11	15 - 35	ALL
W. of WW1	1116674	286130	5080	6.00	2.3	720	9/26/2007	372.3	4707.7	340 - 370	C
	1116674	286130	5080	6.00	2.3	720	9/26/2007	372.3	4707.7	540 - 720	A

Note: * = Abandoned
= Open hole completion
All = alluvial
W. of WW1 = West of Widow Women

Table 2-11 Basic Well Data for Hank Unit.

Sample Point	North Coordinate	East Coordinate	MP Elevation (ft-msl)	Casing Diameter (in)	Stick-up Above LSD	Well Depth (ft-mp)	Date		Depth (ft-mp)		Elevation (ft-msl)		Screen Interval (ft-lsd)	Aquifer
BR-B	1129884	299194	5029.7	5.00	1.5	300	39359		141.61		4888.09		200 - 280	F
BR-F	1128473	302583	5082.25	5.00	1.6	160	39359		69.25		5013		60 - 100	G
BR-G	1125397	305568	5157.27	5.00	1.6	320	39359		148.19		5009.08		240 - 320	F
BR-H	1127077	293768	4957.56	5.00	1.6	200	39359		95.56		4862		140 - 180	G
BR-I	1128729	303971	5130.88	4.00	1.7	80	39322	>	80	<	5050.88		40 - 80	H
BR-K	1129697	306515	5193	4.00	1.7	124	39353	>	129.95	<	5063.05		84 - 124	H
Brown #5	1128252	301915	5061.76	5.00	1.3	540	39351		215.6		4846.16		460 - 540	B
	1128252	301915	5061.76	5.00	1.3	540	39351		215.6		4846.16		460 - 540	B
Brown-WS	1125026	299713	5146	6.00	1.2	702	39134		266.62		4879.38		340 - 380	C
	1125026	299713	5146	6.00	1.2	702	39134		266.62		4879.38		425 - 465	B
	1125026	299713	5146	6.00	1.2	702	39134		266.62		4879.38		540 - 620	A
BR-Q	1125878	305553	5154.22	5.00	1.1	600	39359		292.08		4862.14		500 - 600	B
BR-T	1131333	300699	5033	5.00	---	496	29656		196.5		4836.5		390 - 470	B
BR-U	1128876	300158	4983.18	4.00	1.7	23	30054		11.86		4971.32		39225	ALL
C #1	1100216	304090	5137	5.00	1.1	232	39359		191.95		4945.05		146 - 232	F
Dry Willow #1	1112155	304041	5154.19	6.00	1.3	320	39359		222.1		4932.09		220 - 320	F
DRYMW1	1121212	293031	4930	3.00	0.3	19	39359	>	19.2	<	4910.8		-	ALL
DRYMW3	1121635	292581	4920	3.00	0.5	19	39359	>	18.6	<	4901.4		-	ALL
F. Brown #1	1108650	288324	4890	7.00	2.3	520	39359		198.04		4691.96		423 - 483	B
Hank 1	1122566	302568	5251.01	6.00	1.8	440	39302		355.35		4895.66		354 - 440	F
Means #1	1108983	301384	5259.86	6.00	1.1	700	39351		338.6		4921.26		320 - 330	F
	1108983	301384	5259.86	6.00	1.1	700	39351		338.6		4921.26		640 - 650	B
NBHW-13	1128356	295943	4969.86	4.50	1.7	470	39359		130.63		4839.23		424 - 446	B
North Dry Willow #1	1116100	303879	5205	6.00	0.3	1132	---		---		---		250 - 280	F
	1116100	303879	5205	6.00	0.3	1132	---		---		---		380 - 410	C
	1116100	303879	5205	6.00	0.3	1132	---		---		---		540 - 570	B
	1116100	303879	5205	6.00	0.3	1132	---		---		---		700 - 770	A
	1116100	303879	5205	6.00	0.3	1132	---		---		---		990 - 1100	1
Old Maid #1	1115480	292878	5080	6.00	2.3	300	39239		197.4		4882.6		250 - 300	F
OW43756	1115602	298221	5052	6.00	2	251	39359		146.8		4905.2		-	X
Paden #1	1115635	304361	5195.85	5.00	1.8	650	39134		310		4885.85		400 - 440	X
	1115635	304361	5195.85	5.00	1.8	650	39134		310		4885.85		570 - 630	X
SS1-F	1129626	295559	4975	4.50	1.1	185	39259		116.02		4858.98		145 - 185	F
SS1-FPU	1129700	295428	4976	2.00	2.3	175	39259		117.26		4858.74		-	F
SS1-L	1129551	295690	4974	5.00	0.9	654	39288		140.93		4833.07		534 - 652	A
SS1-M	1129546	295602	4974	5.00	1.2	454	39259		140.41		4833.59		405 - 454	B
SS1-U	1129619	295647	4975	5.00	0.9	372	39251		138.01		4836.99		323 - 372	C
URZHB-6	1124299	302427	5213.78	4.50	1.1	650	39359		352.08		4861.7	#	536 - 650	B
URZHC-2	1118511	302629	5234.76	4.50	1.3	485	39359		342.68		4892.08	#	440 - 485	C
URZHF-1	1118584	302588	5231.73	4.50	0.9	440	39359		328.33		4903.4	#	369 - 440	F
URZHF-5	1124265	302426	5217.67	4.50	1.7	410	39359		316.3		4901.37	#	369 - 386	F
URZHG-3	1118491	302556	5228.82	4.50	1.2	300	39359		273.88		4954.94	#	270 - 300	G
URZHG-4	1124257	302457	5215.78	4.50	1.1	290	39359		280.39		4935.39	#	270 - 290	G
URZHH-7	1118639	301082	5169.37	4.00	2.2	135	39359		96.68		5072.69		115 - 135	H
	1118639	301082	5169.37	4.00	2.2	135	39359		96.68		5072.69		85 - 105	H
WC-MN1	1121306	292653	4942	5.00	2.5	210	36161		99		4843		150 - 210	F

Note: * = Abandoned
= Open hole completion
All = alluvial

2.7.2.2.1 Aquifer Properties

In addition to determining the aquifer properties from the multi-well test, numerous single-well tests were conducted to define the aquifer properties. Several pump tests were previously conducted by Cleveland-Cliffs and Uranerz and the results of these tests were analyzed and included in the general hydrologic analysis.

Table 2-12 presents a summary of the aquifer properties for the Nichols Ranch Unit. This table shows a summary of the aquifer properties for the A, B, C, F and 1 Sands for the Nichols Ranch Unit. For the A Sand, the single-well pump tests are presented first and then the results for the three multi-well pump tests are presented. Transmissivities for the A Sand aquifer vary from a low of 101 to a high of 460 gal/day/ft. A value of 350 gal/day/ft is thought to best represent the A Sand in the Nichols Unit area. The hydraulic conductivity (horizontal permeability) varies from 0.18 to slightly greater than 0.7 ft/day (0.08 to 0.36 Darcy), and a value of 0.5 ft/day is thought to best represent the A Sand. Average storage coefficient for the A Sand was 1.8E-4.

The one single-well pump test in the B Sand produced a transmissivity of 174 gal/day/ft and a horizontal permeability of 0.37 ft/day. The single-well pump tests for the 1 Sand produced a transmissivity of 88 and 101 gal/day/ft for the 1 Sand. A significantly higher transmissivity was obtained from the single-well test for the F Sand well at 1,410 gal/day/ft and a hydraulic conductivity of 3.6 ft/day. A small transmissivity of 45 gal/day/ft and hydraulic conductivity of 0.099 ft/day were determined for the C Sand.

Table 2-13 presents the summary of aquifer properties for the Hank Unit. This table presents results of aquifer properties testing for the F, A, B, C and G aquifers in the Hank Unit area.

The properties in the F Sand vary greatly in the Hank Unit area. The transmissivities vary from a low of 18 to a high of 6,670 gal/day/ft. Hydraulic conductivity varies from a low of 0.14 ft/day to a high of 9.4 ft/day (0.07 to 4.5 Darcy). A transmissivity of 400 gal/day/ft is thought to best represent the majority of the F Sand in the Hank Unit and the hydraulic conductivity of 0.6 ft/day is also thought to best represent the F Sand. A storage coefficient of 6.8E-5 was determined for

Table 2-12 Summary of Aquifer Properties for Nichols Ranch Unit.

	TRANSMISSIVITY (GAL/DAY/FT)				HOR. PERMEABILITY		AQUIFER	STORAGE COEFFICIENT		
	RECOVERY	JACOB	THEIS	BEST VALUE	(FT/DAY)	(DARCY)	THICKNESS (FT)	JACOB	THEIS	BEST VALUE
SINGLE WELL TESTS						**A SAND**				
MN-1	275	453	-	275	-	-	73	-	-	-
MN-1 (2nd test)	-	276	-	276	0.65	0.31	73	-	-	-
MN-3	454	465	-	460	0.57	0.27	107	-	-	-
MN-4	314	308	-	311	0.65	0.31	64	-	-	-
MN-5	284	747	-	-	-	-	104	-	-	-
MN-5 (2nd test)	322	357	-	322	0.41	0.20	104	-	-	-
DW-4L	53	101	-	101	0.18	0.084	77	-	-	-
MULTI WELL TESTS										
MN-1 TEST	303	355	-	329	0.6	0.29	73	-	-	-
MN-2 OBS	610	1034	180	180	0.33	0.16	73	1.5E-04	1.4E-04	1.4E-04
MN-3 OBS	471	1095	265	265	0.48	0.23	73	1.2E-04	1.2E-04	1.2E-04
NICHOLS 1 OBS	570	631	414	414	0.76	0.36	73	1.0E-04	1.7E-04	1.7E-04
MN-6 TEST	360	346	-	353	0.44	0.21	108	-	-	-
NICHOLS 1 OBS	369	384	359	371	0.46	0.22	108	2.8E-05	3.1E-05	-
MN-5 OBS	477	620	359	359	0.44	0.21	108	1.1E-04	1.5E-04	1.5E-04
MN-2 OBS	792	688	337	337	0.42	0.20	108	3.8E-05	3.8E-04	3.8E-04
MN-2 TEST	160	196	-	178	0.23	0.11	102			
MN-1 OBS	51	588	180	180	0.24	0.11	102	1.1E-04	1.0E-04	1.0E-04
SINGLE WELL TESTS						**B SAND**				
URZNB-1	-	306	-	-	-	-	63	-	-	-
URZNB-1 (2nd test)	127	174	-	174	0.37	0.18	63	-	-	-
SINGLE WELL TESTS						**1 SAND**				
DW-4L	53	101	-	101	0.18	0.084	77	-	-	-
URZN1-2	93	105	-	-	-	-	45	-	-	-
URZN1-2 (2nd test)	83	73	-	88	0.26	0.12	45	-	-	-
SINGLE WELL TESTS						**F SAND**				
DW-4U	1460	1360	-	1410	3.6	1.7	52	-	-	-
DW-4U (2nd test)	-	1470	-	-	-	-	-	-	-	-
SINGLE WELL TESTS						**C SAND**				
DW-4M	-	45	-	45	0.099	0.047	61	-	-	-

Table 2-13 Summary of Aquifer Properties for Hank Unit.

	TRANSMISSIVITY (GAL/DAY/FT)				HOR. PERMEABILITY		AQUIFER	STORAGE COEFFICIENT		
	RECOVERY	JACOB	THEIS	BEST VALUE	(FT/DAY)	(DARCY)	THICKNESS (FT)	JACOB	THEIS	BEST VALUE
SINGLE WELL TESTS						**F SAND**				
HANK 1	2210	2210	-	2210	3.5	1.7	84	-	-	-
Dry Willow #1	7020	6670	-	6670	9.4	4.5	95	-	-	-
BR-B	2210	2530	-	-	-	-	88	-	-	-
BR-B (2nd Test)	-	1970	-	2240	3.4	1.6	88	-	-	-
BR-G	2.1	19	-	19	0.14	0.067	18	-	-	-
OW43756	-	18	-	18	-	-	-	-	-	-
MULTI WELL TESTS										
URZHF-5	-	470	-	470	0.69	0.33	91	-	-	-
HANK 1	-	-	-	-	-	-	91	-	-	-
BR-G	-	-	-	-	-	-	91	-	-	-
URZHF-1	149	-	-	149	0.28	0.13	71	-	-	-
SS1-F	-	1530	-	1530	6.4	3.1	32	-	-	-
SS1-FPU	1380	1530	-	1450	6.1	2.9	32	6.80E-05	-	6.80E-05
SINGLE WELL TESTS						**G SAND**				
BR-F	-	0.62	-	-	-	-	10	-	-	-
BR-F (2nd Test)	0.4	2.3	-	0.4	0.005	0.003	10	-	-	-
BR-H	-	2.7	-	-	-	-	18	-	-	-
BR-H (2nd test)	2.9	2.9	-	2.9	0.022	0.01	18	-	-	-
SINGLE WELL TESTS						**C SAND**				
URZHC-2	-	1.9	-	1.9	0.025	0.012	10	-	-	-
SINGLE WELL TESTS						**B SAND**				
BR-Q	264	176	-	264	0.38	0.18	93	-	-	-
NBHW-13	742	1300	-	1300	2.2	1.1	78	-	-	-
SINGLE WELL TESTS						**A SAND**				
SS1-L	954	1100	-	1030	1.1	0.52	126	-	-	-
SS1-L (2nd test)	-	843	-	843	0.89	0.43	126	-	-	-

the F Sand at the SS1-F site. The water level in the ore zone of the Hank Unit is near the top of the sand and therefore the F Sand is not fully saturated and is therefore an unconfined aquifer at the Hank Unit. The primary storage property for an unconfined aquifer is specific yield and a specific yield of 0.05 is thought to best represent the F Sand in this area.

Similar tests were conducted on two G Sand wells. The transmissivities of this G Sand varied from 0.4 to 2.9 gal/day/ft with hydraulic conductivities varying from 0.005 to 0.022 ft/day.

The aquifer properties for the underlying sands were determined for the C, B and A Sands. The aquifer properties for the C Sand were a low transmissivity of 1.9 gal/day/ft and a hydraulic conductivity of 0.025 ft/day. The transmissivities for the B and A Sand varied over a much larger range from 264 to 1,300 gal/day/ft. Hydraulic conductivities for the B and A Sand varied from 0.38 to 2.2 ft/day.

2.7.2.2.2 Aquitard Properties

The vertical permeabilities of the aquitard in the Powder River Basin have been defined at numerous locations. These permeabilities have been measured in multi-well pump tests with the Neuman-Witherspoon (1972) method, determined from the results from the leaky aquifer pump test analysis with the modified Hantush (1960) method, and from laboratory measurements. This data has shown that the vertical permeability of these aquitards is low enough that site specific measurements of the aquitard permeabilities are not necessary. Aquitard permeabilities were measured in the area just north of the Hank Unit in Power Resources North Butte permit. This permit presents aquitards evaluated with the Neuman-Witherspoon field test for the aquitard between the F and C Sands. The vertical permeability of this material was 3.8E-8 cm/sec (3.5E-2 ft/yr). A second multi-well test at the North Butte site defined the aquitard permeability between the A Sand and the 1 Sand. The results of this test were 4.1E-8 cm/sec (4.2E-2 ft/yr). Additional field tests were evaluated using the modified Hantush method to define the vertical permeability of the aquitard. These calculated permeabilities varied from a low of 6.7E-9 to a high of 6.9E-8 cm/sec. Laboratory permeabilities were also measured on two samples of the aquitards at the North Butte permit and these permeabilities varied from

6.4E-9 to 1.3E-8 cm/sec. This data shows that the aquitards in this area have sufficiently small vertical permeabilities to restrict the movement of groundwater from one aquifer to the next. Aquifer confinement will be further defined for each of the wellfields during the wellfield multi-well pump test.

2.7.2.3 Groundwater Flow

Water levels have been measured in the wells in the Nichols Ranch ISR Project area to define the direction and gradient of the groundwater movement and define water-level changes in the aquifers in this area. Addendum D6D in Appendix D6 presents the water-level plots and tabulation of groundwater levels.

The water level elevation for the A Sand, which is the production sand at the Nichols Ranch Unit, is presented in Figure 2-19 (see map pocket). This water-level elevation map shows that the groundwater in the A Sand is flowing to the northwest with an average gradient of 0.0033 ft/ft. This gradient, an effective porosity of 0.05 and an average hydraulic conductivity of 0.5 ft/day indicates that the groundwater in the A Sand is flowing at an average rate of 0.033 ft/day (12 ft/yr).

An F Sand well was added at the Nichols Ranch Unit to define the shallow groundwater at this site. Figure 2-20 (see map pocket) shows the water-level elevation for F Sand well URZNF-3. The water-level elevation of this shallow sand is roughly 25 ft higher than the water-level elevation than the A Sand at this location. An additional shallow monitoring well was installed at the Nichols Ranch Unit in the Cottonwood alluvium. This monitoring well is located on the downstream edge of the Nichols Ranch Unit area (refer to Figure 2-17 for location [see map pocket]). Completion information for this well is presented in Table 2-10 and the well has a water-level elevation of 4,629 ft-msl. This water-level elevation is approximately 35 ft below the water-level elevation of the A Sand in this area.

Figure 2-20 (see map pocket) shows the water-level elevation for the F Sand for the Nichols Ranch ISR Project area. This map includes wells in both the Nichols Ranch and Hank Units.

The groundwater elevation shows that the water in the F Sand is flowing west with an average gradient of 0.005 ft/ft. This gradient, along with an average hydraulic conductivity of 0.6 ft/day and an effective porosity of 0.05, indicates that the groundwater velocity is moving at 0.06 ft/day (22 ft/yr). Groundwater in the F Sand flows into the Cottonwood alluvium in the area of the Nichols Ranch Unit.

Figure 2-21 (see map pocket) presents the water-level elevations for wells that are completed in the B and C Sands. The water-level elevations in these sands indicate that the gradient is to the west in the Nichols Ranch ISR Project area for both the Nichols Ranch and Hank Units (refer to Figure 2-21). The piezometric gradient in the groundwater systems has a north-northwest gradient further to the north of the Hank Unit. Similar gradients are observed in the B and C Sand aquifers as in the A and F Sand aquifers.

The shallow sands in the Hank Unit area are more likely to be affected by local topography changes than the deeper sands. Figure 2-22 (see map pocket) presents a water-level elevation map for the G and H Sands which are the overlying sands for the F Sand in the Hank Unit. These piezometric contours are for the G Sand and show a much steeper gradient of 0.014 ft/ft to the west. This gradient, an average hydraulic conductivity of 0.005 ft/day and an effective porosity of 0.05 indicate that the ground water in these sands is moving at an average rate of 0.0014 ft/day (0.5 ft/year).

The head in H Sand well URZHH-7 is shown on Figure 2-22 with a water-level elevation of 5,072.9 ft-msl. H Sand well URZHH-7 was installed to define the shallow groundwater at the Hank Site. This well is completed in the H Sand which is above the G Sand. The H Sand has a water-level elevation approximately 150 ft higher than the G Sand in this area of the Hank Unit.

2.7.2.3.1 Nichols Ranch Unit Water Level Changes

The water-level elevations have been measured on the Nichols Ranch ISR Project wells and are presented in Addendum D6D in Appendix D6. Table D6D.1-1 in Addendum D6D, in Appendix D6 presents the water-level data tabulation for the Nichols Ranch Unit wells while

Table D6D.2-1 presents the water-level data collected for the Hank Unit wells. Figures D6D.1-1 through D6D.1-3 (see map pockets) in Addendum D6D in Appendix D6; present the water-level elevations versus time for the Nichols Ranch Unit wells. Water levels for the A Sand wells for the last year have been fairly steady.

Water-level elevations for the B Sand well URZNB-1 and the 1 Sand well URZN1-2 are slightly less than the water level elevation in adjacent A Sand well MN-1. The vertical head difference between these two aquifers and the A Sand is approximately 10 ft. Water levels have been fairly steady in the B Sand and 1 Sand in the Nichols Ranch Unit area.

Water-level changes in the DW-4 cluster of wells to the northeast of the Nichols Ranch Unit have also been fairly steady. These water levels were also measured in 1978 and 1979 and were slightly lower than the recent water levels. The comparison in head between the F Sand, C Sand and A Sand and a comparison of the historical 1978 and 1979 data to the recent data are presented for the DW-4 site. Water levels are about 55 ft higher in the F Sand than those observed in the C and A Sands.

2.7.2.3.2 Hank Unit Water Level Changes

The water-level changes for the Hank Unit wells are presented in Figure D6A.2-1 through D6D.2-5 (see map pockets) in Addendum D6D in Appendix D6, while Table D6D.2-1 in Addendum D6D in Appendix D6 lists the water levels. The water-level changes for the Hank 1, Dry Willow #1, URZHF-1, URZHC-2, and URZHG-3 wells are presented in Figure D6A.2-1 (see map pocket) Addendum D6D in Appendix D6. The recent water levels in the F Sand in Hank 1 and Dry Willow #1 wells have been fairly steady. The recent water levels in the Hank 1 well are approximately 14 ft higher than the 1979 measurement. Water levels in the Dry Willow well are approximately five feet higher than they were in 1979.

Figure D6D.2-2 (see map pocket) in Addendum D6D in Appendix D6 presents the water levels measured for the second new well cluster including, G Sand well URZHG-4, F Sand well URZHF-5 and B Sand well URZHB-6. The head in the G Sand in this area is approximately

35 ft higher than the head in the F Sand while the F Sand head is similarly higher than the B Sand head.

The BR wells are presented in Figure D6D.2-3 (see map pocket) in Addendum D6D in Appendix D6 and these wells are located on the northern side of the Hank Unit. These wells were monitored in the early 1980s for a period of slightly more than two years. Recent water levels in F Sand wells BR-B and BR-G are similar to those that were measured in the early 1980s.

Figure D6D.2-4 (see map pocket) in Addendum D6D, in Appendix D6 presents the plot of water levels for F Sand well WC-MN1. This well is monitored continuously by the BLM in conjunction with to their coal bed methane monitoring program. A plot of data for this well shows that in 1999 through early 2000 the water level was rising in this well and then gradually declined for the next 6-7 years. During the last several months of monitoring, the water levels in well WC-WN1 have declined at a faster rate than the previous years. Monitoring in March and April in 2007 shows a gradual water-level rise. This plot also shows one data point that was measured in 1979 which is a slightly lower water level than the present level.

The BLM has also monitored three alluvial wells in the Dry Willow alluvial system. The water levels for these wells are shown in Figure D6D.2-5 (see map pocket) in Addendum D6D in Appendix D6 with alluvial wells DRYMW1 showing saturation in portions of 2000 through 2001 and well DRYMW3 having some saturation in late 2003. Both of these wells were dry in August of 2007 and through the majority of the monitoring period.

2.7.2.3.3 Coal Bed Water Level Changes

The Exhibit D6-5 (see map pocket) in Appendix D6 shows the spacing from the base with the A Sand at the Nichols Ranch Unit to the top of the coal which is 775 ft. The base of the F Sand to the top of the coal of the Hank Unit is 960 ft (see Exhibit D6-5 [see map pocket] in Appendix D6). The BLM has monitored water levels in the coal aquifers and sand aquifers above the coal for the last several years. The network of monitoring wells is used to define the

effects of water extraction from the coal bed production zone. The nearest monitoring site to the Hank Unit is a coal well approximately 5.0 mi due north of the northern boundary of the Hank Unit. Figure D6D.3-1 (see map pocket) of Addendum D6D in Appendix D6-; presents the water-level elevations of the Pistol Coal Well. This coal aquifer well has water levels that varied over a range of slightly greater than 10 ft for the past ten years. This well did not show a significant effect from the production of water from the coal aquifer.

The Bullwacker sand and coal wells, which are located approximately 6.0 mi southwest of the Nichols Ranch Unit, have been monitored since 2002. Figure D6D.3-2 (see map pocket) in Addendum D6D in Appendix D6 presents the water level changes for the two Bullwacker wells. The sand well, which is completed 100 ft above the coal, has had approximately 140 ft of water level decline through early 2007. The coal well, which has also been monitored over this same period of time, shows a decline in water level starting in 2002 with a drop of approximately 600 ft by early 2007. This indicates that, at the Bullwacker site, the coal has had a large amount of drawdown and the sand water level appears to be declining steadily with the coal. This sand unit must be hydraulically connected with the coal or some well completion is allowing connection between the coal and this sand.

The coal and sand are monitored by the BLM at a location 12 mi west of Nichols Ranch Unit at the Streeter site. Figure D6D.3-3 (see map pocket) in Addendum D6D in Appendix D6 presents the water-level elevation for the Streeter sand and coal wells. These figures show that the Streeter sand well has declined by about 9.0 ft from late 2004 to late 2005. Water levels in most of 2006 were fairly steady. This sand is 624 ft above the top of the coal. The water levels from the Streeter coal well were fairly steady from late 2004 through mid 2005 when water levels started to gradually decline. Water levels from this well have declined approximately 22 ft from mid 2005 through late 2006. The change in the water level from the Streeter sand well is unusual because the water level initially declined and then became steady. Additional water level monitoring will be necessary to determine whether the observed water level decline should be attributed to the water production from the coal aquifer.

The sand well in the All Night Creek area is completed 124 ft above the coal. These two wells (completed in the sand and coal) are approximately 11 mi to the southwest of the Hank Unit. Figure D6D.3-4 (see map pocket) in Addendum D6D presents the water level changes for the All Night Creek wells. The water level changes in the coal are nearly 500 ft while the water levels have not changed significantly in the sand well.

The Beaver Federal sand and coal wells are located approximately 20 mi north-northeast of the Hank Unit. Figure D6D.3-5 (see map pocket) of Addendum D6D in Appendix D6 presents the water levels for the Beaver Federal sand and coal wells. The water level has not changed appreciably in the Beaver Federal sand well, while the coal's water level has declined greater than 200 ft. This sand is 541 ft above the coal, similar to the A Sand completion above the coal. The response of the ore sand water levels in the Nichols Ranch project to coal bed production should be similar to the response in this well.

2.7.2.4 Groundwater Quality

The groundwater quality at the Nichols Ranch ISR Project areas has been defined by sampling numerous wells in several aquifers in this area. Addendum D6E in Appendix D6 contains a tabulation of all groundwater quality. Some of the older water quality results were deemed not representative of the aquifer and are not used in the summary calculations of water quality. A criterion was established whereby the largest measured constituent concentration was deemed an outlier if it was greater than five times the next highest value in the data set. These outlier water quality results are highlighted in the water quality table in Addendum D6E in Appendix D6.

Table 2-14 presents the summary of the groundwater quality. These summaries are grouped for the A Sand, F Sand, B and C Sands together, then the G and H Sands and finally the 1 Sand. The values in Addendum D6E in Appendix D6 that are highlighted are not included in Table 2-14 calculations. Three sets of parameters are listed in the upper half of the first page in Table 2-14. The A Sand wells MN-1, MN-2, MN-3, MN-4, MN-5, MN-6 and DW-4L were used to calculate the average concentrations for the A Sand. The first row presents the number of samples followed by the average of those samples for that particular constituent. The maximum, mean

Table 2-14 Summary of Groundwater Quality.

A SAND WELLS: MN-1, MN-2, MN-3, MN-4, MN-5, MN-6 and DW-4L

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Temp	TDS	Cond	Cond(f)	pH	pH(f)
No. of Samples	29	29	29	29	29	29	29	29	25	29	24	26	24	28
Average	7.61	8.06	4.41	138.86	2.23	0.57	113.62	135.03	15.43	333.14	564.13	574.23	8.48	8.42
Maximum	11	16	24	156	5.7	1	130	183	20	370	643	720	8.74	9.5
Minimum	5.3	4	0.5	80	1.7	0.4	84	85	13.6	289	489	507	7.41	7.26
Standard Deviation	1.47	2.96	5.08	20.51	0.78	0.16	9.00	22.92	1.63	22.68	35.69	55.85	0.26	0.45

	Fe	Mn	NH3	NO3 + NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
No. of Samples	29	28	29	24	29	28	28	28	28	28	28	28	29	28
Average	0.07	0.01	0.09	0.05	0.24	0.05	0.00	0.05	0.02	0.01	0.08	0.00	0.00	0.07
Maximum	0.65	0.03	0.57	0.05	0.3	0.05	0.009	0.05	0.025	0.005	0.5	0.005	0.0007	0.5
Minimum	0.005	0.005	0.02	0.05	0.1	0.05	0.0005	0.05	0.005	0.005	0.05	0.0025	0.0002	0.05
Standard Deviation	0.13	0.01	0.13	0.00	0.07	0.00	0.00	0.00	0.01	0.00	0.11	0.00	0.00	0.09

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra226(e)
No. of Samples	28	29	29	29	28	29	28	28
Average	0.02	0.01	0.00	0.01	0.05	0.01	5.02	0.66
Maximum	0.025	0.08	0.0015	0.027	0.05	0.04	36.3	3
Minimum	0.005	5E-04	0.0005	0.00015	0.05	0.005	0.1	0.2
Standard Deviation	0.01	0.02	0.00	0.01	0.00	0.01	9.35	0.64

F SAND WELLS: DW-4U, HANK 1, DRY WILLOW #1, WC-MN1, BR-B, C #1, SS1-F, URZHF-1, URZHF-5 and URZNF-3

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Temp	TDS	Cond	Cond(f)	pH	pH(f)
No. of Samples	36	36	26	36	36	35	36	36	30	35	24	33	25	34
Average	101.02	5.56	0.65	173.86	7.29	25.04	182.17	592.11	12.00	1019.09	1411.04	1530.24	7.80	7.74
Maximum	293	33	4.3	421	14	96	245	981	17.1	1860	1880	3370	8.5	10.4
Minimum	44	0.5	0.5	45	5	10	94	418	9	710	994	995	7.16	6.7
Standard Deviation	48.00	5.39	0.75	80.09	1.81	16.60	31.17	132.63	1.66	241.67	193.87	436.68	0.31	0.74

	Fe	Mn	NH3	NO3 + NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
No. of Samples	36	36	35	19	36	33	33	31	33	33	36	33	33	32
Average	0.34	0.06	0.05	0.05	0.14	0.05	0.0017	0.05	0.02	0.01	0.08	0.0035	0.0005	0.05

Table 2-14 (Continued)

Maximum	3.9	0.26	0.13	0.05	0.5	0.4	0.015	0.05	0.03	0.08	0.5	0.014	0.0013	0.05
Minimum	0.005	0.005	0.005	0.05	0.01	0.005	0.0005	0.015	0.005	0.005	0.005	0.001	0.0002	0.05
Standard Deviation	0.74	0.05	0.03	0	0.10	0.06	0.0027	0.01	0.01	0.02	0.09	0.0023	0.0002	0

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra226(e)
No. of Samples	33	33	33	36	33	35	34	29
Average	0.02	0.01	0.02	0.16	0.05	0.02	43.14	2.00
Maximum	0.025	0.05	0.574	5.25	0.05	0.32	562	7.2
Minimum	0.005	5E-04	0.0005	0.0005	0.025	0.005	0.1	0.2
Standard Deviation	0.01	0.01	0.10	0.87	0	0.05	100.38	1.71

B and C SAND WELLS: BR-Q, BR-T, DW-4M, F. Brown #1, Brown #5, NBHW-13, SS1-M, SS1-U, URZNB-1, URZHC-2 and URZHB-6

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Temp	TDS	Cond	Cond(f)	pH	pH(f)
No. of Samples	58	58	39	58	57	58	47	61	46	60	35	52	44	44
Average	51.27	7.60	3.58	120.62	6.86	10.80	190.57	462.93	13.08	793.53	1155.11	1224.79	8.17	8.12
Maximum	103	80	26	242	41	22	250	620	18	966	1450	2100	9.63	10.07
Minimum	5	1	0.5	26	3	0.5	85	121	3	278	537	535	7.16	6.84
Standard Deviation	23.14	10.59	5.83	38.65	5.26	4.69	40.94	133.87	3.21	181.82	281.89	342.85	0.60	0.71

	Fe	Mn	NH3	NO3 + NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
No. of Samples	57	57	57	22	54	58	57	57	57	57	56	57	56	46
Average	0.102	0.024	0.648	0.050	0.179	0.089	0.002	0.052	0.016	0.012	0.112	0.004	0.001	0.070
Maximum	1	0.09	26	0.05	0.88	0.7	0.007	0.15	0.025	0.2	0.7	0.02	0.0043	0.5
Minimum	0.005	0.005	0.02	0.05	0.01	0.025	0.0005	0.015	0.003	0.005	0.005	0.0005	5E-05	0.05
Standard Deviation	0.186	0.022	3.558	0	0.169	0.105	0.002	0.032	0.009	0.028	0.162	0.003	0.001	0.083

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra226(e)
No. of Samples	57	57	57	55	57	56	50	38
Average	0.019	0.010	0.002	0.059	0.047	0.241	16.022	1.711
Maximum	0.07	0.13	0.025	2.16	0.2	3.19	128	9
Minimum	0.005	5E-04	0.0005	0.00015	0.003	0.005	0.1	0.2
Standard Deviation	0.011	0.019	0.004	0.291	0.040	0.595	29.489	1.866

Table 2-14 (Continued)

G and H SAND WELLS: BR-F, BR-H and BR-I

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Temp	TDS	Cond	Cond(f)	pH	pH(f)
No. of Samples	13	13	13	13	13	13	13	13	12	13	11	13	13	9
Average	40.5	8.2	10.1	157.0	5.7	7.2	101.6	187.5	11.6	427.8	691.3	726.2	8.5	8.6
Maximum	78	27	48	270	13	16	190	400	14.8	696	1080	1886	10.9	10.24
Minimum	8	3	0.5	13	2	0.5	8	9	7.9	225	400	380	7.1	7.06
Standard Deviation	23.37	7.27	16.15	81.01	3.32	5.22	67.15	159.89	1.89	214.14	296.48	446.48	1.24	1.08

	Fe	Mn	NH3	NO3 + NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
No. of Samples	13	13	13	6	12	12	12	12	12	12	12	12	12	6
Average	0.57	0.06	0.11	0.05	0.26	0.49	0.003	0.06	0.02	0.01	0.28	0.003	0.0005	0.05
Maximum	2.16	0.22	0.66	0.05	0.4	1.6	0.007	0.25	0.025	0.01	1	0.005	0.0005	0.05
Minimum	0.015	0.005	0.025	0.05	0.1	0.05	0.0005	0.025	0.005	0.005	0.05	0.001	0.0001	0.05
Standard Deviation	0.77	0.07	0.17	0.00	0.10	0.54	0.002	0.06	0.01	0.003	0.31	0.001	0.0001	0

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra226(e)
No. of Samples	12	12	12	12	12	11	8	7
Average	0.02	0.03	0.003	0.004	0.03	0.02	0.44	0.29
Maximum	0.025	0.117	0.005	0.018	0.05	0.1	1.9	0.6
Minimum	0.02	5E-04	0.0005	0.00015	0.003	0.005	0.1	0.2
Standard Deviation	0.003	0.04	0.002	0.01	0.02	0.03	0.67	0.16

1 SAND WELL: URZN1-2

	Ca	Cl	CO3	HCO3	K	Mg	Na	SO4	Temp	TDS	Cond	Cond(f)	pH	pH(f)
No. of Samples	4	4	4	4	4	4	4	4	2	4	4	4	4	4
Average	3.75	5.00	15.75	233.75	2.25	0.50	99.50	1.50	15.20	232.00	411.50	416.00	8.63	8.94
Maximum	4	6	24	246	3	0.5	104	2	16.3	248	425	421	9.39	9.15
Minimum	3	4	12	209	2	0.5	92	1	14.1	204	393	409	7.07	8.78
Standard Deviation	0.50	0.82	5.56	16.82	0.50	0.00	5.26	0.58	1.56	20.33	13.38	5.03	1.05	0.17

	Fe	Mn	NH3	NO3 + NO2	F	Al	As	Ba	Cr	Cu	B	Cd	Hg	Mo
No. of Samples	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Average	0.015	0.005	0.07	0.05	0.65	0.05	0.0005	0.05	0.025	0.005	0.05	0.0025	0.0005	0.05
Maximum	0.015	0.005	0.09	0.05	0.7	0.05	0.0005	0.05	0.025	0.005	0.05	0.0025	0.0005	0.05

Table 2-14 (Continued)

Minimum	0.015	0.005	0.05	0.05	0.6	0.05	0.0005	0.05	0.025	0.005	0.05	0.0025	0.0005	0.05
Standard Deviation	0	0	0.02	0.00	0.06	0	0	0	0	0	0	0	0	0

	Ni	Pb	Se	Unat	V	Zn	Ra226	Ra226(e)
No. of Samples	4	4	4	4	4	4	4	4
Average	0.025	5E-04	0.0005	0.00015	0.05	0.005	0.1	0.2
Maximum	0.025	5E-04	0.0005	0.00015	0.05	0.005	0.1	0.2
Minimum	0.025	5E-04	0.0005	0.00015	0.05	0.005	0.1	0.2
Standard Deviation	0	0	0	0	0	0	0	0

and standard deviation are also given in the summary tabulations. The A Sand water typically has very low TDS, (less than 500 mg/l), with its major components being sodium, sulfate and bicarbonate.

For the twenty-nine samples, the TDS varies from a minimum of 289 to 370 mg/l with a standard deviation of 23 mg/l. The sulfate concentrations for the twenty-nine samples vary from 85 to 183 mg/l while the chloride concentrations vary from 4 to 16 mg/l. Variations are 84 to 130 mg/l for sodium and 5.3 to 11 mg/l for calcium. The variation of uranium concentrations are over a small range from less than detection values to a maximum 0.027 mg/l. These A Sand wells are fully penetrating wells and therefore the uranium and radium concentrations will be significantly less for the average of the aquifer than within the ore zone. Radium concentrations from the A Sand vary from less than detection to 36.3 pCi/l. The radium-226 concentrations would likely be in a few hundred pCi/l for a partially penetrating well completed only in the ore zone.

The second group of three sets of summary parameters is for the F Sand wells DW-4U, Hank 1, Dry Willow #1, WC-MN1, BR-B, C #1, SS1F, URZHF-1, URZHF-5 and URZNF-3. F Sand wells BR-G and OW43756 were not included in summary calculations because their water level elevations indicate that they are receiving water from an aquifer with a higher head. Thirty-six samples have been collected from the F Sand wells, with the average TDS concentration greater

than 1,000 mg/l. The range in TDS concentration is from 710 to 1,860 mg/l. Sodium, calcium, bicarbonate and sulfate are the major dissolved constituents in this water.

The sulfate concentrations varied over a large range from 418 to 981 mg/l while the chloride concentrations are low in the F Sand water with a variation of less than detection to 33 mg/l. The cations with the largest concentrations are sodium with a variation from 94 to 245 mg/l and calcium which varies from 44 to 293 mg/l. Uranium concentrations varied from less than detection to a high of 5.25 mg/l in this ore bearing sand. Radium concentrations have varied from less than detection to 562 pCi/l.

The two sands that are typically between the A and F production sands are the B and C Sands. The water quality data for these two sands were grouped together in water quality tabulations, and these two sands are connected in some areas. The second page of Table 2-14 presents the summary of the water quality for the B and C Sands. This analysis includes wells BR-Q, BR-T, NBHW-13, DW-4M, F. Brown #1, Brown #5, SS1-M, SS1-U, URZNB-1, URZHC-2 and URZHB-6. TDS concentrations for these aquifers are typically above 600 mg/l with the larger major constituent concentrations being those of sodium, bicarbonate and sulfate.

The TDS of this water ranges from 278 to 966 mg/l. Sodium is the major cation in this water with concentration variations of 85 to 250 mg/l. Sulfate is a major anion with concentrated variation from 121 to 620 mg/l. These sands do show low concentrations of uranium in some areas that is attributed to limited mineralization. The radium concentrations in the B and C aquifers vary from less than detection to a maximum of 128 pCi/l.

The second group of parameters on the second page of Table 2-14 is for the G and H Sands which are the overlying sands for the F Sand in the Hank Unit area. This summary was made from water quality from BR-I, BR-F and BR-H wells. This tabulation shows that, on average, the TDS is near 500 mg/l with a range of 225 to 696 mg/l. The major constituents with the highest concentrations are sodium, sulfate and bicarbonate. Well BR-I could not be located and there is no recent sample.

The uranium concentrations in the G and H Sands varied from less than detection to 0.018 mg/l for uranium and from less than detection up to 1.9 pCi/l for radium-226. This data indicates that the wells completed in the G and H Sands are not near mineralized areas.

The third page of Table 2-14 presents the summary of water quality for the 1 Sand well URZN1-2 in the Nichols Ranch Unit area. This data shows that the TDS is slightly greater than 200 mg/l with sodium and bicarbonate being the major components of this water quality. The sulfate and chloride concentrations for the 1 Sand vary over a very small range. Sodium concentrations vary from 92 to 104 mg/l. Bicarbonate is the major anion in this water with very low levels of uranium and radium indicating no mineralization near this 1 Sand well. No other constituent concentrations are significant in the water from the 1 Sand.

2.7.3 Water Rights

Surface and groundwater rights on, adjacent to, and within 3.0 mi of the Nichols Ranch ISR Project are listed in Table D6F.1-1 in Addendum D6F and Table D6F.2-1 for the surface water and Tables D6G.1-1, D6G.1-2, D6G.2-1 and D6G.2-2 in Appendix D6 for the Nichols Ranch Unit and Hank Unit permitted water wells. Table D6G.1-1 in Appendix D6 lists the wells within the Nichols Ranch Unit while Table D6G.1-2 in Addendum D6G in Appendix D6 lists wells in and within 3.0 mi of the Nichols Ranch Unit. Table D6F.1-2 in Addendum D6F in Appendix D6 lists the abbreviations used by the State Engineers Office for both the surface and groundwater rights. Figures 2-23 and 2-24 (see map pockets) present the locations of the Nichols Ranch Unit and Hank Unit surface rights respectively. Exhibits D6-1 and D6-2 (see map pockets) in Appendix D6 show the locations of the permitted wells within 3.0 mi of the Nichols Ranch Unit and Hank Unit respectively. No adjudicated surface water rights are located in or adjacent to (within 0.5 mi of the project unit) the Nichols Ranch ISR Project. The surface water rights that do exist within the proposed mining project area are limited to stock/storage ponds and ephemeral creeks. Groundwater rights in the Nichols Ranch ISR Project area are mainly associated with the old monitoring wells and stock wells. No other adjudicated water rights are in the project area and lands adjacent to the project area according to the Wyoming State Engineers Office. Uranerz Energy Corporation also does not hold any adjudicated water rights

in the project area. Most wells that are located within the Nichols Ranch ISR Project area were previously installed by uranium exploration companies, the T-Chair Livestock Company, or coal bed methane companies. Several additional wells have been completed in the project areas by Uranerz Energy Corporation for use in collecting base line groundwater quality data.

Wells in the area of the proposed project area are uniformly distributed over the area excluding monitoring/sampling wells that are permitted by Uranerz Energy Corporation. Most of the wells are used for livestock watering through the use of windmills or electric well pumps. Well depths vary from 180 ft to 1,000 ft in depth, and most wells are completed in sands other than the ore bearing sands. Those wells that are completed in the ore bearing sand will be abandoned using acceptable WDEQ methods or will be used as monitoring wells if not completed in multiple sands. No wells in or adjacent to the project area are used for domestic water consumption. A domestic water supply well is found on the Pfister Ranch (BR-T), located approximately 0.6 mi north of the northern boundary of the Hank Unit. This well is completed at a depth that is stratigraphically below the zones planned for the ISR mining at the Hank Unit. Additionally, the well is located at a large distance from any Hank planned wellfield areas and in the B Sand. It is unlikely that any mining activities that take place in the Hank area will affect this well because of the physical separation of the well from the ore zone. The extensive groundwater monitoring program utilized during the mining project will detect any problems prior to this well being adversely affected by mining activity.

Six permitted wells exist within 0.5 mi of the Hank Unit area. These wells consist of the Connie #2 well which is nearly 0.5 mi east of the project area. This well is used to supply water for stock and has a depth of 350 ft. This well is thought to be in the top portion of the F Sand. The Paden #1 and North Dry Willow #1 wells are very near the mineralized areas near the Hank Unit. The North Dry Willow #1 well is completed in the F Sand through sands down below the 1 Sand and will have to be abandoned before a wellfield pump test in this area. The Paden #1 well is also very near the ore zone in this area and is completed in the C, B and A Sands. This well will have to be monitored during pump testing to determine if it has any connection with the F Sand. If the Paden #1 well has connection with the F Sand it will also need to be replaced. The Brown-WS well is completed in the C, B and A Sands. It is located

greater than 1,000 ft west of the mineralized area in Hank Unit. The Brown #5 stock well is located just north of the northern edge of the Hank Unit area. This well has a depth of 540 ft and is completed in the B Sand. The distance of the ISR operation from this well makes it unlikely that mining operations will affect its water level or water quality. The sixth permitted well at the Hank Unit is the Means #1 well, which is used for stock watering and is 700 ft deep and also likely extends down to the A Sand.

Six permitted wells that are not related to the mining operations also exist within 0.5 mi of Nichols Ranch Unit. The Red Spring Artesian #1 well is located just north of the northwest corner of the project area. This well is completed to 740 ft deep and was a flowing well. The well was not flowing in August of 2007. This well likely extends to sands below the A Sand.

The other five wells are in the southern portion of the project area. The Brown 20-9 well is within the Nichols Ranch Unit. This well is thought to be completed in the A Sand and has a total depth of 740 ft with perforations from 495 to 695 ft.

The Dry Fork #3 well is completed to a depth of 360 ft. With this depth, the well completion interval should be significantly shallower than the A sand.

The N1, 11894 well, which is located in Section 19, is completed down to a depth of 310 ft. This well is likely completed in the C Sand.

2.7.4 Coal Bed Methane Wells and Oil/Gas Wells

Wells permitted for coal bed methane production is presented on Exhibits D6-3 and D6-4 (see map pockets) in Appendix D6 for the Nichols Ranch Unit and Hank Unit respectively. The tabulation of the coal bed methane wells is presented in Addendum D6H in Appendix D6. Exhibit D6-5 (see map pocket) in Appendix D6 shows the footage between the base of the ore sand for each of the two sites and the top of the coal bed methane coal.

Oil/Gas wells are shown on Exhibit D6-6 (see map pocket) in Appendix D6 for the combined Nichols Ranch Project. Tabulation of the oil/gas wells is presented in Addendum D6H in Appendix D6.

2.7.5 Exploration Drill Holes

A search of the drill hole database maintained by Uranerz Energy Corporation resulted in a total of 546 abandoned exploration drill holes located within the Nichols Ranch ISR Project boundaries. Holes drilled from 1997 through 2007 have been plugged in accordance with current State of Wyoming regulations. A reasonable inspection of the project area showed that these abandoned holes were marked with a stake or pin flag after plugging was completed. To the best of Uranerz Energy Corporations knowledge, all holes drilled prior to 1997 were sealed and surface plugged in compliance with the State of Wyoming regulations in effect at the time of drilling. No problems are anticipated with past abandoned drill holes.

All known abandoned drill holes are listed in Tables D6I.1-1, D6I.1-2, D6I.2-1 and D6I.2-2 in Appendix D6 and the location and density is shown on Exhibits D6-7 and D6-8 (see map pockets) in Appendix D6.

2.8 ECOLOGY

2.8.1 Topography

The Nichols Ranch ISR Project area is located in the Powder River Basin in northeast Wyoming (Knight 1994). The project area is composed of two noncontiguous units located west and southwest of the North Middle Butte in the Pumpkin Butte area. The Hank Unit is located near the western flank of the North Middle Butte and is located in southwest Campbell County. Topography of the Hank Unit includes gently rolling hills and low ridges, as well as steep terrain near North Middle Butte and some steeply eroded areas associated with Dry Willow Creek (an ephemeral stream) located in the southern portion of this unit. Elevations in the Hank Unit range

from 5,055 to 5,209 ft AMSL and the area is dissected by a series of unnamed ephemeral drainages that generally drain west and southwest toward Dry Willow Creek.

The Nichols Ranch Unit is located approximately 4.2 mi southwest of the Hank Unit on the border between Johnson and Campbell Counties. Topography in this area is relatively flat with gently rolling hills and low ridges that drain south toward Cottonwood Creek (an intermittent stream) that is located in the southern portion of the unit. Elevations in the Nichols Ranch Unit range from 4,670 to 4,900 ft AMSL.

2.8.2 Soils

Soils within the Hank and Nichols Ranch Units were inventoried and mapped based on standards of a National Cooperative Soil Survey (U.S. Department of Agriculture 1993) and include an inventory of soil types (soil map units) and soil series based on an Order 3 soil survey conducted in 2006. A soil map delineating the soil types was prepared and as directed by the Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD), soil samples from potential disturbance areas were collected and analyzed. Physical and chemical characteristics of the topsoil within the potential disturbance areas and estimated depths of salvageable topsoil from the potential disturbance areas for future reclamation purposes were also estimated.

Soils occurring in the Hank and Nichols Ranch Units are generally fine textured throughout with patches of sandy loam on upland areas and fine-textured soils occurring in or near drainages. The project area contains deep soils on lower toeslopes and flat areas near drainages with shallow and moderately deep soils located on upland ridges and shoulder slopes.

Based on the results of the soil sampling, there are no factors that will limit the suitability of topsoil as a plant growth medium during the reclamation phase. All laboratory values were compared to Table I-2 of WDEQ/LQD Guideline No. 2 (1994) and the results were determined to be within the suitable range, except for marginal soil texture for four soil profiles from three samples collected in the Hank Unit. These four soil profiles were determined to have clay soil textures. Additionally, based on a reconnaissance survey conducted by Natural Resource

Conservation Service, no prime farmland was identified within the Nichols Ranch ISR project area.

Detailed soils information for the Nichols Ranch ISR Project area is presented in Appendix D-7 of the WDEQ/LQD Permit to Mine Application and includes a literature review, results and interpretations of the soil survey, analytical results of soil sampling, and an evaluation of soil suitability as a plant growth medium.

2.8.3 Vegetation

Baseline vegetation studies of the Nichols Ranch ISR Project area were conducted in June and July 2006 in accordance with a vegetation study plan approved by the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ/LQD) for noncoal permit areas. The sampling design and methods used for the vegetation study followed Rule 1-V (revegetation performance standards): Noncoal Rules, Chapter 3 (WDEQ/LQD, amended April 25, 2006), WDEQ/LQD Guideline Number 2 (WDEQ/LQD 1997), and WDEQ/LQD Draft Guideline 2 Rewrite (WDEQ/LQD 2004).

The Nichols Ranch Project area is composed of eight vegetation/habitat types, with approximately 88% of the project area composed of two vegetation types (sagebrush shrubland and mixed grasslands) (refer to Table 2-6). One wetland area was found, and this will be avoided by project activities. No federal threatened, endangered, candidate, or proposed plant species were found, and none are known to occur in the project area. Only one designated noxious weed species (Canada thistle) and one selenium indicator species (two-groove milkvetch) were found during surveys; both were found in small numbers in disturbed areas. Table 2-15 presents the results of vegetation studies conducted in June and July 2006.

Table 2-15 Vegetation/Habitat Types, Number of Acres, and Sampling Intensity, Nichols Ranch ISR Project, 2006.[1]

Vegetation/Habitat Type	Premine No. of Acres	Percent of Project Area	Estimated Affected Acres	Minimum Sample Size[1]	Adequate Sample Size (Nmin)[2] for Vegetative Cover
Sagebrush shrubland	1,905.4	56.8	7	20	6.3
Mixed grassland	1,061.7	31.4	5	20	10.2
Juniper outcrop	148.3	4.4		20	28.2
Bottomland	125.1	3.7		20	16.5
Greasewood shrubland	64.4	1.9		15	12.2
Wetland	1.1	<0.1		Not sampled	--
Rock outcrop	17.5	0.5		Not sampled	--
Disturbed lands[3]	42.3	1.2		Not sampled	--
Total	3,370.53	100	12[4]		

1 Based on WDEQ/LQD (2004) and on approved sampling plan for the project submitted WDEQ/LQD prior to sampling.
2 Includes 8.3 acres of previously disturbed lands as evident by annual grasses and weeds and 8.8 mi (32.0 acres) of roads (30-ft wide disturbance).
3 Estimated disturbance from the two production plants. Disturbance from wells, pipelines, and additional access roads is unknown.

Detailed vegetation information for the Nichols Ranch ISR Project area is presented in Appendix D8 of the WDEQ/LQD Permit to Mine Application and includes results of vegetation mapping and a description of the vegetation communities, results of cover sampling, a species list, and a discussion of threatened and endangered species, noxious weeds, and selenium indicator species.

2.8.4 Wildlife

2.8.4.1 General

The Nichols Ranch ISR Project area is located within the 10- to 14-inch Northern Plains (10-14NP) zone of Northeastern Wyoming (Natural Resources Conservation Service 1988) and the project area provides habitat for wildlife that is typical for the region. The study area has the potential to provide habitat for mule deer, elk, pronghorn antelope, jackrabbit, cottontail rabbit,

coyote, bobcat, mountain lion, red fox, badger, raccoon, skunk, chipmunk, rodents, songbirds, waterfowl, eagles, hawks, owls, sage grouse, chukar, wild turkey, Hungarian partridge, mourning dove, magpie, and crow. Most species are yearlong residents; however, some species such as elk, eagles, songbirds, and waterfowl are more abundant during migration periods (Cerovski et al. 2004).

Mammal and bird species found during site specific surveys of the project area included pronghorn, mule deer, bobcat, coyote, badger, desert cottontails, white-tailed jackrabbits, greater sage-grouse, and gray partridge. Small mammals included black-tailed prairie dogs and thirteen-lined ground squirrels. Raptors confirmed breeding included great horned owl, long-eared owl, golden eagle, red-tailed hawk, and prairie falcon; wintering raptors included bald eagle, golden eagle, red-tailed hawk, and rough-legged hawk.

Detailed wildlife information for the Nichols Ranch ISR Project area is presented in Appendix D9 of the WDEQ/LQD Permit to Mine Application and includes a complete species list, methods and results of site-specific species surveys, potential wildlife impacts and mitigation measures, and information concerning threatened and endangered species.

2.8.4.2 Federal Threatened, Endangered, Proposed and Candidate Species

Two federal threatened, endangered, proposed, and candidate (TEPC) animal species have been identified by the U.S. Fish and Wildlife Service (USFWS) to have the potential to occur within or in the vicinity of the Nichols Ranch ISR Project area. These species include black-footed ferret (endangered) and bald eagle (threatened).

Prairie dogs are the main food of the endangered black-footed ferrets (BFF) and several black-tailed prairie dog colonies occur in and adjacent to the Nichols Ranch and Hank Units. However, specific surveys for BFF were not conducted because the USFWS has determined that BFF surveys are no longer required in black-tailed prairie dog towns statewide. The area has been block-cleared for the black-footed ferret; therefore, the project will have no affect on black-footed ferrets.

The USFWS defines communal roosts as six or more birds at one site; the BLM defines roosts as areas that bald eagles show consistent use. Consistent use areas are areas where eagles are seen two or more times within a given winter or multiple winters (personal communication, February 22, 2007, with Thomas Bills, biologist, BLM Buffalo Field Office). The BLM is moving away from the USFWS roost concept and protecting the "consistent use areas" because it is seldom that six or more birds are observed roosting in one area (personal communication, February 22, 2007, with Thomas Bill, biologist, BLM Buffalo Field Office). Based on the BLM database (2006), two roost sites have been recorded on the south side of North Pumpkin Butte and two roost sites have been recorded in Middle North Butte. No communal roosts, as defined by the USFWS, were observed; however, several bald eagles exhibited an affinity for certain areas adjacent the Nichols Ranch Project area by either flying or roosting in the survey area. One adult bald eagle was observed perched in a cottonwood tree along Dry Willow Creek, just north of the Hank Unit during two of the three winter surveys.

Bald eagles were observed flying over or in the vicinity of the Nichols Ranch Unit during two of the three winter surveys. Two adult bald eagles were observed soaring above the Nichols Ranch Unit during the January 6th survey and one bald eagle was observed flying adjacent the Nichols Ranch Unit during the January 17th survey.

The nearest known bald eagle winter roost site is located 4.5 mi Southwest of the Nichols Ranch Unit. The closest bald eagle nest is located along the Powder River in Johnson County approximately 10 mi west of the Nichols Ranch ISR Project area (personal communication, February 22, 2007, with Thomas Bill, biologist, BLM Buffalo Field Office).

While a few bald eagles may hunt or forage in the Nichols Ranch Project area there are no defined communal roosts or consistent use areas within or immediately adjacent to the project area. Therefore, the Nichols Ranch ISR Project is expected to have no affect on bald eagles.

Based on the results of site specific surveys and other available data, the Nichols Ranch ISR Project is expected to have no affect on any federal TEC&P species.

2.8.4.3 BLM Special Status Species

The Bureau of Land Management (BLM), Buffalo Field Office also monitors and manages nonlisted (under the federal Endangered Species Act) special status (SS) species (i.e., species of concern) that could occur on federal lands to reduce potential impacts that might lead to their listing by the USFWS. The BLM list of SS species included six mammals, 15 birds, two amphibians, and one fish species.

No mountain plovers were seen during the two surveys or during opportunistic observations throughout the 2006 field season. In addition, there are no records that mountain plovers exist within the wildlife study area (BLM 2006; WNDD 2006). The closest BLM sighting of mountain plover is approximately 4.0 mi from the project area (BLM 2006). Therefore, the Nichols Ranch ISR Project is expected to have minimal impacts to mountain plovers.

One swift fox, a BLM SS species, was observed crossing the Van Buggen road approximately 5.0 mi east of the Nichols Ranch Project area during the 2006 field season. It is likely that swift fox inhabit the wildlife survey area because of the suitable short mixed grassland habitat. Therefore, the Nichols Ranch ISR Project is expected to have minimal impacts to swift foxes.

The greater sage-grouse, a BLM SS species, is a year-long resident in the project area and ten greater sage-grouse leks occur within the wildlife study area. All of the leks were active in 2006. Direct potential impacts to greater sage-grouse from project activities would include habitat loss and fragmentation from mine, road, pipeline, and power line construction; alteration of plant and animal communities; increased human activity that could cause the birds to avoid an area; increased noise that could cause the birds to avoid an area or reduce breeding efficiency; increased motorized access by the public leading to legal and illegal harvest; direct mortality from increased vehicular traffic; and an increase in mortality from raptors if power poles are placed in occupied greater sage-grouse habitat.

To minimize impacts to breeding greater sage-grouse, Nichols Ranch Project activities and vehicular traffic would be minimized in areas within 0.25 mi of an active lek between the hours of 8:00 pm and 8:00 am during the greater sage-grouse strutting period (March 1-May 15), and Nichols Ranch ISR Project activities (i.e., drilling and construction) would be minimized within

2.0 mi of an active lek between March 15 and July 15. To reduce raptor predation on greater sage-grouse, the construction of overhead power lines, permanent high-profiled structures such as storage tanks, and other perch sites would not be constructed within 0.25 mi of an active lek. To minimize impacts to greater sage-grouse and other upland bird species (i.e., Hungarian partridge), removal and disturbance of vegetation will be kept to a minimum through the use of existing roads for travel and for the placement of pipelines. All lands disturbed by Nichols Ranch Project activities will be revegetated as soon as practical following the project disturbing activities following approved reclamation practices.

Therefore, with implementation of the mitigation measures described above, the Nichols Ranch ISR Project will have minimal impacts to greater sage-grouse.

The WNDD and BLM have occurrence records of several BLM SS species in the vicinity of the Nichols Ranch Project area including sage sparrow, Brewer's sparrow, loggerhead shrike, sage thrasher, burrowing owl, ferruginous hawk, and northern leopard frog. Based on the lack of any observations and existing data, the Nichols Ranch ISR Project is expected to have minimal impacts on these species. In addition, these are no occurrence records or observations of any of the remaining BLM SS species; therefore, the Nichols Ranch ISR Project is expected to have no impacts on any of the remaining BLM SS species.

2.9 BACKGROUND RADIOLOGICAL CHARACTERISTICS

2.9.1 Surface Soil, Subsurface Soils and Sediment

2.9.1.1 Purpose and Procedure

In June of 2007, an extensive soil and sediment sampling program was completed for the Nichols Ranch and Hank Units of the Nichols Ranch ISR Project. The purpose of the effort was to develop a representative radiological baseline for surface and subsurface soils and sediments.

Prior to conducting a field reconnaissance and collecting the samples, a map was prepared on a large-scale U.S. Geological Survey (USGS) topographic base showing the license boundary,

plant site location and ore zone footprint (in as much as it was known at the time). Because of their importance in an assessment such as this, the location of cultural features (residences, ranches, water wells, water impoundments, roads, etc.) with respect to the future process facility, production areas and license boundary were considered in the sampling design.

After completing the base map described above, a field reconnaissance was conducted to visually inspect the project area. All of the features just noted were considered in terms of their respective locations to the license boundary. Following the reconnaissance, a sample site map was prepared. Coordinates for each sample site were included with the map.

In determining the number, type (surface, subsurface and sediment) and areal distribution of sampling locations, pertinent NRC documents were used, along with judgment based on many years of experience developing pre-operational and operational environmental monitoring programs for in situ recovery (ISR) operations. The primary documents included: (1) NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," USNRC, April 25, 1980; (2) NUREG-1569, Standard Review Plan for In Situ Leach Uranium Extraction License Applications," Final Report, USNRC, June 2003; and (3) NUREG-1748 "Environmental Review Guidance for Licensing Actions Associated with NMISS Programs," Final Report, USNRC, August 2003.

Regulatory Guide 4.14 is the document that outlines the specifics of a pre-operational radiological monitoring program. Table 1 in the guide, for example, lists the suggested number, type, location and frequency of samples. Because of the age of the guide, and because it primarily addresses conventional mills, Uranerz employed a modified baseline sampling program designed for a modern ISR facility. From a standpoint of physical disturbance and radiological alteration, it is widely recognized that a modern-day ISR operation has minimal impact on surface and subsurface soils.

There are three major reasons why the impacts are insignificant: (1) the recovery technique does not require the removal of overburden nor does it require the physical removal of the ore zone; (2) it is a wet process up to the stage of drying and packaging; and (3) modern dryers and

packaging systems do not have significant particulate discharges. Thus in the absence of significant particulate sources, radiological impacts on soils and sediments through aerial dispersal and subsequent deposition are not associated with modern ISR operations.

Experience shows that potential radiological impacts are almost exclusively associated with accidental spills from pipe leaks or ruptures that occur off of the process facility pad (i.e., within the wellfields and between the wellfields and the process facility). Spills occurring on the process pad are fully contained by the curbed volume of the pad and its sump system. It should be noted that an accidental spill from a pipe break in a wellfield does not necessarily result in a major impact on soils or sediments. Engineering controls and a management program based on the principles of ALARA provide a high degree of assurance that impacts will be minimal. To illustrate, a pipeline break would cause a loss in pressure and this would be quickly detected by the monitoring system. In addition to engineering controls, employees who are in the wellfields on a daily basis are trained to observe routinely the condition pipelines and wellheads. Leaks or breaks would be reported immediately. In the event of a break, the wetted area would be surveyed, sampled and recorded on a spill map. Soils with significantly elevated levels of uranium and radium-226 would be removed and disposed at a licensed site.

Knowing that potential impacts are attributed to pipeline ruptures and leaks, the pre-operational sampling program was designed to thoroughly characterize radiological baseline conditions in the areas most likely to experience potential impacts. A review of Exhibit D11-1(see map pocket), Nichols Unit-Soil and Sediment Sample Location Map, and Exhibit D11-2 (see map pocket) Hank Unit Soil and Sediment Sample Location Map in the attached Appendix D11 clearly shows that the focus of the baseline characterization was on the wellfield areas and the intermittent/ephemeral streams passing through the license area. A close examination of the map shows that sediment samples were collected from upstream and downstream locations in all of the streambeds. In addition to thoroughly sampling the wellfields and water courses, the radiological baseline was supplemented by including samples from areas within the license area (see sample sites labeled LAS on the map), the process facility location and the Rn-222/Gamma monitoring stations. Again, using Regulatory Guide 4.14 for general guidance, all soils and sediments were analyzed for Ra-226 and a large percentage of the total number of samples

included analyses for U, Pb-210 and Th-230. In brief, the extensive coverage of the sampling effort provides a representative radiological baseline against which operational activities can be measured.

2.9.1.2 Sampling Methodology

The sample site map and coordinates described above, guided field personnel to the sample site locations. Surface and subsurface soils were collected with a 3-inch diameter bucket auger. Surface soils were collected from surface to a depth of 6-inches, and subsurface soils were collected in 12-inch increments to a total depth of 36 inches. The depth increments generally follow Regulatory Guide 4.14.

To avoid cross-contamination, the sampler and other tools were cleaned after each use using paper towels and de-ionized water. Samples were placed in 1-gallon plastic freezer bags and stored in ice chests prior to delivery to the laboratory. While collecting the soil samples, gamma measurements were taken using a Ludlum Model 19 μR Survey Meter. The calibration date on the meter for the June 2007 survey was June 8, 2007. While holding the meter at waist level, the area at and proximate to the sample point was surveyed for approximately two minutes. Gamma levels were recorded along with the GPS coordinates for each site.

The procedure for collecting sediment samples varied slightly from the soil sampling methodology. Instead of a single incremental sample, several samples were taken around each site to form a composite sample. As with the soil samples, sediments were placed in 1-gallon plastic freezer bags and placed in ice chests prior to delivery to the laboratory. Gamma measurements were taken following the protocol just described.

2.9.1.3 Nichols Ranch Unit Results

Table 2-16, Radiological Background in Surface and Subsurface Soil - Nichols Ranch Unit, provides a summary of the analyses for each sample point as well as some basic statistical measures (minimum, maximum, average and standard deviation).

Table 2-16 Radiological Background in Surface and Subsurface Soil - Nichols Ranch Unit.

Sample Site	Depth Inches	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
R-1	0-6	1.85	2.1	0.3	0.8	0.2	0.7	0.1
R-2	0-6	1.42	0.9	0.2	0.8	0.2	ND	
R-3	0-6	1.93	1.1	0.2	0.7	0.2	ND	
R-4	0-6	2.58	1.1	0.2	1.2	0.2	ND	
R-5	0-6	1.66	0.1	0.1	0.6	0.1	ND	
SS-6	0-6				0.8	0.2		
SS-7	0-6				1.3	0.2		
SS-8	0-6	1.12	0.7	0.1	0.6	0.2	ND	
SS-9	0-6				0.8	0.2		
SS-10	0-6				0.9	0.2		
SS-11	0-6	1.39	ND		0.9	0.2	ND	
SS-12	0-6				0.3	0.2		
SS-13	0-6				0.8	0.2		
SS-14	0-6				0.9	0.2		
SS-15	0-6				0.6	0.2		
SS-16	0-6				1.5	0.2		
SS-17	0-6				0.8	0.2		
SS-18	0-6				0.8	0.2		
SS-19	0-6	1.64	ND		1.4	0.2	0.1	0.1
SS-20	0-6				0.8	0.1		
SS-21	0-6				2.4	0.2		
SS-22	0-6	1.89	ND		0.9	0.1	0.8	0.6
SS-23	0-6				0.6	0.1		
SS-24	0-6				0.4	0.1		
SS-25	0-6				0.5	0.1		
SS-26	0-6				0.7	0.1		
SS-27	0-6				0.7	0.1		
SS-28	0-6				0.7	0.1		
SS-29	0-6				0.8	0.1		
SS-30	0-6				1.2	0.1		
LAS-1	0-6	0.97	ND		0.4	0.1	0.3	0.1
LAS-2	0-6	2.96	ND		0.9	0.2	0.7	0.1
LAS-3	0-6	2.58	ND		0.8	0.2	0.3	0.1
LAS-4	0-6	1.37	ND		1.0	0.2	0.7	0.1
LAS-5**	0-6	4.72	ND		26.4	3.9	0.6	0.1
LAS-6	0-6	2.19	ND		1.3	0.2	0.6	0.1
LAS-7	0-6	1.73	1.0	0.4	1.0	0.2	0.5	0.1
LAS-8	0-6	1.51	ND		1.0	0.2	0.5	0.1

Table 2-16 (Continued)

Sample Site	Depth Inches	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
Plant Site								
Center	0-12	1.43	ND		1.0	0.2	0.5	0.1
	12-24	1.22	0.5	0.4	1.0	0.2	0.4	0.1
	24-36	1.37	ND		0.7	0.2	0.6	0.1
NW	0-6	1.43	0.4	0.1	1.2	0.2	ND	
NE	0-6	1.42	0.6	0.1	0.9	0.2	ND	
SE	0-6	1.2	0.3	0.1	1.1	0.2	ND	
SW	0-6	1.45	1.0	0.2	1.0	0.2	1.1	0.6
SB-4	0-12	2.7	ND		1.0	0.1	0.5	0.1
	12-24	3.95	ND		1.0	0.1	0.6	0.1
	24-36	2.34	ND		0.8	0.1	0.4	0.1
SB-5	0-12	1.00	ND		0.7	0.1	0.4	0.1
	12-24	1.35	1.6	0.4	0.6	0.1	0.4	0.1
	24-36	1.91	0.7	0.3	0.7	0.1	0.2	0.1
SB-6	0-12	1.29	ND		0.8	0.2	0.5	0.1
	12-24	1.8	0.5	0.4	1.6	0.2	0.4	0.1
	24-36	2.05	0.4	0.4	0.8	0.2	0.5	0.1
SB-7	0-12	1.01	ND		0.8	0.1	0.3	0.1
	12-24	1.45	ND		0.9	0.2	0.4	0.1
	24-36	1.73	ND		0.9	0.2	0.6	0.1
SB-8	0-12	1.88	ND		1.1	0.2	0.7	0.1
	12-24	2.23	ND		1.0	0.1	0.7	0.1
	24-36	2.59	ND		1.0	0.1	0.5	0.1

Table 2-16 (Continued)

Sample Site		Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
Surface Soil:								
Minimum		**0.97**	**0.1**		**0.3**		**0.1**	
Maximum		**4.72**	**1.1**		**26.4**		**1.1**	
Average		**1.69**	**0.7**		**0.9**		**0.6**	
Standard Deviation		**0.52**	**0.3**		**0.4**		**0.2**	
Subsurface Soil:								
Minimum		**1.00**	**0.4**		**0.6**		**0.2**	
Maximum		**3.95**	**1.6**		**1.6**		**0.7**	
Average	**0-12**	**1.55**	**ND**		**0.9**		**0.5**	
	12-24	**2.00**	**0.4**		**1.0**		**0.5**	
	24-36	**2.00**	**0.2**		**0.8**		**0.5**	

Notes:
R-1: Nearest Residence. R-1 through R-4: Rn-222 and Gamma Monitoring Locations.
*Reporting Limit: 0.50.
SS: Surface Soil.
SB: Subsurface Soil.
LAS: License Area Sample.
ND: Not Detected
See Exhibit D11-1 for sample site locations.
**U and Ra-226 values for LAS-5 appear to be anomalies and were not used in the statistics.

Most of the surface soil sample and all of the subsurface samples have typical background radiological characteristics (approximately 1 pCi/g or less). For comparison purposes, normal soils typically have a Ra-226 content of 1 pCi/g (NCRP Report No.78). With the exception of one site, (LAS-5), which had a Ra-226 level of 26 pCi/g, the table shows normal background levels. The elevated level at LAS-5 might be attributed to old exploration activities.

With respect to sediment, Table 2-17 Radiological Background in Sediment - Nichols Ranch Unit shows that 40% of the samples exceed normal background levels of 1 pCi/g for Ra-226. Elevated levels were detected at sample sites SD-1, 8, 9 and 10. A possible explanation for this departure could be that earlier exploration activities may have left ore zone cuttings on the surface.

Table 2-17 Radiological Background in Sediment - Nichols Ranch Unit.

Sample Site	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
SD-1	2.1	ND		16.2	3.0	0.5	0.1
SD-2	2.02	ND		0.6	0.1	0.5	0.1
SD-3	1.84	0.7	0.3	0.7	0.1	0.5	0.1
SD-4	1.77	ND		0.7	0.1	0.4	0.1
SD-5	1.96	2.0	0.4	1.0	0.2	0.4	0.1
SD-6	0.95	ND		0.5	0.1	0.2	0.1
SD-7	3.07	0.5	0.4	1.0	0.2	0.6	0.1
SD-8	2.67	1.8	0.4	32.2	4.2	1.0	0.2
SD-9	3.03	ND		23.5	3.6	0.6	0.1
SD-10	4.02	ND		19.4	3.3	0.9	0.1
Minimum	**0.95**	**ND**		**0.5**		**0.2**	
Maximum	**4.02**	**2.0**		**32.2**		**1.0**	
Average	**2.34**	**1.3**		**9.6**		**0.6**	
Standard Deviation	**0.87**	**0.8**		**12.1**		**0.2**	

Notes:
SD: Sediment.
*Reporting Limit: 0.50.
ND: Not Detected.
See Exhibit D-11-1 for sample site locations.

Because a significant percentage of the sites have elevated Ra-226, the average value 9.6 pCi/g is well in excess of normal background. Pb-210 was also detected at higher than normal background levels at two of the sites, resulting in a slightly higher than normal average.

2.9.1.4 Hank Unit Results

Table 2-18 Radiological Background in Surface and Subsurface Soil - Hank Unit provides a summary of the analyses for each sample point as well as some basic statistical measures (minimum, maximum, average and standard deviation). With just a few exceptions, the values in the table are within the expected ranges. Briefly, the average value for Ra-226 is 1.1 pCi/g, and this nearly matches the reference radium concentration of 1 pCi/g in normal soil (NCRP Report No. 78). Similarly, values for U, Th-230 and Pb-210 also fall within expected background ranges. One site, LAS-2, had the highest values for uranium (8.4 mg/kg), Pb-210 (1.2 pCi/g), Ra-226 (3.8 pCi/g) and Th-230 (2.5 pCi/g).

Table 2-18 Radiological Background in Surface and Subsurface Soil - Hank Unit..

Sample Site	Depth Inches	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
R-1	0-6	1.26	3.9	0.4	1.3	0.2	0.9	0.2
R-2	0-6	1.71	ND		0.5	0.1	ND	
R-3	0-6	1.04	ND		0.4	0.1	ND	
R-4	0-6	2.77	0.3	0.2	0.3	0.1	ND	
R-5	0-6	2.46	ND		1.0	0.2	ND	
SS-6	0-6				1.5	0.1		
SS-7	0-6	2.19	ND		1.7	0.2	1.2	0.6
SS-8	0-6				1.2	0.1		
SS-9	0-6				1.1	0.1		
SS-10	0-6				2.1	0.1		
SS-11	0-6				1.1	0.1		
SS-12	0-6				1.0	0.1		
SS-13	0-6				0.9	0.1		
SS-14	0-6				1.3	0.1		
SS-15	0-6				1.1	0.1		
SS-16	0-6	1.37	ND		1.3	0.2	ND	
SS-17	0-6				1.3	0.1		
SS-18	0-6				0.8	0.1		
SS-19	0-6				0.9	0.1		
SS-20	0-6				1.2	0.1		
SS-21	0-6				1.1	0.2		
SS-22	0-6				1.3	0.2		
SS-23	0-6				0.9	0.2		
SS-24	0-6				1.1	0.2		
SS-25	0-6	1.81	ND		1.0	0.2	1.2	0.6
SS-26	0-6				0.7	0.1		
SS-27	0-6				0.7	0.1		
SS-28	0-6				0.9	0.2		
SS-29	0-6				1.1	0.2		
SS-30	0-6				1.2	0.2		
SS-31	0-6				0.7	0.2		
SS-32	0-6				1.2	0.2		
SS-33	0-6				0.9	0.2		
SS-34	0-6	2.10	ND		1.3	0.2	1.2	0.5
SS-35	0-6				1.1	0.2		
LAS-1	0-6	1.60	0.5	0.1	0.9	0.1	0.3	0.1
LAS-2**	0-6	8.40	1.2	0.1	3.8	0.1	2.5	0.1
LAS-3	0-6	1.40	ND		0.8	0.1	0.4	0.1
LAS-4	0-6	1.00	ND		0.8	0.1	0.2	0.1
LAS-5	0-6	1.60	0.6	0.1	1.1	0.1	0.5	0.1
LAS-6	0-6	1.50	ND		0.9	0.1	0.4	0.1
LAS-7	0-6	1.00	0.3	0.1	0.6	0.1	0.3	0.1
LAS-8	0-6	1.10	ND		0.6	0.1	0.5	0.1

Table 2-18 (Continued)

Sample Site	Depth Inches	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
LAS-9	0-6	1.39	ND		1.3	0.2	0.7	0.2
LAS-10	0-6	1.47	ND		1.2	0.2	0.7	0.2
LAS-11	0-6	2.35	ND		1.0	0.2	0.5	0.2
LAS-12	0-6	2.40	ND		1.3	0.1	0.6	0.1
LAS-13	0-6	1.90	ND		1.2	0.1	0.8	0.1
LAS-14	0-6	1.50	0.3	0.1	1.0	0.1	0.5	0.1
SB-4	0-12	2.30	0.9	0.1	1.6	0.1	0.9	0.1
	12-24	2.00	0.7	0.1	1.1	0.1	0.5	0.1
	24-36	1.70	ND		0.8	0.1	0.4	0.1
SB-5	0-12	1.30	ND		0.9	0.1	0.5	0.1
	12-24	ND	0.7	0.1	1.1	0.1	0.4	0.1
	24-36	1.80	0.6	0.1	1.1	0.1	0.4	0.1
SB-6	0-12	1.60	0.3	0.1	1.2	0.1	0.5	0.1
	12-24	1.40	0.2	0.1	1.2	0.1	0.7	0.1
	24-36	1.60	ND		1.2		0.7	0.1
SB-7	0-12	3.11	ND		0.9	0.1	0.4	0.1
	12-24	2.33	ND		0.9	0.2	0.6	0.1
	24-36	3.62	ND		1.1	0.2	0.7	0.2
SB-8	0-12	1.43	ND		1.3	0.2	0.4	0.1
	12-24	1.42	ND		1.2	0.2	0.4	0.1
	24-36	1.60	ND		0.8	0.2	0.6	0.2
SB-9	0-12	1.13	ND		0.9	0.2	0.5	0.3
	12-24	1.30	ND		0.8	0.2	0.2	0.1
	24-36	1.43	ND		1.0	0.2	0.6	0.3
Plant Site								
Center	0-12	1.35	ND		1.0	0.2	0.5	0.1
	12-24	1.28	ND		0.9	0.2	0.7	0.1
	24-36	1.57	0.7	0.04	0.9	0.2	0.5	0.1
NW	0-6	1.83	ND		1.0	0.2	ND	
NE	0-6	2.18			1.0	0.2	0.9	0.5
SE	0-6	1.82	ND		1.2	0.2	ND	
SW	0-6	1.67	0.3	0.2	1.0	0.2	ND	
Surface Soil:								
Minimum		**1.00**	**0.3**		**0.3**		**0.2**	
Maximum		**8.40**	**0.6**		**2.1**		**1.2**	
Average		**1.73**	**0.4**		**1.0**		**0.6**	
Standard Deviation		**0.48**	**0.1**		**0.3**		**0.3**	

Table 2-18 (Continued)

Subsurface Soil:					
Minium				**0.8**	**0.2**
Maximum				**1.6**	**0.9**
Average	**0-12**	**1.75**	**0.2**	**1.1**	**0.5**
	12-24	**1.39**	**0.2**	**1.0**	**0.5**
	24-36	**1.90**	**0.2**	**0.8**	**0.6**

Notes:
R-1: Nearest Residence. R-1, 2, 3, 4 and 5: Rn-222 and Gamma Monitoring Locations.
*Reporting Limit: 0.50.
SS: Surface Soil.
SB: Subsurface Soil.
LAS: License Area Sample.
ND: Not Detected
See Exhibit D11-2 for sample site locations.
**Values for LAS-2 appear to be anomalies and were not used in the statistics.

Radiological background levels were measured at 26 different sediment sample sites at the Hank Unit. Table 2-19 Radiological Background in Sediment - Hank Unit summarizes the individual values and provides basic statistical information (minimum, maximum, average and standard deviation). Sample site SD-25 has a Pb-210 value (2.5 pCi/g) that is a few times higher than normal background but the rest of the sites are typical of what one would normally expect to find.

2.9.2 Baseline Gamma Survey

2.9.2.1 Purpose and Procedure

The purpose of a gamma survey is the same as it is for establishing other radiological levels; namely to characterize baseline conditions. Baselines serve as a backdrop against which operational impacts can be measured.

Table 2-19 Radiological Background in Sediment - Hank Unit.

	Uranium mg/kg*	Pb-210 pCi/g	Precision Plus/Minus	Ra-226 pCi/g	Precision Plus/Minus	Th-230 pCi/g	Precision Plus/Minus
SD-1	2.8	ND		1.3	0.2	0.7	0.1
SD-2	3.5	ND		1.1	0.2	0.5	0.1
SD-3	2.5	0.4	0.2	1.0	0.2	0.6	0.1
SD-4	1.3	0.5	0.2	1.1	0.2	0.6	0.1
SD-5	1.8	1.8	0.3	1.0	0.2	0.6	0.1
SD-6	1.8	0.7	0.2	1.6	0.2	0.8	0.1
SD-7	2.6	ND		1.4	0.2	0.8	0.1
SD-8	3.1	0.6	0.1	1.4	0.2	0.7	0.1
SD-9	2.7	0.9	0.1	1.6	0.2	1.0	0.2
SD-10	2.6	0.6	0.1	0.8	0.2	0.5	0.1
SD-11	2.5	ND		1.1	0.2	0.5	0.1
SD-12	2.1	ND		1.2	0.2	0.7	0.1
SD-13	1.91	ND		0.9	0.2	0.5	0.2
SD-14	2.80	ND		1.4	0.2	0.6	0.2
SD-15	2.92	ND		2.2	0.2	0.6	0.2
SD-16	2.52	ND		1.0	0.2	0.3	0.1
SD-17	1.98	ND		1.0	0.2	0.5	0.1
SD-18	3.46	ND		1.2	0.2	0.9	0.2
SD-19	2.23	ND		0.9	0.2	0.3	0.1
SD-20	1.85	ND		0.8	0.2	0.2	0.1
SD-21	2.17	ND		1.2	0.2	0.4	0.1
SD-22	3.74	ND		1.9	0.2	1.1	0.2
SD-23	1.91	ND		1.3	0.2	1.0	0.2
SD-24	2.08	ND		0.9	0.2	0.3	0.1
SD-25	1.18	2.5	0.5	1.0	0.2	0.6	0.1
SD-26	1.79	ND		1.0	0.2	0.4	0.2
Minium	**1.18**	**ND**		**0.8**		**0.2**	
Maximum	**3.74**	**2.5**		**2.2**		**1.1**	
Average	**2.38**	**1.0**		**1.2**		**0.6**	
Standard Deviation	**0.65**	**0.7**		**0.3**		**0.2**	

Notes:
SD: Sediment.
*Reporting Limit: 0.50.
ND: Not Detected.
See Exhibit D11-2 for sample locations.

The gamma survey that was performed for the project site differs in pattern from the survey described in Regulatory Guide 4.14. The layout of the pattern given in the guide is based on a conventional mine and mill, which have significant particulate source terms. Particulate sources at ISR facilities are negligible. Because of the vast difference between ISR and conventional mining and milling, a procedure was developed to measure baseline gamma levels in a more concentrated pattern in the areas where operational activities will occur. Since the operational areas are the most likely targets for potential impacts, these areas were given a higher degree of sampling. Referring back to the discussion in the soils section, it was noted that potential impacts on soils and sediments from ISR operations is attributed to accidental spills from pipeline breaks or leaks.

This aspect of potential impact played a major part in the baseline sampling pattern for soils, sediments and gamma. In addition to the large number of gamma readings taken throughout the future production area and process site, readings were also taken in the drainages passing through the license area; at the nearest residence; and near the license boundary. Exhibit D11-3 (of the attached Appendix D11) Nichols Ranch Unit – Gamma Sample Location Map, shows the sample sites within and near the license boundary.

2.9.2.2 Survey Methodology

A Ludlum Model 19 μR Survey Meter was the instrument used in the gamma survey. The calibration date on the meter for the June 2007 survey was June 8, 2007. As described in the soils section of the application, a sample site map was developed prior to conducting the survey. Gamma measurements were recorded by holding the meter at waist level and slowly passing it over each soil/sediment sample point and over the area proximate to the sample location.

2.9.2.3 Nichols Ranch Unit Results

Table 2-20 summarizes the gamma readings and cross-references the gamma sites with the soil and sediment sample locations. A total of 57 gamma measurements were taken over an area of approximately 116 acres. The 116 acre-area consisted of the future production areas (113 acres)

Table 2-20 Nichols Ranch Unit Gamma/Soil and Sediment Sample Locations.

Sample Site	µR/hr	Gamma Site
R-1 Dry Fork Ranch	13	G-54
R-2	14	G-55
R-3	12	G-56
R-4	13	G-57
SS-6 Nichols URZ	15	G-45
SS-7 Nichols URZ	15	G-40
SS-8 Nichols URZ	12	G-36
SS-9 Nichols URZ	12	G-32
SS-10 Nichols URZ	13	G-20
SS-11 Nichols URZ	13	G-17
SS-12 Nichols URZ	14	G-14
SS-13 Nichols URZ	13	G-12
SS-14 Nichols URZ	13	G-11
SS-15 Nichols URZ	13	G-8
SS-16 Nichols URZ	13	G-7
SS-17 Nichols URZ	13	G-5
SS-18 Nichols URZ	13	G-4
SS-19 Nichols URZ	14	G-1
SS-20 Nichols URZ	12	G-2
SS-21 Nichols URZ	15	G-6
SS-22 Nichols URZ	13	G-9
SS-23 Nichols URZ	12	G-13
SS-24 Nichols URZ	11	G-16
SS-25 Nichols URZ	12	G-18
SS-26 Nichols URZ	13	G-24
SS-27 Nichols URZ	13	G-33
SS-28 Nichols URZ	12	G-37
SS-29 Nichols URZ	14	G-41
SS-30 Nichols URZ	13	G-47
LAS-1 Nichols URZ	12	G-21
LAS-2 Nichols URZ	11	G-23
LAS-3 Nichols URZ	13	G-35
LAS-4 Nichols URZ	13	G-44
LAS-5 Nichols URZ	13	G-51
LAS-6 Nichols URZ	13	G-46
LAS-7 Nichols URZ	14	G-38
LAS-8 Nichols URZ	13	G-25

Table 2-20 (Continued)

Sample Site	µR/hr	Gamma Site
SB-4 Nichols URZ	12	G-3
SB-5 Nichols URZ	11	G-26
SB-6 Nichols URZ	12	G-43
SB-7 Nichols URZ	13	G-42
SB-8 Nichols URZ	13	G-22
Plant Site:		
Center	13	G-29
Northwest	13	G-27
Northeast	13	G-28
Southeast	13	G-31
Southwest	13	G-30
Minimum	**11**	
Maximum	**15**	
Average	**13**	
Standard Deviation	**1**	
SD-1 Nichols URZ	13	G-53
SD-2 Nichols URZ	13	G-10
SD-3 Nichols URZ	12	G-15
SD-4 Nichols URZ	13	G-19
SD-5 Nichols URZ	13	G-39
SD-6 Nichols URZ	11	G-34
SD-7 Nichols URZ	14	G-48
SD-8 Nichols URZ	15	G-49
SD-9 Nichols URZ	15	G-50
SD-10 Nichols URZ	13	G-52
Minimum	**11**	
Maximum	**15**	
Average	**13**	
Standard Deviation	**1**	

Notes:
R-1through R-4 are the locations of the baseline Rn-222 and Gamma monitors.
SS: Surface Soil Site.
SB: Subsurface Soil Site.
SD: Sediment Sample Site.
LAS: License Area Sample.
See Exhibits D11-1 and D11-3 for sample site locations.

and the plant site (3 acres). On a per acre basis, the density of the survey was 1 reading per 2 acres.

As can be readily seen from Table 2-20, gamma readings are for the most part tightly grouped between 12 to 13 μR/hr. The average, minimum and maximum values are not unusual for this part of the U.S. To illustrate, the values recorded at the Nichols Ranch Unit are very much in line with earlier surveys completed at nearby North Butte. In brief, the detailed gamma survey completed at the North Butte ISL project site in 1979 was compared to a verification survey conducted by Uranerz in 1992. The mean gamma reading in the verification study was 11.7 μR/hr and the range was 11 to 13 μR/hr. These values were consistent with the North Butte survey. When compared to the average natural background range for the U.S. (8 to 15 μR/hr), it can be seen that the Nichols project site falls near the high end of the average.

There are a few sites with slightly elevated gamma levels of 15 μ R/hr. Some of the 15 μ R/hr values correspond with some of the soil and sediments sites that had elevated levels of Ra-226. For example, SS-21 has a radium value of 2.4 pCi/g; SD-8 radium is 32 pCi/g; and SD-9 radium is 23.5 pCi/g.

Although it is well known that gamma readings taken with a general survey-type meter do not have a high degree of correspondence with chemically-measured radium content, a higher-than-background gamma reading (usually 2.5 to 3 times background) can serve as a first level screening test for detecting sites that might have elevated levels of radionuclides. In summary, the density of the survey and its consistent values provide reasonable assurance that a representative baseline was established.

2.9.2.4 Hank Unit Results

Table 2-21 summarizes the gamma readings and cross-references the gamma sites with the soil and sediment sample locations. A total of 86 gamma readings were recorded across the site (see Exhibit D11-4 [of the attached Appendix D11]). Although the survey was designed to thoroughly characterize baseline conditions in the areas where activities will occur (production areas and process facility site), it also provided background levels for sites at the license

Table 2-21 Hank Unit Gamma/Soil and Sediment Sample Locations.

Sample Site	µR/hr	Gamma Site
R-1 Pfsister Ranch Hank URZ	13	G-82
R-2	13	G-83
R-3	12	G-84
R-4	11	G-85
R-5	14	G-86
SS-6 Hank URZ	15	G-5
SS-7 Hank URZ	15	G-7
SS-8 Hank URZ	12	G-9
SS-9 Hank URZ	12	G-10
SS-10 Hank URZ	14	G-11
SS-11 Hank URZ	13	G-14
SS-12 Hank URZ	13	G-15
SS-13 Hank URZ	13	G-20
SS-14 Hank URZ	13	G-21
SS-15 Hank URZ	13	G-23
SS-16 Hank URZ	13	G-28
SS-17 Hank URZ	12	G-32
SS-18 Hank URZ	13	G-40
SS-19 Hank URZ	13	G-41
SS-20 Hank URZ	14	G-44
SS-21 Hank URZ	14	G-48
SS-22 Hank URZ	14	G-50
SS-23 Hank URZ	12	G-52
SS-24 Hank URZ	14	G-53
SS-25 Hank URZ	12	G-81
SS-26 Hank URZ	13	G-57
SS-27 Hank URZ	12	G-61
SS-28 Hank URZ	13	G-62
SS-29 Hank URZ	14	G-64
SS-30 Hank URZ	13	G-66
SS-31 Hank URZ	13	G-67
SS-32 Hank URZ	14	G-68
SS-33 Hank URZ	15	G-71
SS-34 Hank URZ	13	G-75
SS-35 Hank URZ	13	G-76
LAS-1 Hank URZ	14	G-17
LAS-2 Hank URZ	18	G-25
LAS-3 Hank URZ	13	G-18
LAS-4 Hank URZ	12	G-24
LAS-5 Hank URZ	13	G-30
LAS-6 Hank URZ	13	G-31

Table 2-21 (Continued)

Sample Site	µR/hr	Gamma Site
LAS-7 Hank URZ	11	G-46
LAS-8 Hank URZ	12	G-42
LAS-9 Hank URZ	14	G-59
LAS-10 Hank URZ	13	G-47
LAS-11 Hank URZ	15	G-55
LAS-12 Hank URZ	13	G-43
LAS-13 Hank URZ	14	G-34
LAS-14 Hank URZ	14	G-29
SB-4	16	G-6
SB-5	12	G-16
SB-6	13	G-33
SB-7	14	G-51
SB-8	12	G-65
SB-9	13	G-77
Plant Site:		
Center	13	G-37
Northwest	15	G-35
Northeast	13	G-36
Southeast	13	G-39
Southwest	13	G-38
Minimum	**11**	
Maximum	**18**	
Average	**13**	
Standard Deviation	**1**	
SD-1 Hank URZ	14	G-1
SD-2 Hank URZ	16	G-3
SD-3 Hank URZ	14	G-2
SD-4 Hank URZ	11	G-4
SD-5 Hank URZ	13	G-12
SD-6 Hank URZ	13	G-13
SD-7 Hank URZ	15	G-8
SD-8 Hank URZ	15	G-19
SD-9 Hank URZ	14	G-22
SD-10 Hank URZ	14	G-27
SD-11 Hank URZ	15	G-26
SD-12 Hank URZ	14	G-80
SD-13 Hank URZ	16	G-49
SD-14 Hank URZ	13	G-45
SD-15 Hank URZ	18	G-54
SD-16 Hank URZ	17	G-58

Table 2-21 (Continued)

Sample Site	µR/hr	Gamma Site
SD17 Hank URZ	15	G-60
SD-18 Hank URZ	17	G-56
SD-19 Hank URZ	16	G-63
SD-20 Hank URZ	15	G-70
SD-21 Hank URZ	17	G-72
SD-22 Hank URZ	16	G-73
SD-23 Hank URZ	14	G-69
SD-24 Hank URZ	14	G-74
SD-25 Hank URZ	13	G-79
SD-26 Hank URZ	13	G-78
Minimum	**11**	
Maximum	**18**	
Average	**15**	
Standard Deviation	**2**	

Notes:
R-1 through R-5 are the locations of the baseline Rn-222 and Gammma monitors.
SS: Surface Soil Site.
SB: Subsurface Soil Site.
SD: Sediment Sample Site.
LAS: License Area Site.
See Exhibits D11-2 and D11-4 for sample site locations.

boundary, nearest residence and numerous stream courses passing through and near the site. Based on the approximate 156 acres in the production areas and the 3-acre process facility site, the resulting survey density is 1 reading per 2 acres.

As can be seen from Table 2-21, gamma readings do not vary significantly across the area. However, there are a few sites with elevated gamma (16 to 18 µ R/hr levels). Comparing the elevated gamma levels with the soil and sediment analyses show some correspondence. Sample site LAS-2, for example, has the highest gamma level of 18 µ R/hr and it also has the highest U (8.4 mg/kg), Pb-210 (1.2 pCi/g), Ra-226 (3.8 pCi/g) and Th-230 (2.5 pCi/g) values.

As shown below, the minimum, maximum and average values recorded at the Hank Unit compare favorably with those measured at the Nichols Ranch Unit.

	Nichols Ranch Unit (μR/hr)	Hank Unit (μR/hr)
Minimum	11	11
Maximum	15	18
Average	13	13

Between the Hank Unit and the Nichols Ranch Unit, there are 143 gamma sample points. With a combined area of 275 acres (production areas and plant site areas), the overall survey density is one sample per two acres. This density, coupled with the close agreement between the measurements taken at both sites, provides a good baseline for gamma levels.

2.9.3 Baseline Radon-222 and Direct Gamma Exposure Rates

2.9.3.1 Purpose and Procedure

As noted in the discussion on soil and sediment baseline sampling, ISR operations do not generate significant levels of particulates, but they do have Rn-222 emissions, which include radon daughter products with varying half-lives. For this reason, ambient baseline Rn-222 levels should be established. In establishing the baseline, the monitoring procedure outlined in Regulatory Guide 4.14 was followed, and it involved deploying Rn-222 detectors and gamma dosimeters at suggested locations.

2.9.3.2 Survey Methodology

The detectors that were used in the one-year monitoring program were Landauer Extra Sensitive Outdoor Rn-222 Detectors and X-9 Gamma Dosimeters. Prior to installing the detectors, the prevailing wind direction was obtained from the National Climatic Data Center for Gillette. The data covered a period from 1996 through 2005. Data from this period was compared to data from Casper and to a data collected between 1978 and 1979 by AeroVironment for Cleveland Cliffs Iron Company (CCI), who operated a meteorological station near North Butte

(Pathfinder Mines Corporation, 1988). CCI's baseline data was used in support of their NRC license application for the North Butte ISL Project. A comparison of the databases showed that Casper has a stronger southwest/west-southwest/south-southwest component, while North Butte and Gillette have a component from the south/southwest/southeast.

The detectors were deployed and retrieved at the same time for each location. Exposure time was on a quarterly basis. Detector locations included: (1) the nearest residence or structure that could be occupied; (2) locations at or near the license boundary; and (3) a control point to reflect background (upwind of the site). Exhibits D11-3 and D11-4 (of the attached Appendix D11) show the locations of the Rn-222 and gamma dosimeters.

Given that the prevailing wind direction is from the south, two monitoring stations were placed in the northern parts of both sites see previously referenced Exhibits D11-3 and D11-4 (of the attached Appendix D11). In contrast, control detectors were placed in the extreme southern parts of the license areas. During operations, the downwind monitors will reflect the maximum change from baseline while the control detectors will measure the minimum change. In addition to these placements, two monitors were placed near the license boundary on the east and west side of the Hank Unit and one was placed at a nearest residence (Dry Fork Ranch), which is approximately 1.3 mi to the southwest of the process facility location.

2.9.3.3 Nichols Ranch Unit Results

The one-year monitoring results are given in Table 2-22. A comparison of the values shows background levels to be within the expected range. When compared to historical radon levels measured over a one year period (1988-1989) at the nearby North Butte Project site, it can be seen that values at Nichols are not surprisingly different. North Butte's annualized average was 0.8 pCi/l compared to Nichols' 1.2 pCi/l average. Because radon levels are known to vary widely from place to place, the difference between 0.8 pCi/l and 1.2 pCi/l is not significant. It must also be remembered that some of difference between the two annual averages can be attributed to the detectors. Significant improvements have been made in this area over the past 10 years. As noted above, Extra Sensitive detectors were used in the monitoring program at the Nichols and Hank Units. Differences in the prevailing weather conditions at the two sites would also play a role in the background concentrations.

Table 2-22 Ambient Radon-222 Levels - Nichols Ranch Unit.

		Fourth Quarter (10/06 to 1/07) pCi/l	First Quarter (1/07 to 3/07) pCi/l	Second Quarter (4/07 to 7/07) pCi/l	Third Quarter (7/07 to 10/07) pCi/l
R-1	Nearest Residence	1.2	0.7	0.9	1.1
R-2	Upwind Control	0.9	0.8	1.1	1.7
R-3	Downwind Boundary	0.6	27.7*	2.3	1.4
R-4	Downwind Boundary	0.7	0.8	1.9	1.4
	Site Averages	0.9	0.8	1.6	1.4

1. *The adhesive that holds the detector within the protective housing failed and the detector was found on the ground. The anomalous value was not used in the average.
2. The annualized average for all sites combined is 1.2 pC/l.
3. The annualized average measured between 1988 and 1989 at the nearby North Butte; Project was 0.8 pCi/l.
4. The U.S. average outdoor Rn-222 level is 0.4 pCi/l (U.S. EPA).

Both sites have ambient radon levels that are much above the U.S. average. According to EPA, the U.S. outdoor average radon concentration is 0.4 pCi/l. The higher-than-background levels are not surprising given that with the exception of two counties, Weston and Platte, indoor radon levels in Wyoming are at or above the EPA Action Level of 4 pCi/l (EPA, 2007). The indoor average for the U.S. is 1.3 pCi/l--this puts Wyoming at 3 times the average.

Background gamma exposure rates from the one year monitoring program are summarized in Table 2-23. The averages range from 35 mrem to 48 mrem. When compared to the gamma survey results from the North Butte Project mentioned earlier, the values are similar. The North Butte quarterly averages ranged from 32.3 mrem to 39.7 mrem. To put these values into perspective, the following exposure rates are given.

- Average dose to the U.S. Public from natural sources: 300 mrem.
- Background radiation (total) in the Colorado Plateau: 75 to 140 mrem.
- Terrestrial background (Rock Mountains): 40 mrem.
- Average dose to the public from all sources: 360 mrem.

Table 2-23 Background Gamma Exposure Rate - Nichols Ranch Unit.

		Fourth Quarter (10/06 to 1/07) mrems	First Quarter (1/07 to 3/07) mrems	Second Quarter (4/07 to 7/07) mrems	Third Quarter (7/07 to 10/07) mrems
R-1	Nearest Residence (Dry Fork Ranch)	34.7	41.1	49.3	37.4
R-2	Downwind Boundary (Northwest)	36.4	41.9	48.2	38.0
R-3	Boundary (Northeast)	35.2	49.4	41.1	39.1
R-4	Upwind Control (South)	33.6	57.6	52.8 (LP)	44.0
Site Averages		35.0	47.5	47.9	39.6

Notes: LP: Low energy photon.

2.9.3.4 Hank Unit Results

Not unexpectedly, Rn-222 levels measured at the Hank Unit match up well with those just discussed for the Nichols Ranch Unit. The one high value (9.2 pCi/l) was caused by the detector being on the ground for some unknown period of time. This value was not used in calculating the average shown on Table 2-24. Background gamma exposure rates from the one year monitoring program are summarized in Table 2-25. The averages range from 34.4 mrem to 55 mrem. Once again these results are very similar to the Nichols Ranch Unit results and those of the historic North Butte results.

2.9.4 Flora and Fauna

2.9.4.1 Purpose and Procedure

The purpose of establishing baseline radiological conditions prior to initiating operations is to have a reference for comparing potential impacts. When designing a pre-operational baseline sampling program, the operational features of the activity should be kept in mind. In other words, particular attention should be given to the pathways through which contaminants could

Table 2-24 Ambient Radon-222 Levels - Hank Unit.

		Fourth Quarter (10/06 to 1/07) pCi/l	First Quarter (1/07 to 3/07) pCi/l	Second Quarter (4/07 to 7/07) pCi/l	Third Quarter (7/07 to 10/07) pCi/l
R-1	Nearest Residence	1.2	1.2	1.4	2.2
R-2	Downwind Boundary	0.4	0.6	0.7	3.4
R-3	Boundary	0.5	0.3	0.9	1.4
R-4	Upwind Control	0.3	9.2*	1.0	1.0
R-5	Boundary	0.4	0.5	0.8	1.7
Site Averages		0.6	0.6	1.0	1.9

Notes:
1. *The adhesive that holds the detector within the protective housing failed and the detector was found on the ground. The anomalous value was not used in the average.
2. The annualized average for all sites combined is 1.0 pC/l.
3. The annualized average measured between 1988 and 1989 at the nearby North Butte; Project was 0.8 pCi/l.
4. The U.S. average outdoor Rn-222 level is 0.4 pCi/l (U.S. EPA).

Table 2-25 Background Gamma Exposure Rate - Hank Unit.

		Fourth Quarter (10/06 to 1/07) mrems	First Quarter (1/07 to 3/07) mrems	Second Quarter (4/07 to 7/07) mrems	Third Quarter (7/07 to 10/07) mrems
R-1	Nearest Residence (Pfister Ranch)	33.5	39.0	45.1	H
R-2	Downwind Boundary (North)	33.5	50.0 (LP)	49.9	H
R-3	Boundary (Northwest)	33.5	40.5	53.9	44.0
R-4	Upwind Control (South)	34.1	114.5 (LP)	51.8	39.1
R-5	Boundary (Southeast)	37.5	31.3	52.0	41.4
Site Averages		34.4	55.0	50.5	41.5

enter the environment. In developing the baseline sampling program, pathways were considered in conjunction with guidance given in Regulatory Guide 4.14.

According to Section 2.1.4 in Regulatory Guide 4.14, vegetation, food and fish samples should be collected if, in individual licensing cases, a significant pathway to man is identified. As discussed in Sections 2.9.1.1 and Section 7.3 of Chapter 7.0 of this report, pathways for radiological contaminants to enter the environment from modern ISR operations have been markedly reduced or virtually eliminated. ISR operations do not have fluid discharges nor do they generate significant particulate emissions. The main avenue for radiological constituents to enter the environment is limited to the emission of Rn-222. Because emissions are restricted to nearly-particulate-free Rn-222, significant build up of radionuclides in soil, vegetation and other media is not likely to occur. The minimal accumulation of radionuclides is supported by MILDOS modeling results, and is borne out in operational monitoring data that had been collected at various ISR facilities over the past 25 years.

The baseline sampling program was modified somewhat from the guidance given in Regulatory Guide 4.14. Departure from the guide is discussed in the Methods Section below. While developing the pre-operational baseline studies, it was understood through experience and through the evolution of ISR, that pathways to flora and fauna and hence to human populations are not significant. The reasons supporting this assertion were given above and are discussed in other sections of this application.

Even though potential impacts from ISR operations on flora, fauna and the food chain have been shown to be insignificant, good baseline characterizations continue to be an important part of a RML application. Measured baseline values can be compared to values during actual operations to validate the minimal to no-impact prediction of the MILDOS model. Additionally, having baseline data to compare with values recorded during operations, underscores the fact that modern ISR activities do not have a significant impact on human health and the environment. Following is a description of the baseline sampling program that was performed at the Nichols Ranch Unit and the Hank Unit.

2.9.4.2 Methods

Regulatory Guide 4.14 suggests that vegetation, crops, livestock and fish samples should be collected and analyzed for Ra-226 and Pb-210. According to the field reconnaissance, no permanent surface water exists at or immediately adjacent to the sites. Given the absence of water, fish too are absent. The sites were surveyed for the presence a crop-growing areas and none was found. Agricultural activities appear to be limited to cattle grazing. Although the guide suggests sacrificing livestock to obtain samples, it is Uranerz's opinion that this is not necessary for ISR operations. To reiterate, ISR operations do not cause significant build up of radionuclides in soil or vegetation and therefore a significant pathway for exposure does not exist. In addition, since operational monitoring will include routine sampling of vegetation, food crops (if they are grown in the area) and grazing/forage foods, a mechanism will be in place to monitor this pathway to local fauna.

Given this setting, baseline sampling included samples from grazing areas and vegetation from the nearest residences and Rn-222/gamma monitoring locations. Grab samples were collected in mid-August. While collecting the samples, care was taken to clip the vegetation approximately one inch above the ground to avoid mixing with surface soil. Samples were placed in large plastic bags and transported to the laboratory with 24 hours of collection. All samples were analyzed for Ra-226, Pb-210, Po-210, Th-230, Uranium, Arsenic and Selenium.

2.9.4.3 Nichols Ranch Unit Results

Table 2-26 summarizes the radiological and nonradiological (arsenic and selenium) background concentrations found in the samples. Although there is the usual variation in concentrations for the radiometric parameters, the values are within normal background ranges. The same generalization can be made for the arsenic and selenium values.

Table 2-26 Radiological and Nonradiological Background Levels in Vegetation Nichols Ranch Unit.

	Radiological Elements				
Sample Location	Ra-226 (µCi/kg)	Pb-210 (µCi/kg)	Po-210 (µCi/kg)	Th-230 (µCi/kg)	Uranium (µCi/kg)
R-1 Dry Fork Ranch	3.7E-04	4.2E-04	9.3E-05	3.7E-06	1.1E-04
+/-	5.1E-06	2.9E-05	2.7E-05	1.8E-06	4.6E-07*
R-2 Control Upwind	8.8E-05	4.5E-04	1.5E-04	2.8E-06	6.6E-05*
+/-	6.0E-06	2.3E-05	2.3E-05	4.2E-06	3.0E-07*
R-3 Downwind NE	1.4E-04	7.5E-04	1.1E-04	3.6E-05	9.5E-05*
+/-	8.0E-06	3.0E-05	2.3E-05	4.4E-04	3.3E-07*
R-4 Downwind NW	2.7E-04	6.6E-04	9.9E-05	1.4E-04	2.4E-04*
+/-	1.1E-05	2.6E-04	2.2E-05	9.9E-06	2.8E-07*
Grazing Area	6.7E-05	4.3E-04	7.2E-05	2.4E-05	8.3E-05*
+/-	4.2E-06	1.8E-05	1.7E-05	3.6E-05	2.1E-07*

	Non-radiological Elements			
Sample Location	Arsenic (mg/kg-dry)	RL*	Selenium (mg/kg-dry)	RL*
R-1 Dry Fork Ranch	ND	0.5	ND	0.5
R-2 Control Upwind	ND	0.5	ND	0.5
R-3 Downwind NE	1.0	0.5	0.7	0.5
R-4 Downwind NW	0.7	0.5	1.3	0.5
Grazing Area	ND	0.5	1.2	0.5

2.9.4.4 Hank Unit Results

Background values for the Hank Unit are given in Table 2-27. A comparison of the concentrations with those reported for the Nichols Ranch Unit shows a great deal of consistency. In brief, the values are not unusual for baseline conditions.

2.9.5 Radon Flux

Regulatory Guide 4.14 indicates that radon flux measurements should be conducted at eight locations within 1.5 km of the site. Because there will be no tailings impoundments or evaporation ponds at the Nichols Ranch ISR Project, radon flux is not an applicable radiological parameter for baseline characterization. Radon flux measurements have not been collected in support of this project and none are planned in association with future monitoring schedules.

2.10 BACKGROUND NONRADIOLOGICAL CHARACTERISTICS

2.10.1 Nonradioactive Airborne Effluents

Nonradioactive airborne effluents associated with the Nichols Ranch ISR Project are those discussed in Section 2.5.6 Air Quality. Since the effluents will be generated during construction and operation of the Nichols Ranch ISR Project, no baseline information was collected or could be collected. Estimates of the airborne effluents associated with the operation Nichols Ranch ISR Project processing facilities, such as CO_2, HCL, H_20_2, NaOH, and Fugitive Dust, are found in Table 2-7.

Table 2-27 Radiological and Nonradiological Background Levels in Vegetation Hank Unit.

	Radiological Elements				
Sample Location	Ra-226 (µCi/kg)	Pb-210 (µCi/kg)	Po-210 (µCi/kg)	Th-230 (µCi/kg)	Uranium (µCi/kg)
R-1 Pfister Ranch	7.5E-05	4.0E-04	4.1E-05	2.3E-06	4.5E-05
+/-	5.7E-06	2.1E-05	1.3E-05	3.6E-06	2.8E-07*
R-2 Downwind	4.6E-05	5.8E-04	2.9E-05	2.0E-05	4.9E-05*
+/-	2.0E-06	2.1E-05	8.5E-06	4.5E-06	2.1E-07*
R-3 West Boundary	6.3E-05	2.5E-04	1.5E-04	6.8E-06	1.5E-05*
+/-	6.1E-06	2.1E-05	2.9E-05	2.1E-06	3.9E-07*
R-4 Control South	7.3E-05	2.6E-04	4.9E-05	2.4E-05	4.5E-05*
+/-	5.4E-06	1.8E-05	1.3E-05	4.2E-06	2.8E-07*
R-5 East Boundary	9.6E-05	5.9E-04	1.1E-04	3.5E-05	7.1E-07*
+/-	6.9E-06	2.8E-05	2.8E-05	4.9E-06	3.4E-07
Grazing Area	6.7E-05	2.5E-04	5.9E-05	8.1E-06	4.0E-05*
+/-	7.0E-06	2.4E-05	2.3E-05	2.7E-06	4.5E-07*

	Non-radiological Elements			
Sample Location	Arsenic (mg/kg-dry)	RL*	Selenium (mg/kg-dry)	RL*
R-1 Pfister Ranch	ND	0.5	0.8	0.5
R-2 Downwind	ND	0.5	0.6	0.5
R-3 West Boundary	1.0	0.5	ND	0.5
R-4 Control South	ND	0.5	ND	0.5
R-5 East Boundary	ND	0.5	1.7	0.5
Grazing Area	ND	0.5	1.0	0.5

Notes: *RL is the reporting limit for U.
+/- is the counting error.

2.10.2 Nonradioactive Liquid Effluents

Nonradioactive effluents will not be discharged to the environment during the operation of the Nichols Ranch ISR Project. The processing plants will be zero discharge facilities as all nonradioactive effluents will be sent to the deep disposal well. Because of this, no background information was obtained or necessary.

2.10.3 Nonradioactive Baseline Studies

Baseline studies where conducted for soils, vegetation, and ground water for the Nichols Ranch ISR Project. All studies were conducted based upon consultation and approval of the Wyoming Department of Environmental Quality.

2.10.3.1 Soils

A baseline detailed soil inventory was conducted for the Nichols Ranch ISR Project to inventory the pre-operational soil characteristics with the project area. The attached Appendix D7 contains all of the information that was collected during the baseline survey. The information includes an inventory of soil types (soil map units) and soil series based on the Order 3 soil survey, a base map delineating the soil types, physical and chemical characteristics of the topsoil for potential disturbance areas, and estimated depths of salvageable topsoil from the potential disturbance areas for future reclamation purposes.

2.10.3.2 Vegetation

Baseline vegetation studies of the Nichols Ranch ISR Project were conducted to establish a detailed inventory of the pre-operational vegetation characteristics within and adjacent to the proposed project area. The study was also use to provide baseline vegetative information for evaluating future reclamation success with the project area. The attached Appendix D8 contains all information collected during the baseline study including a description of the vegetation types

and their distribution, species diversity, and composition, percent vegetative and percent total ground cover, and existing disturbances with the project area.

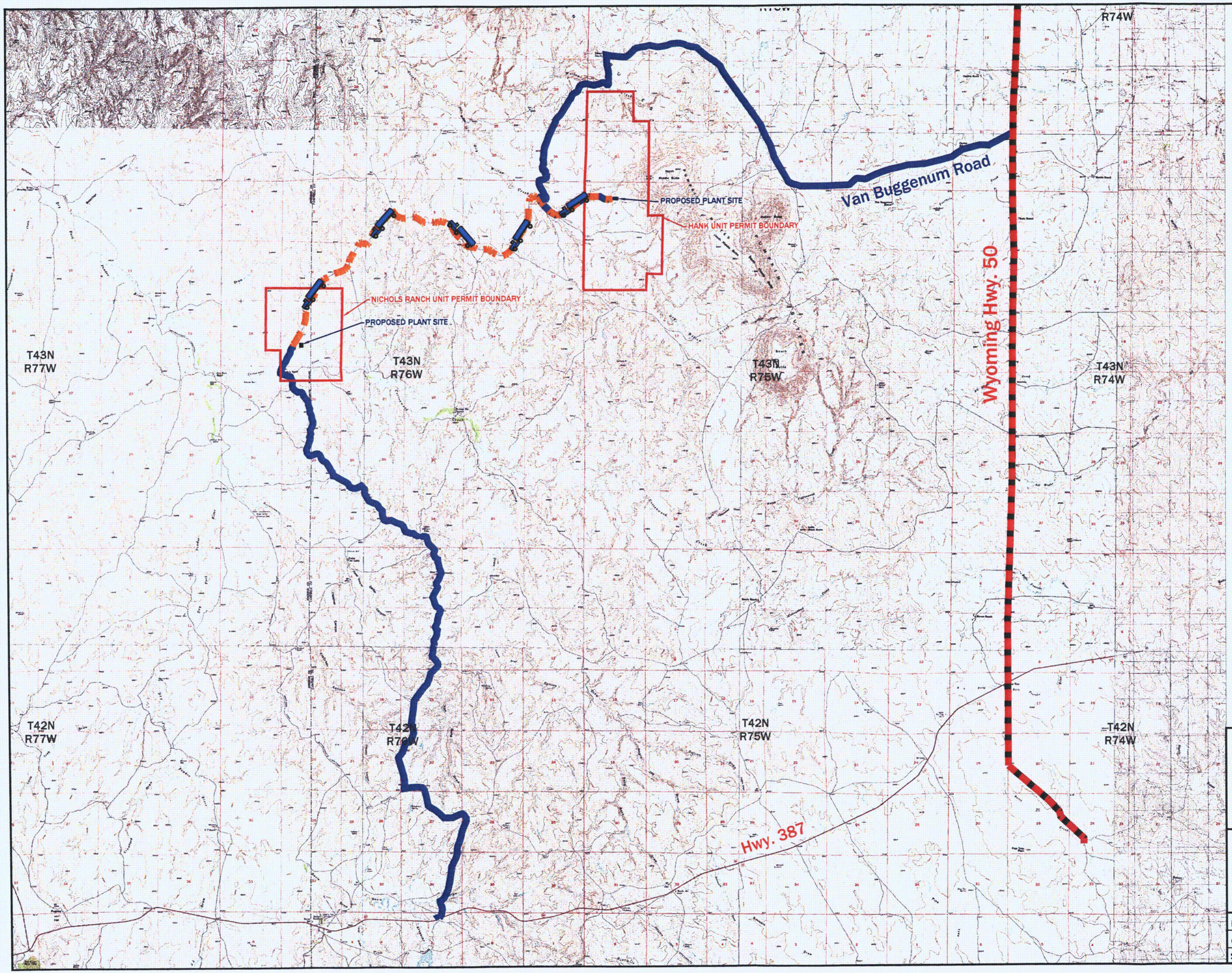
2.10.3.3 Groundwater

A pre-operational regional ground water baseline water quality survey was conducted for the Nichols Ranch ISR Project. The regional ground water quality was defined by the sampling of numerous wells in several aquifers in the area surrounding the Nichols Ranch ISR Project. The baseline study included collecting samples from the numerous regional wells once a calendar quarter for a year and having them analyzed for the constituents found in Table 2-28. These samples were collected to determine the regional ground water characteristics in order to aid in evaluating future restoration success and for excursion detection in the event that one were to occur. The attached Appendix D6 contains detailed information on the regional baseline water quality results. Section 2.7 of this chapter also contains information regarding the results of the baseline study.

Table 2-28 Groundwater Baseline Water Quality Parameters.

Parameter*	**Analytical Method**
Ammonia Nitrogen as N	EPA 350.1
Nitrate + Nitrite as N	EPA 353.2
Bicarbonate	EPA 310.1/310.2
Boron	EPA 212.3/200.7
Carbonate	EPA 310.1/310.2
Fluoride	EPA 340.1/340.2/340.3
Sulfate	EPA 375.1/375.2
Total Dissolved Solids (TDS) @ 180°F	EPA 160.1/SM2540C
Dissolved Arsenic	EPA 206.3/200.9/200.8
Dissolved Cadmium	EPA 200.9/200.7/200.8
Dissolved Calcium	EPA 200.7/215.1/215.2
Dissolved Chloride	EPA 300.0
Dissolved Chromium	EPA 200.9/200.7/200.8
Total and Dissolved Iron	EPA 236.1/200.9/200.7/200.8
Dissolved Magnesium	EPA 200.7/242.1
Dissolved Manganese	EPA 200.9/200.7/200.8/243.1/243.2
Dissolved Molybdenum	EPA 200.7/200.8
Dissolved Potassium	EPA 200.7/258.1
Dissolved Selenium	EPA 270.3/200.9/200.8
Dissolved Sodium	EPA 200.7/273.1
Dissolved Zinc	EPA 200.9/200.7/200.8
Radium-226 (pCi/L)	DOE RP450/EPA 903.1/SM7500-R-AD
Radium-228 (pCi/L)	SM7500-R-AD
Gross Alpha (pCi/L)	DOE RP710/CHEM-TA-GP B1/EPA 900
Gross Beta (pCi/L)	DOE RP710/CHEM-TA-GP B1/EPA 900
Uranium	DOE MM 800/EPA 200.8
Vanadium	EPA 286.1/286.2/200.7/200.8

* All parameters measured in mg/L unless otherwise denoted.



SCALE: 1"=8000'

0 4000 8000 feet

LEGEND

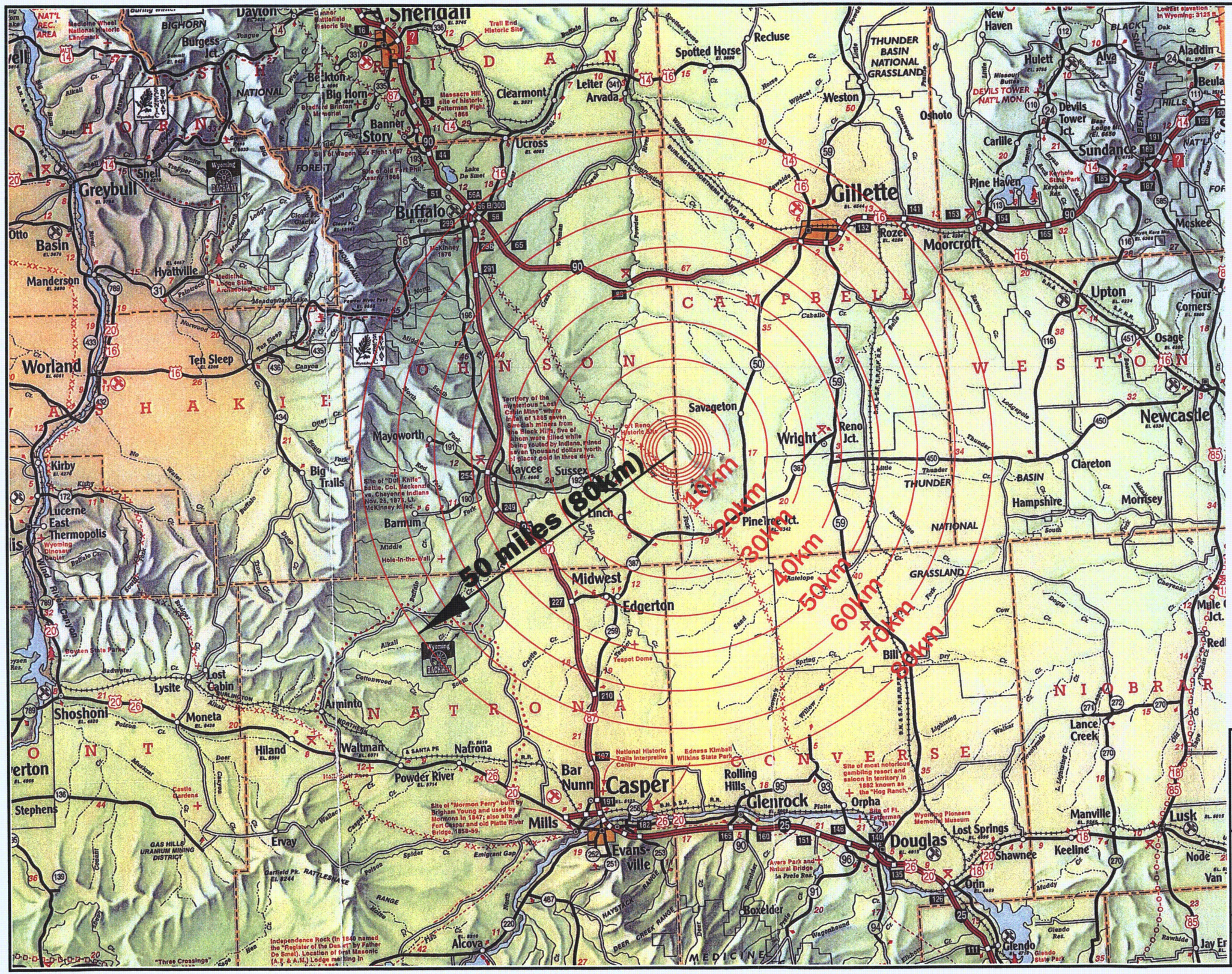
- ACCESS ROAD
- HIGHWAYS
- RESIN TRANSFER ROUTE

Uranerz
ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

NICHOLS RANCH ISR PROJECT

FIGURE 2-1
ACCESS ROADS AND RESIN TRANSFER ROUTE

By: S.M.F.	Date: 10/15/2007
Contour Interval: 20 FEET	Revision Date:
Scale: 1"=8000'	Datum: NAD 27 UTM 13



SCALE: 1"=80,000'

0 40,000 80,000 feet

Uranerz ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

NICHOLS RANCH ISR PROJECT

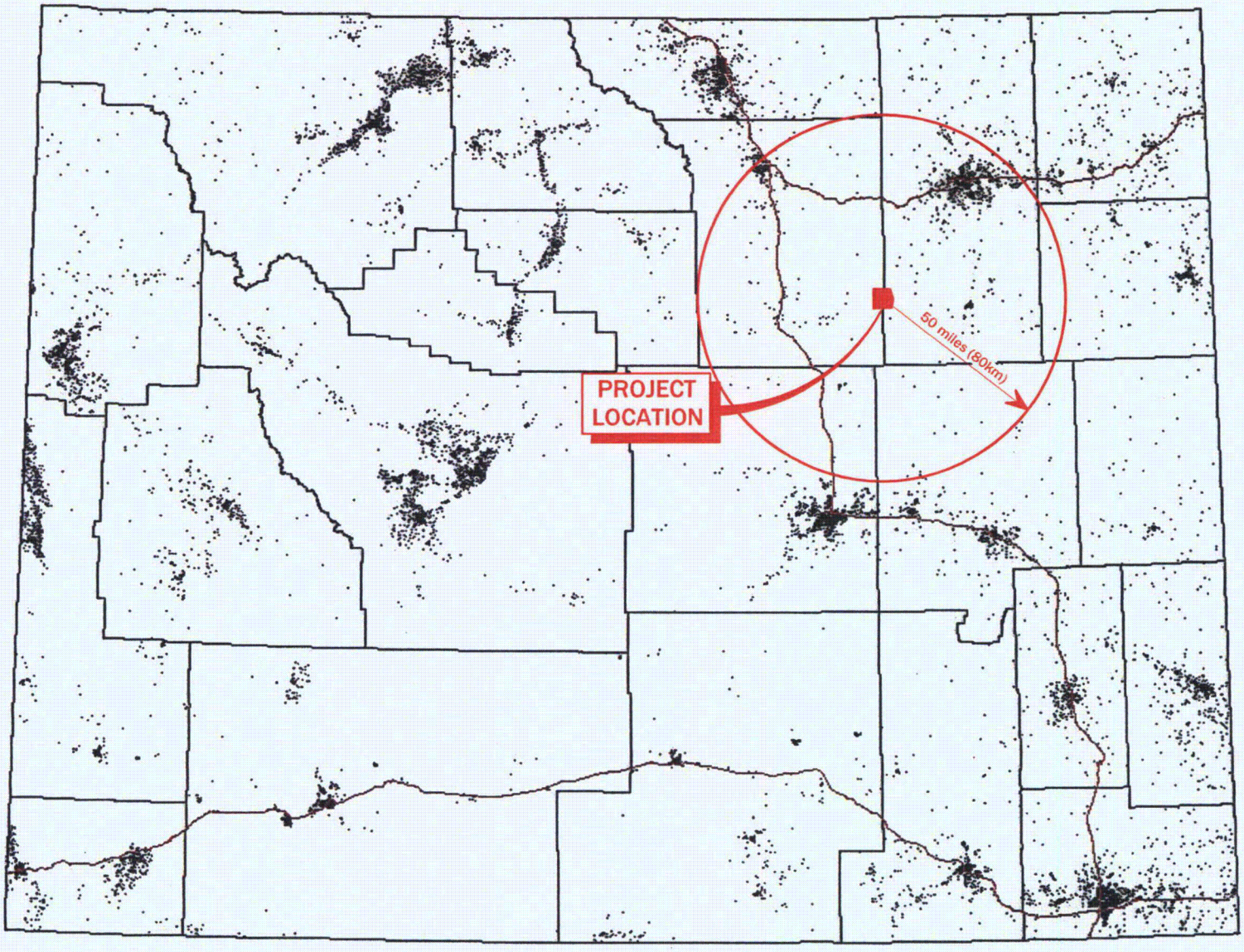
FIGURE 2-2

LOCATION OF TOWNS AND CITIES WITHIN 50 MILES (80km) OF PROJECT AREA

Drawn By: S.M.F.	Date: 10/15/2007
Contour Interval: N/A	Revision Date:
Scale: 1"=80,000'	DATUM: N/A

Population Density Map for Wyoming: 2000

1 dot = 10 persons Total population = 493,782



Prepared by Wyoming Department of A & I, Division of Economic Analysis

SCALE: 1"=240,000'

0 120,000 240,000 feet

Uranerz
ENERGY CORPORATION
1701 East "E" Street
P.O. Box 50850
Casper, Wyoming
USA 82605-0850

NICHOLS RANCH ISR PROJECT

FIGURE 2-3

POPULATION DENSITY MAP FOR WYOMING WITHIN 50 MILES (80km) OF PROJECT AREA

Drawn By: S.M.F.	Date: October 15, 2007
Datum: N/A	Revision Date:
Scale: 1"=240,000'	Contour Interval: N/A

CAMPBELL COUNTY

COUNTY EMPLOYMENT STATISTICS: 2004 Average	
Labor Force	22,455
Employment	21,755
Unemployment	700
Unemployment Rate	3.1%
Weekly Wage - Covered employment*	$786

*Source: State of Wyoming, Department of Employment *Source: U.S. Department of Labor, Bureau of Labor Statistics*

COUNTY FINANCE	
Assessed Valuation (For 2005)	$3,660,527,493
Total Property Taxes Levied (2005)	$216,758,364
Sales and Use Tax Distribution (FY2005)	$42,815,186
Bank Deposits (6/30/2005)	$571,362,000
2005 Avg. County Levy (mills)	59.215

Source: State of Wyoming, Department of Revenue and Department of Audit

POPULATION BY AGE: 2004		Percent
Under 5 years	2,518	6.9
5 to 14 years	5,329	14.5
15 to 19 years	3,107	8.5
20 to 24 years	3,033	8.3
25 to 34 years	4,784	13.0
35 to 44 years	5,608	15.3
45 to 54 years	6,961	19.0
55 to 64 years	3,335	9.1
65 to 74 years	1,281	3.5
75 years & over	765	2.1
TOTAL	36,721	100.0

Source: U.S. Census Bureau

RACE AND HISPANIC ORIGIN	2004 Estimate	% of Total
TOTAL	36,721	100.0%
White alone	35,689	97.2%
Black or African American alone	79	0.2%
American Indian and Alaska Native alone	385	1.0%
Asian alone	142	0.4%
Native Hawaiian and Other Pacific Islander alone	42	0.1%
Two or More Races	384	1.0%
Race alone or in combination with one or more races:		
White	36,063	98.2%
Black or African American	123	0.3%
American Indian and Alaska Native	649	1.8%
Asian	221	0.6%
Native Hawaiian and Other Pacific Islander	49	0.1%
Hispanic Origin:		
Hispanic or Latino (of any race)	1,529	4.2%
Non-Hispanic or Latino	35,192	95.8%
White alone	34,281	93.4%

Note: Hispanic is an ethnic origin not a race. *Source: U.S. Census Bureau*

CRIME INDEX OFFENSES BY CONTRIBUTOR: 2004	
Violent Crimes	54
Murder	0
Forcible Rape	7
Robbery	2
Aggravated Assault	45
Property Crimes	1,277
Burglary	137
Larceny-Theft	1,106
Motor Vehicle Theft	34
TOTAL	1,331

Source: State of Wyoming, Attorney General's Office, DCI

LANDOWNERS	Acres	Sq Miles
United States Government National Park Service	0	0.0
Forest Service	143,754	224.6
Fish and Wildlife	0	0.0
Bureau of Land Management	231,418	361.6
Bureau of Reclamation	0	0.0
Wyoming		
State Lands Commission	186,082	290.8
Recreation Commission	0	0.0
Game and Fish	0	0.0
Local Government		
County	1,387	2.2
City	972	1.5
School Districts & Colleges	272	0.4
Other Lands	7,819	12.2
Surface Water	3,072	4.8
Total Public	571,704	893.3
Total Private	2,495,176	3,898.7
TOTAL LAND	3,066,880	4,792.0

Source: University of Wyoming, Department of Geography & Recreation

SELECTED STATISTICS: SCHOOL YEAR 2003 - 2004	
Number of School Districts	1
Number of Schools	20
Fall Enrollment	7,234
High School Graduates	493
Average Daily Membership (ADM)	7,155
Average Daily Attendance (ADA)	6,745
Certified Teachers	537
Certified Staff	50
Administration	36
Classified Staff	600
Students Transported Daily	2,853
Bonded Indebtedness, 6/30/2004	$8,980,000
Total General Fund Revenues	$61,817,872
Total General Fund Expenditures	$59,446,584
Operating Cost Per ADM	$9,917

Source: State of Wyoming, Department of Education, Statistical Report Series No. 3, annual

Figure 2-4 Campbell County Profile.

JOHNSON COUNTY

COUNTY EMPLOYMENT STATISTICS: 2004 Average	
Labor Force	3,798
Employment	3,669
Unemployment	129
Unemployment Rate	3.4%
Weekly Wage - Covered employment*	$463

*Source: State of Wyoming, Department of Employment *Source: U.S. Department of Labor, Bureau of Labor Statistics*

COUNTY FINANCE	
Assessed Valuation (For 2005)	$210,600,217
Total Property Taxes Levied (2005)	$15,014,968
Sales and Use Tax Distribution (FY2005)	$3,749,458
Bank Deposits (6/30/2005)	$223,661,000
2005 Avg. County Levy (mills)	71.296

Source: State of Wyoming, Department of Revenue and Department of Audit

POPULATION BY AGE: 2004		Percent
Under 5 years	319	4.2
5 to 14 years	907	11.8
15 to 19 years	518	6.8
20 to 24 years	545	7.1
25 to 34 years	755	9.9
35 to 44 years	902	11.8
45 to 54 years	1,312	17.1
55 to 64 years	1,041	13.6
65 to 74 years	700	9.1
75 years & over	658	8.6
TOTAL	7,657	100.0

Source: U.S. Census Bureau

RACE AND HISPANIC ORIGIN	2004 Estimate	% of Total
TOTAL	7,657	100.0%
White alone	7,511	98.1%
Black or African American alone	7	0.1%
American Indian and Alaska Native alone	54	0.7%
Asian alone	17	0.2%
Native Hawaiian and Other Pacific Islander alone	0	0.0%
Two or More Races	68	0.9%
Race alone or in combination with one or more races:		
White	7,579	99.0%
Black or African American	11	0.1%
American Indian and Alaska Native	108	1.4%
Asian	25	0.3%
Native Hawaiian and Other Pacific Islander	2	0.0%
Hispanic Origin:		
Hispanic or Latino (of any race)	173	2.3%
Non-Hispanic or Latino	7,484	97.7%
White alone	7,350	96.0%

Note: Hispanic is an ethnic origin not a race. *Source: U.S. Census Bureau*

CRIME INDEX OFFENSES BY CONTRIBUTOR: 2004	
Violent Crimes	21
Murder	0
Forcible Rape	0
Robbery	0
Aggravated Assault	21
Property Crimes	179
Burglary	31
Larceny-Theft	142
Motor Vehicle Theft	6
TOTAL	200

Source: State of Wyoming, Attorney General's Office, DCI

LANDOWNERS	Acres	Sq Miles
United States Government National Park Service	0	0.0
Forest Service	326,881	510.8
Fish and Wildlife	0	0.0
Bureau of Land Management	502,588	785.3
Bureau of Reclamation	0	0.0
Wyoming		
State Lands Commission	217,474	339.8
Recreation Commission	34	0.1
Game and Fish	12,223	19.1
Local Government		
County	(a)	(a)
City	(a)	(a)
School Districts & Colleges	(a)	(a)
Other Lands	8,618	13.5
Surface Water	5,389	8.4
Total Public	1,067,817	1,668.5
Total Private	1,603,991	2,506.2
TOTAL LAND	2,671,808	4,174.7

(a) - Data not available

Source: University of Wyoming, Department of Geography & Recreation

SELECTED STATISTICS: SCHOOL YEAR 2003 - 2004	
Number of School Districts	1
Number of Schools	8
Fall Enrollment	1,222
High School Graduates	88
Average Daily Membership (ADM)	1,234
Average Daily Attendance (ADA)	1,160
Certified Teachers	107
Certified Staff	17
Administration	12
Classified Staff	81
Students Transported Daily	582
Bonded Indebtedness, 6/30/2004	$0
Total General Fund Revenues	$11,466,879
Total General Fund Expenditures	$11,604,690
Operating Cost Per ADM	$10,710

Source: State of Wyoming, Department of Education, Statistical Report Series No. 3, annual

Figure 2-5 Johnson County Profile.

NATRONA COUNTY

COUNTY EMPLOYMENT STATISTICS: 2004 Average	
Labor Force	39,872
Employment	38,387
Unemployment	1,485
Unemployment Rate	3.7%
Weekly Wage - Covered employment*	$621

*Source: State of Wyoming, Department of Employment *Source: U.S. Department of Labor, Bureau of Labor Statistics*

COUNTY FINANCE	
Assessed Valuation (For 2005)	$753,353,114
Total Property Taxes Levied (2005)	$52,323,685
Sales and Use Tax Distribution (FY2005)	$36,632,691
Bank Deposits (6/30/2005)	$1,047,516,000
2005 Avg. County Levy (mills)	69.454

Source: State of Wyoming, Department of Revenue and Department of Audit

RACE AND HISPANIC ORIGIN	2004 Estimate	% of Total
TOTAL	69,010	100.0%
White alone	66,337	96.1%
Black or African American alone	628	0.9%
American Indian and Alaska Native alone	840	1.2%
Asian alone	289	0.4%
Native Hawaiian and Other Pacific Islander alone	24	0.0%
Two or More Races	892	1.3%
Race alone or in combination with one or more races:		
White	67,215	97.4%
Black or African American	880	1.3%
American Indian and Alaska Native	1,336	1.9%
Asian	438	0.6%
Native Hawaiian and Other Pacific Islander	69	0.1%
Hispanic Origin:		
Hispanic or Latino (of any race)	3,440	5.0%
Non-Hispanic or Latino	65,570	95.0%
White alone	63,193	91.6%

Note: Hispanic is an ethnic origin not a race. *Source: U.S. Census Bureau*

POPULATION BY AGE: 2004		Percent
Under 5 years	4,328	6.3
5 to 14 years	8,902	12.9
15 to 19 years	5,076	7.4
20 to 24 years	5,643	8.2
25 to 34 years	8,350	12.1
35 to 44 years	9,355	13.6
45 to 54 years	11,221	16.3
55 to 64 years	7,384	10.7
65 to 74 years	4,569	6.6
75 years & over	4,182	6.1
TOTAL	69,010	100.0

Source: U.S. Census Bureau

CRIME INDEX OFFENSES BY CONTRIBUTOR: 2004	
Violent Crimes	131
Murder	0
Forcible Rape	7
Robbery	16
Aggravated Assault	108
Property Crimes	3,354
Burglary	643
Larceny-Theft	2,527
Motor Vehicle Theft	184
TOTAL	3,485

Source: State of Wyoming, Attorney General's Office, DCI

LANDOWNERS	Acres	Sq Miles
United States Government National Park Service	0	0.0
Forest Service	5,598	8.7
Fish and Wildlife	1,535	2.4
Bureau of Land Management	1,447,641	2,261.9
Bureau of Reclamation	28,599	44.7
Wyoming		
State Lands Commission	388,020	606.3
Recreation Commission	516	0.8
Game and Fish	147	0.2
Local Government		
County	8,255	12.9
City	7,418	11.6
School Districts & Colleges	537	0.8
Other Lands	8,536	13.3
Surface Water	22,931	35.8
Total Public	1,896,802	2,963.8
Total Private	1,660,318	2,594.2
TOTAL LAND	3,557,120	5,558.0

Source: University of Wyoming, Department of Geography & Recreation

SELECTED STATISTICS: SCHOOL YEAR 2003 - 2004	
Number of School Districts	1
Number of Schools	36
Fall Enrollment	11,590
High School Graduates	671
Average Daily Membership (ADM)	11,420
Average Daily Attendance (ADA)	10,576
Certified Teachers	803
Certified Staff	166
Administration	81
Classified Staff	834
Students Transported Daily	3,562
Bonded Indebtedness, 6/30/2004	$2,055,000
Total General Fund Revenues	$90,844,048
Total General Fund Expenditures	$89,363,566
Operating Cost Per ADM	$9,373

Source: State of Wyoming, Department of Education, Statistical Report Series No. 3, annual

Figure 2-6 Natrona County Profile.