CHAPTER I. LOCAL DATA

A narrative describing local topography, industry, agriculture, population densities, culture, wildlife, and fish and other aquatic life within the area of review and existing economic activities of the region including, but not limited to, agriculture, recreation, tourism and industry with a projection as to the probable effects of the system.

RESPONSE:

I.1 Uses of Adjacent Lands and Waters

The information in this section provides relevant data concerning the physical, ecological, and social characteristics of the proposed North Trend Expansion Area (NTEA), and the surrounding environment for uranium in-situ mining.

This section indicates the nature and extent of present and projected land and water use and trends in population or industrial patterns. The information in this section was initially developed over a 9-month period in 1982 as part of the Nuclear Regulatory Commission (NRC) Research and Development (R&D) License Application, updated in 1987 for the NRC Commercial License Application, and application and supporting environmental report for the State of Nebraska Underground Injection Control Program Commercial License; and updated in 1997 and 2006/2007 for the respective NRC License Renewal Application. Preliminary data were obtained from several sources followed by field studies to collect on-site data to check land uses. Interviews with various state and local officials provided additional information. In 2006, Crow Butte Resources, Inc. (CBR) submitted a request for a license amendment to increase the plant throughput from 5,000 to 9,000 gallons per minute (gpm). The NRC issued an Environmental Assessment and Finding of No Significant Impact on October 24, 2007. The NRC issued the license amendment on November 30, 2007.

A license renewal request for an amendment to the existing Source Material License (SUA-1534) for the development of the NTEA Satellite Facility was submitted to the NRC on May 30, 2007. Population, land use, and water use data were re-evaluated by CBR during the spring of 2004 specifically for the NTEA. These original data were updated through additional data collection and review, personal communications, and site reconnaissance. Population distribution characteristics were updated in 2004 as well. This land use information gathered in 2004 was reviewed in 2006, 2007, and 2008, and in some cases, updated as needed and where information was available. Overall, the information presented is deemed to be representative of current conditions in the NTEA and surrounding area.

Land use within the NTEA and a 2.25-mile review area is illustrated on **Figure I.1-1**. Little change has been noted in area land use in the past 23 years, reflecting the stagnant nature of economic activity in the area and slight decline in the populations of the City of Crawford and Dawes County.

I.1.1 General Setting

Dawes County has three distinct topographic regions including the Dawes Table lands in the southern half of the county, the Pine Ridge region that runs west to east through the center of the county, and the grasslands of the Pierre Hills. The Pine Ridge escarpment is composed of low hills and often precipitous bluffs marked by buttes, deeply cut canyons filled with Ponderosa Pines, and spring-fed streams and creeks (Louis Berger Group 2005). The Pierre Hills, north of the Pine Ridge, is an area characterized by rolling, short-grass prairie with narrow creeks. The Dawes Tablelands are located south of the Pine Ridge.

The NTEA is located in west-central Dawes County, Nebraska, just north and west of the Pine Ridge Area. The topography consists of low rolling hills dominated by the Pine Ridge.

The Rocky Mountains (located to the west of the site) and the Black Hills (located to the north) effectively block moisture from these directions while moisture from the south is directed eastward by a plateau south of the region. As a result of this topography, the project area is generally drier than the rest of the panhandle.

Figure I.1-1 shows land use in the general location of the proposed NTEA. **Table I.1-1** provides a description of the land use types depicted on **Figure I.1-1**.

The proposed NTEA satellite plant is located approximately 2.0 miles north of the city limits of the City of Crawford (**Figure Appl.1-1** of Application) and approximately 4.5 miles northwest of the current process plant. State Highway 2/71 runs along the east boundary of the NTEA. State Highway 2/71 provides access to the project area north of Crawford. U.S. Highway 20 provides access to Crawford and the project area from points east and west.

I.1.2 Land Use

Land use within the NTEA and an Area of Review (AOR) (2.25-mile radius boundary) around the NTEA is illustrated on **Figure I.1-1. Table I.1-1** describes the land use types depicted on **Figure I.1-1**. The AOR includes the zone of endangering influence (ZOEI) fixed 0.25-mile radius around the project permit boundary, plus an area of 2 miles in radius extending beyond the ZOEI (NDEQ Title 122, Chapter 14, Section 001).

I.1.2.1 North Trend Expansion Area

Table I.1-2 presents land uses in 22 1/2° sectors centered on each of 16 compass points radiating out from the geographic center of the NTEA. **Table I.1-1** explains each of the land use types. Rangeland comprises the greatest portion of land use within the NTEA and surrounding 2.25-mile review area (47 percent), cropland (39 percent), recreation (10 percent), forest land (1 percent), urban land (1 percent), and residential land (2 percent) are the other significant land uses (Table I.1-2).

The primary land use, specifically in the NTEA, is cropland, primarily for the production of wheat. A small amount of cropland in the NTEA is used for producing alfalfa. In 2003, the total wheat production in Dawes County was 1,836,500 bushels, an increase of 169 percent over the 2002 wheat production of 682,200 bushels.

Livestock raising is a major land use activity within the NTEA and the surrounding 2.25-mile review area. While most of the land within the NTEA is cropland, most of the review area is rangeland, resulting in a higher proportion of land used for grazing. In 2003, an average of 48,000 head of livestock was reported in Dawes County (NASS 2004a). Native grasslands are used for grazing or for cut hay. Livestock values have remained consistent between the years 1990 and 2001, the last year for which livestock values are available. In 2001, cash receipts for livestock and products totaled $21.0 million in Dawes County.

Recreational lands also are present in Dawes County (see **Table I.1-3**). Recreational opportunities provided by federal and state lands in the county have become an increasingly important component of the local economy. A portion of Fort Robinson State Park, the largest state park in Nebraska, is located within the 2.25-mile review area for the NTEA. Approximately 9 percent of the area within a 5-mile (8-km) radius of the current license area site is located within the Fort Robinson State Park. This part of the state park is west of Crawford, and includes portions of the Red Cloud Agency Historical Site, the White River Trail, and several scenic landforms in a rugged area of buttes and Ponderosa Pine forest.

Other facilities at the Fort Robinson State Park include lodging, showers, electrical hookups, pit toilets, ski and snowmobile trails, a rodeo arena, and a museum. Visitors to the park may go hunting, fishing, hiking, swimming, or horseback riding. Other recreational facilities in Dawes County include the Ponderosa Wildlife Management Area, Chadron State Park, Soldier Creek Management Unit, and the Red Cloud Picnic Area and associated trails in the Nebraska National Forest (NGPC 2007).

There are a number of privately owned and operated recreational facilities within a 50-mile radius of the NTEA. For example, there are guest ranches that provide a variety of activities including horseback riding, hiking, hunting/fishing, biking, and bird viewing. Golfing is also available in the area (e.g., Legend Buttes and Ridgeview Country Clubs located near Crawford and Chardon, respectively).

The Oglala National Grassland is a U.S. National Grassland located approximately 2 ½ miles from the north end of the NTEA. It extends from the northwest corner of Dawes County into Sioux County. The grassland occupies 94,400 acres (382 square kilometers [km^2]), and is one of the few National Grasslands administered by the U.S. Department of Agriculture's Forest Service (Olsen, E. 1997). The Oglala National Grassland is home to some of the most striking badlands formations in Toadstool Geological Park. In addition, the Hudson-Meng Bison Kill, located within the grassland is an archaeological excavation in progress. The grassland also contains the Agate, Bordgate, and Rock Bass Reservoirs.

The Buffalo Gap National Grassland is located in southwest South Dakota. The southern end of the Grassland is located approximately 17½ miles from the north end of the NTEA permit boundary. This grassland is the second largest National Grassland, which includes mixed prairie and chalky badlands (Olsen, E. 1997). As with the Oglala National Grassland, it is managed by the U.S. Forest Service.

Residential and industrial land uses in the county are concentrated within the city limits of Crawford and Chadron. Industrial land uses are located within the city limits of Crawford, and occur primarily around railroad facilities.

I.1.2.1.1 Agriculture

Several of the soil types found in the vicinity of the NTEA are classified as prime farmland. However, in Dawes County, soils are classified by the Natural Resources Conservation Service (NRCS) as prime farmland only if irrigated. According to 2004 Nebraska State Agricultural Statistics, only 2 percent of Dawes County agricultural land is irrigated, and about 10 percent of harvested cropland acreage is irrigated. The remainder of the irrigated land is used for pasture, habitat, or rangeland (NASS 2007b).

Tables I.1-4 and **I.1-5** show agricultural productivity within Dawes County and the NTEA. Most of these crops are used for livestock feed while the remaining crops are commercially sold. Data for the acres of land planted and harvested, and production for beans, sunflowers, and sugar beets, were last reported by the National Agricultural Statistics Service (NASS 2004b) for the years 2001 and 2002. These crops are not produced in the Permit Area and surrounding 2.25-mile buffer area. The livestock inventory for Dawes County indicates that cattle account for more than 94 percent of all livestock (**Table I.1-6**). According to a report prepared for the Economic Development Department of the Nebraska Public Power Corporation (NPPC 2005), the market value of livestock products accounted for 85.7 percent of the total market value of all agricultural products sold in 2002. Livestock and livestock products carried a value of $28.81 per acre, indicating that livestock production on rangeland within the review area (9,532 acres) has a potential value of more than $275,000.

I.1.2.1.2 Habitat

Habitat lands are those dedicated wholly or partially to the production, protection, or management of species of fish or wildlife. Significant areas classified as habitat include the Ponderosa State Wildlife Management Area, which is south of the NTEA and adjacent to the current license area as shown in **Figure I.1-1**. Deer and turkey hunting are permitted within the Ponderosa State Wildlife Management Area. There is no land within the license area that is used primarily for wildlife habitat. Wildlife habitat is a secondary use of rangeland, forestland, and recreational land within the license area and the 2.25-mile review area.

I.1.2.1.3 Residential

Based on a site reconnaissance (conducted in June 2004 and updated in February 2008) and a Nebraska Department of Natural Resources (NDNR) aerial photo of the license area, there is one occupied housing unit in the NTEA (Figure C.1-3). This resident will remain, at his or her discretion, at the current location during operations at the North Trend site. Within a 2.25-mile area of review (AOR) of the NTEA boundary, the City of Crawford contains 537 housing units, of which 473 are occupied. Within the 2.25-mile AOR and outside the NTA boundary, an estimated 49 occupied rural housing units are located outside of the city limits of Crawford (US Census 2000). There are a total of 50 occupied rural housing units within the 2.25-mile review area, including the NTEA.

Table I.1-7 shows the distance to the nearest residence and to the nearest site boundary of residences within the 2.25-mile radius review area from the center of the NTEA for each 22 1/2° sector centered on each compass point.

There are no dwelling units within 0.62 mile (1 km) of the center point of the proposed NTEA. Four dwelling units are within 1.24 miles (2 km) of the center point. **Table I.1-8** shows the distance to the nearest residence and to the nearest site boundary from the center of the site for each 22 1/2° sector centered on each compass point for the proposed NTEA.

I.1.2.1.4 Commercial and Services

There are retail and commercial establishments within Crawford and at Fort Robinson State Park. Commercial establishments are also secondary uses of some residential areas in Crawford. The four largest establishments include the Legend Buttes Health Clinic, the Ponderosa Villa Nursing Home, a livestock sale barn, and railroads. Facilities located outside of Crawford and within the 2.25-mile review area include the Crawford Cemetery, located at the east-central boundary of the license area.

I.1.2.1.5 Industrial and Mining

There are no industrial or mining uses within the NTEA. A total of two sand and gravel sites were identified in the NTEA AOR (University of Nebraska at Lincoln 2008) (**Figure I.1-2**). One of the sand and gravel facilities is listed as active and one as inactive. **Table I.1-9** summarizes available information on these facilities.

Besides CBR, Conoco, Amoco Minerals, Santa Fe Mining, and Union Carbide have also drilled exploratory testing holes in the area. There are no other industrial facilities within the 2.25-mile review area.

There have been a total of six oil and gas exploration drill holes in the NTEA 2.25-mile AOR. There has been only one drilled in the NTEA. Based on review of public plugging records, all the referenced oil and gas test holes have been abandoned in accordance with the Nebraska Oil and Gas Conservation Commission regulations (NOGCC 2008). Oil and gas exploration drilling activities are discussed in Chapter D.

I.1.2.1.6 Recreational

Part of Fort Robinson State Park lies within the 2.25-mile review area of the NTEA (see **Figure I.1-1**). Other recreation areas within the review area include the Crawford City Park and the Legend Buttes Golf Course.

I.1.2.1.7 Aesthetics

The NTEA is located on rolling plains with a backdrop of the spectacular buttes of the Fort Robinson State Park, located west of the project area. The North NTEA landscape is rural and agricultural in character. The landscape colors are dominated by tan, gold, and green vegetation and tan soils. Riparian vegetation along the White River and Spring Creek exhibits considerable variety in form, texture, and color. Dark to light green colors and a variety of forms and textures of the riparian vegetation provide pleasing contrasts to the flat, horizontal lines of the surrounding agricultural land in the project area. As the NTEA has been used historically for cropland and grazing, it is unlikely that any undisturbed area exists within the proposed license boundary. Human influence is evidenced by producing croplands, scattered farmhouses, and fencing.

I.1.2.1.8 Transportation and Utilities

Nebraska Highway 2/71 and U.S. Highway 20 converge in Crawford. The 2003 average daily traffic counts are 360 vehicles on Nebraska Highway 2/71 at the east side of the NTEA, and between 1,330 and 1,720 vehicles on U.S. Highway 20 at Crawford south of the license area (NDTT 2004). County roads that cross through the NTEA are Moody and Mill Roads. These roads provide access to residences and agriculture within the license area. The county roads are accessed from Highway 2/71. The Burlington Northern Santa Fe Railroad (BNSF) runs in a northwesterly direction along the western boundary of the permit area. The Dakota, Minnesota and Eastern Railroad (DM&E) runs in a northeasterly direction and runs near the southeast boundary of the license area. The junction of the two railroads is about 0.5 mile south of the license area (Figure D.1-1).

I.1.2.2 References

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I.1.3 Water Use

I.1.3.1 Surface Water

The NTEA is drained by the White River, which flows to the northeast along the southern boundary of the proposed permit boundary and through the 2.25-mile AOR (**Figure H.1-1** of Chapter H).

The White River is used to support agricultural production, wildlife habitat, and both warm- and cold-water fish. For the period of record from 2000 through 2005, the average monthly flow for the river at Crawford ranged from 16.7 to 21.9 cubic feet per second (cfs), with a mean value of 20.3 cfs (NDNR 2008a). The flow of the White River at Crawford from January through September 2006 ranged from 10.0 to 26.4 cfs, with an annual mean of 19.7 cfs. Flow and water chemistry data for the White River at Crawford is presented in Chapter G.

Spring Creek flows west-to-east through the northern portion of the NTEA (**Figure H.1-1** of Chapter H). Little Cottonwood and Sand Creeks flow west-to-east along the northern portion of the 2.25-mile review area where they join the White River. Squaw, English, and White Clay Creeks flow to the White River in the southeastern portion of the 2.25-mile review area. On the south side of the review area, Dead Man's, Cherry, and Bozle Creeks flow northward to the White River.

No surface water impoundments are located within the NTEA. Several small impoundments are located on private ranches within the 2.25-mile review area, primarily along English, White Clay and Squaw Creeks (southeastern portion of the review area) and Little Cottonwood Creek (northern portion of the review area). Surface water features are shown on **Figure H.1-1** of Chapter H. Only one naturally occurring spring (# 8001) is documented within the 2.25-mile AOR (**Figure H.1-1**). Based on field inspections by CBR personnel, there is no irrigated farmland within the NTEA boundary.

The White River and associated tributaries indirectly supply some of the drinking water to the citizens of Crawford. The city system, which serves a population of 1,115 (NDHHS 2004), is supplied by three infiltration galleries (located along the White River, Dead Man's Creek, and Soldier Creek) and two wells which produce "groundwater under the influence of surface water" (UNCE No Date). In 1981, average daily usage ranged from a low of 199 gallons per day per person (expressed as gallons per capita per day [gpcd]) in February to a high of 508 gpcd in July. The maximum recorded daily water usage in Crawford through the year 1981 was nearly 1 million gallons. Based on the Crawford Municipal Water Conservation Plan (Spring of 2003), the average per capita water use in 2002, including residential and business customers, public facilities such as parks, and water lost to system leaks, was 323 gallons per day. Information regarding the City of Crawford water system is summarized in **Table I.1-10** (Teahon 2007).

I.1.3.2 Groundwater

In general, groundwater supplies in the vicinity of the NTEA are limited due to topography and shallow geology (UNLCSD 1986). Groundwater quality within the White River drainage generally is poor (Engberg and Spalding 1978). Locally, groundwater is obtained at limited locations from shallow alluvial sediments. The primary groundwater supply is the Brule Formation, typically encountered at depths from 60 to 100 feet. The static water level for Brule Formation wells in the NTEA vicinity ranges from 10 to 60 feet below ground surface. Groundwater from the underlying Basal Chadron Sandstone aquifer is not used as a domestic supply within the NTEA because of the greater depth (350 to 700 feet bgs) and inferior water quality. Gosselin et al. (1996) state that: (1) "*the sands near the bottom of the Chadron Formation yield sodium-sulphate water with high total dissolved solids,*" and (2) in proximity to "*uranium deposits in the Crawford area, groundwater from the Chadron Formation is not suitable for domestic or livestock purposes because of high radium concentrations.*"

Based on the National Groundwater Association website (NGWA 2004), average water use for rural (domestic) wells in Nebraska is approximately 380 gallons per day (gpd). Assuming an average family size of four persons, this correlates well with data from the U.S. Geologic Survey (USGS) who suggest an average per capita use on the order of 97 gpd (USGS 1999). Only one residence is located within the NTEA (Sections 27 and 34), which would indicate a total groundwater use within the NTEA of only 380 gpd based on the average per capita use.

In order to assess potential impacts on water supply users in the NTEA and associated 2.25-mile AOR, CBR has used the results of water well surveys conducted by CBR in 1996, with updates in 2004, 2007 and 2008. The surveys consisted of interviews of individual home/property owners and local drillers, and in 2008, a review of the Nebraska Department of Natural Resources (NDNR) groundwater well database (NDNR 2008b) for registered wells in the AOR. The water user survey determined the location, depth, casing size, depth to water and flow rate of all wells within the area that were (or could) be used for domestic, agricultural or livestock uses. Under current Nebraska law, domestic or livestock wells completed prior to September 09, 1993, do not have to be registered (NRS 2008). Therefore, well completion records for wells prior to September 09, 1993, are limited. However, efforts were made by CBR to gather available information on such wells completed in the injection zone of the AOR of the NTEA through interviews with home/property owners and local well drillers. This interview process has significantly improved the completeness of CBR's well user survey information presented in Appendix 6.

In 1984, Wyoming Fuel Company notified the NDEQ that during a 1984 water supply well survey, local residents reported that 18 private water supply wells located within the City of Crawford had been abandoned (Collings, S.P. 1984). The locations of these wells were as follows:

1121 - 1st Street	228 Ash Street
233 Reed Street	Old Creamery – 2 wells
311 Annin Street	5th and Main Streets
320 Annin Street	410 Pine Street
702 Annin Street	5th and Oak Streets
704 Annin Street	End of Fremont Street (south end)
708 Annin Street	235 Elm Street

5th and Linn Streets | 10118 - 3rd Street

Sam Schmidt Place

There was little information available for such wells other than being abandoned. Due to the lack of information, these wells have not been included in the water well user survey data presented in **Appendix 6**.

Table G.2-1 and **Appendix** 6 list the active, inactive, and abandoned groundwater wells in the NTEA and the 2.25-mile AOR, which are depicted on **Figure H.2-2** of Chapter H, **Figure C.1-2** of Chapter C. Within the 2.25-mile AOR, 149 of the wells are completed in the Brule Formation and 15 are completed in the Chadron Formation (not including the "RC" monitor wells).

Other than the monitor wells installed by CBR, there are 7 active permitted water supply wells completed in the Brule Formation within the NTEA (**Table G.2-1, Figure H.2-1**). All 7 of these water supply wells are used for domestic as well as agricultural (i.e. livestock watering) purposes. The Brule Formation is hydraulically isolated from the underlying Basal Chadron Sandstone by up to 500 feet of low permeability claystones and siltstones (see Section G.4.2). None of the water supply wells within the NTEA are used for drinking water. All active, inactive and abandoned water wells within the NTEA are depicted on **Figure H.2-1**. **Table G.2-1** and **Appendix 6** present information from the updated water well user survey for the water supply wells within the NTEA. The water well user survey was recently updated based on a search of Nebraska Department of Natural Resources (NDNR) records for registered wells near the City of Crawford. Note that some of the wells are old windmills (e.g., Well 198) or hand pump wells (e.g., Well 211 and Well 218) that are inactive and no longer in use, but have not yet been formally abandoned. There are no active water supply wells completed in the Basal Chadron Sandstone within the NTEA.

The updated water user survey indicates that the only domestic groundwater supply within the NTEA is the Brule Formation (Well 83). The only Chadron Formation water supply well within the NTEA (Well 81A) was abandoned. None of the water supply wells within the NTEA are used for drinking water. Groundwater pumped from active wells within the 2.25-mile AOR is used either to water livestock or for domestic purposes (**Appendix 6**).

Ten active water supply wells are completed in the Basal Chadron Sandstone outside of the NTEA (Well 55, Well 61, Well 97, Well 98, , Well 123, RC-1, Well 5001, Well 5003, Well 5035 and Well 5069). Sevenof these wells are used exclusively for agricultural purposes (Well 55, Well 97, Well 123, RC-1, Well 5001, Well 5003 and Well 5035) and only three wells (Well 61, Well 98 and Well 5069) are used as a domestic/agricultural water supply. The extraction rate for Well 61 and Well 98 is currently unknown. The extraction rate for Well 437 and Well 443 is 10 gpm (**Appendix 6**). The extraction rate for Well 5069 is 12 gpm (**Appendix 6**). Well 5069 is the only well located within the city limits. All other active wells that are completed in the Chadron Formation as listed in **Table G.2-1** (Well 437, Well 440, Well 441 and Well 443) are screened in clay units that overly the Basal Chadron Sandstone. These 4 wells were not cemented during well installation and contain either gravel pack or are open hole between the Brule Formation and the Chadron clay. Water levels at these wells ranges from 18 to 54 ft bgs. Given their locations and the measured water levels in the Brule Formation and Basal Chadron Sandstone, it is clear that the wells are not in hydraulic communication with Basal Chadron Sandstone and are likely in hydraulic communication with the Brule Formation (**Figures F.2-3a** of Chapter F and **H.2-2, H.2-3** and **H.2-5** of Chapter H).

As stated above, Well 61, Well 98 and Well 5069 are the only domestic water supply wells within the 2.25-mile AOR that are screened in the Basal Chadron Sandstone. Well 5069 is the only well located within the city limits. Groundwater from artesian well RC-1, located southeast of the NTEA, is limited to agricultural use by the landowner for livestock watering.

Four active Chadron Formation wells (RC-1, Well 97, Well 123 and Well 437) are located in close proximity to the NTEA boundary (**Figure H.2-2** of Chapter H). Three of the wells (RC-1, Well 97 and Well 123) are artesian and do not contain pumps. Because of artesian pressure, most of the limited number of wells screened in the Basal Chadron Sandstone in the vicinity of the NTEA either flow at the surface or have water levels very close to surface (**Figures F.2-3a** through **F.2-3d** of Chapter F). Wells 97 and 123 are periodically used as limited alternate supplies of stock water. Artesian flow at the surface for Well 97 is estimated to be 6 gpm. The extraction rate for Well 437 and Well 443 is 10 gpm (Appendix 6). The flow rates at Wells 123 and RC-1 are currently unknown.

Wells RC-1and RC-2 are located on land leased by CBR (**Figure H.2-2** of Chapter H). The prefix "RC" in the well name stands for "Regional Chadron" formation well. All three wells were originally installed as monitor wells. The lease on the land containing RC-1 was discontinued by CBR and the well was not abandoned. The land was subsequently sold by the owner. RC-1 is now used as an agricultural water supply well. RC-2 is located within the NTEA and is used as a monitor well. RC-3 was recently abandoned in May 2008.

CBR abandoned Well 65 and RC-3 in May, 2008, 425 in July 2008, Well 114 in October 2008 and Well 52 in November 2008. Well 5004 and 5026 were also abandoned in June 2008 by an independent driller.

Section G.5, Chapter M and Chapter Q include discussons as to how CBR will maintain hydraulic control of injection fluids in order to avoid migration of mining solutions from the respective wellfields. These hydraulic controls will be used to ensure private water wells are not negatively impacted.

In summary, there is no domestic use of groundwater from the Basal Chadron Sandstone within the NTEA. The only residence within the NTEA is supplied by two water supply wells (Wells 83 [domestic] and 84 [agricultural]) which are completed in the relatively shallow Brule Formation (**Figure H.2-2** of Chapter H **and Table G.2-1**). The Brule Formation is vertically and hydraulically isolated from the aquifer proposed for exemption. Based on population projections (CBR 2007) future water use within the NTEA and the 2.25-mile AOR likely will be a continuation of present use. It is unlikely that any irrigation development will occur within the NTEA due to the limited water supplies, topography, and climate. Irrigation within the review area is anticipated to be consistent with the past (e.g., limited irrigation in the immediate vicinity of the White River). It is anticipated that the City of Crawford water supply will continue to be provided by the groundwater and infiltration galleries related to the White River and associated tributaries.

I.1.3.3 References

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I.2 Demographics

Information presented in this section concerns those demographic and social characteristics of the environment that may be affected by the proposed expansion of the Crow Butte Uranium Project to include operations in the North Trend Permit Area. Data were obtained through the 1980, 1990, and 2000 U.S. Census of Population and various State of Nebraska government agencies.

I.2.1 Population

The area within a 50-mile (80-km) radius of the project site includes portions of six counties in northwestern Nebraska, two counties in southwestern South Dakota, and two counties in eastern Wyoming. Because the 50-mile radius extends only slightly into two very rural counties in Wyoming (with a combined population of less than 2,000 persons within the 50-mile radius boundary), the regional demography in Wyoming is not discussed in detail beyond that summarized in **Tables I.2-1** through **I.2-3**. **Figure I.2-1** depicts significant population centers within the 50-mile radius of the proposed NTEA.

Historical and current population trends in the project area counties and communities are contained in **Table I.2-1**. Between 1960 and 1980, Box Butte County exhibited the fastest rate of growth, with more than a 17 percent population increase, largely occurring in the latter half of the 1970s. Box Butte County lost population between 1980 and 2000, with the greater population losses occurring during the 1990s.

All of the Nebraska counties comprising the project area experienced slight growth or actual population decline between 1960 and 1980 and population decline between 1980 and 1990. The state experienced its fastest growth since the 1920s during the years between 1990 and 2000. The total state population in 2000 was 1.7 million, which was an 8.4-percent increase over the 1990 population of 1.6 million. The Nebraska counties in the project area experienced little of the state's growth spurt. However, with the exception of Box Butte, the counties experienced a reversal of the downward trends of the 1980s. In general, population trends for the last decade show that population in urban areas is increasing, while population in rural areas is declining. Areas within 50 miles of the project site that are defined as urban (all territory, population, and housing units in urbanized areas and in places of more than 2,500 persons outside of urbanized areas) by the U.S. Census 2000 are the Cities of Chadron in Nebraska, and Hot Springs and Pine Ridge in South Dakota.

Dawes County grew slightly between 1990 and 2000, gaining 0.4 percent in population. Most of this growth occurred in the City of Chadron. The Dawes County communities of Chadron and Crawford are the nearest communities to the project site. Chadron is located approximately 25 miles (40 km) northeast of the project site with a year 2000 population of 5,634, an increase of 0.8 percent from 1990. The community of Crawford, within 2 miles (10 km) of the site, had a 2000 population of 1,107. Chadron experienced a small population gain between 1990 and 2000, while Crawford lost population. The overall population density of Dawes County, based on the U.S. Census 2000 population, is 6.46 people per square mile.

Sioux County lost population at a slower rate in the years between 1980 and 1990 than in the previous decade. The slower decline of the county population occurred in part because the City of Harrison gained nearly 16 percent, which is a reversal of a trend that shows a decline in population since 1960. Between 1980 and 1985, the downward trend continued in Sioux and Morrill Counties, with Sheridan County exhibiting a slight turnaround. Between 1985 and 1990, the downward trend continued in the Nebraska counties, with the exception of Morrill County, which experienced an increase of 6.3 percent; however, this growth is a decrease from the 1980 population.

Sheridan County has experienced an overall decline of nearly 32 percent since 1960. Population has declined in the Cities of Hay Springs and Rushville between 1980 and 2000, despite earlier gains in the 1980s. Scotts Bluff County experienced gradual population growth over the two-decade period between 1960 and 1980.

Scotts Bluff County, which is just south of the 50-mile radius around the project site, was included within the 50-mile radius of the original permit area. The county experienced population gains between 1990 and 2000, primarily because the City of Scotts Bluff, which is an urban area, showed a strong increase in population of 7.4 percent between 1990 and 2000.

The two South Dakota counties in the 50-mile study area include Fall River and Shannon. Fall River County experienced an overall population decline by more than 30 percent between 1960 and 2000; however, between 1990 and 2000, there was a small increase of 1.4 percent. The City of Ardmore lost more than 80 percent of its population between 1960 and 1980, and was disincorporated in 1984 (USCB 1990). Shannon County, on the other hand, grew by 25.9 percent between 1990 and 2000, more than double the 1960 population. Much of the growth occurred in the Pine Ridge and Oglala Census Designated Places (CDPs), which are urban areas as defined by the U.S. Census, but are not incorporated municipalities. Most of Fall River County is included within 50 miles of the project site; however, only the southwest portion of Shannon County is within 50 miles of the project site.

The population declines in the counties within the 50-mile radius reflect trends in the overall region, where declines have been attributed to the declines in the rural farming based economy and limited economic opportunities for youth. Persistent drought conditions have also contributed to the shrinking of the agriculture-based economy. Rural residents have been migrating to larger cities, depopulating the largely rural Great Plains states. Many of the people migrating out of the state are young adults and families, which results in fewer people of childbearing age, and therefore, fewer children. This trend also contributes to the increasing proportion of the elderly population in the state.

I.2.1.1 Population Characteristics

Year 2000 population, listed by age and sex, for counties within 50 miles of the Crow Butte Project area is shown in **Table I.2-2**. Overall, 67.7 percent of the population in the region is more than 20 years old. Fall River and Niobrara Counties reported the highest percentage of persons older than 18 with 75.0 percent. About 6.7 percent of the population was less than 5 years old in 2000. Shannon County reported the youngest population, with 10.9 percent less than 5 years old and slightly more than half (51.0 percent) at 18 years of age and under. Females slightly outnumbered males in most counties, with an overall population of 50.1 percent female to 49.9 percent male.

In 2000, slightly more than 75 percent of the ten-county population was classified as white. Indians and persons of Hispanic origin comprised 21.2 percent and 4.3 percent, respectively, of the total population. Nearly 80 percent of the Indians were Sioux living on the Pine Ridge Reservation in Shannon County, South Dakota.

I.2.1.2 Population Projections

The projected population for selected years by county within the 50-mile radius of the proposed Crow Butte Project is shown in **Table I.2-3**. The population is expected to decrease in the Nebraska Counties of Box Butte, Sheridan, and Sioux. These counties are primarily rural, with agriculture-based economies. It is anticipated that the declining population trends of the last two decades will continue into the foreseeable future for these counties. The projected population for Dawes County is expected to increase at an annual rate of less than 1 percent over the next 20 years. This rate reflects recent increases in the population of Chadron that are expected to continue. In addition, Dawes County provides a scenic setting for a variety of outdoor recreation activities. The Pine Ridge region will probably increase in popularity with visitors and recreationists from outside of the region, as participation in outdoor recreational activities is expected to increase nationwide. An increase in visitor utilization of recreation facilities in Dawes County would revitalize the local economy, adding to the overall attractiveness of the region to potential residents.

I.2.1.3 Seasonal Population and Visitors

The various state parks in northwest Nebraska, the Pine Ridge Ranger District, and the Oglala National Grassland are increasingly becoming regional tourist destinations (USFS 2001).

Approximately 358,000 people visited Fort Robinson State Park in 2002. This number represents a 4.8-percent increase from 2001, but a decrease of 5.1 percent from the 1981 visitation of 377,000 people and a slight decrease of less than 1 percent from the 359,000 visitors in 1984 (NDED 2003). Approximately 50 percent of the visitors in 2002 were from other states, which is an increase in the number of out-of-state visitors from 1981, as the majority of 1981 visitors were Nebraskan families. It is likely that the decline of visitors from Nebraska has resulted from the overall decline of population in rural counties within a few hours' commuting distance of the park.

There were 55,000 visitors to the Pine Ridge District of the Nebraska National Forest in 2001. Camping and motorized travel/viewing scenery is the two most popular recreation categories on the Pine Ridge Ranger District and the Ogalala National Grassland.

The forest provides a wide range of other undeveloped backcountry recreation opportunities such as hunting, hiking, backpacking, fishing, and wildlife observation. The district provides the greatest number of miles of mountain biking trails in the state. District trails also attract horseback riders and off-highway motorized vehicle use. The Pine Ridge is an important destination for deer hunting and provides the most popular turkey hunting area in Nebraska.

One source of seasonal population in this region is Chadron State College, located approximately 21.6 miles (35 km) from the site. During the 2001 fall semester, enrollment was 2,804, an increase of 25 percent over the fall 1986 enrollment of 2,240 (Nebraska Department of Economic Development 2002; Schmiedt, J. 1987). In the 1994 fall semester, a total of 3,296 students were enrolled at the college (Taylor, A. 1995).

I.2.1.4 Schools

The Crawford Public School District serves Crawford. The Crawford Elementary accommodates grades Kindergarten through 6, and includes a pre-school classroom that was added in 2006. The junior/senior high school accommodates grades 7 through 12. The high school and grade school are presently under capacity. Total enrollment in these two schools as of fall 2006 is 137 in the high school and 133 in the elementary school, with maximum capacities of 545 and 185, respectively (NDE 2008). Current enrollment numbers are comparable to annual enrollments since 1987 for both schools. The grade school currently has a student-to-teacher ratio of 15 to 1; while the high school has a ratio of 11 to 1. No historical high was given for the grade school; however, it was estimated that the high school historical high was more than 200 pupils.

There is one rural school supporting grades 1 through 8 outside of Crawford. The Belmont School is a two-room schoolhouse. Students living in the rural area district attend Crawford High School. There were six pupils as of the fall 2007 at the Belmont School from which Crawford High School draws, a decline from the 1995 enrollment of an estimated 100 pupils in seven rural school districts (NDE 2008).

Families moving into the Crawford District as a result of the proposed North Trend Permit Area operations would not stress the current school system because it is presently under capacity.

I.2.1.5 Sectorial Population

Existing population, as determined for the original analysis in the CBR commercial license application prepared in 1987 for the 80-km (50-mile) radius, was estimated for 16 compass sectors by concentric circles of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the site (a total of 208 sectors). Sectorial population for the application prepared in 2004 was updated with data from the 2000 U.S. Census. Subtotals by sector and compass points, as well as the total population, are shown in **Table I.2-4**.

Population within the 50-mile radius was estimated using the following techniques:

- U.S. Census 2000 data were used to estimate the total population within a 50-mile radius, measured from the center of the proposed North Trend Permit Area site. The data were created by Geographic Data Technology, Inc., a division of ESRI, from Census 2000 boundary and demographic information for block groups within the United States.

- ArcInfo Geographic Information System (GIS) was used to extract data from U.S. Census 2000 population estimates for 40 Census Tract Block Groups located wholly or partially within the 50-mile radius from the approximate center of the NTEA. Urban areas within each county were generally assigned their own block group.
- To assign a population to each sector, a percentage area of each sector within one or more block groups was calculated for all of the block groups.
- 2000 U.S. Census of population estimates for cities and counties in Nebraska, South Dakota, and Wyoming were used to determine total urban population.

I.2.2 Local Socioeconomic Characteristics

I.2.2.1 Major Economic Sectors

In 2002, average annual unemployment rates in Dawes and Box Butte Counties decreased from the 1994 rates. **Table I.2-5** summarizes unemployment rates and employment in the Nebraska project area counties. Dawes and Box Butte Counties exhibited unemployment rates at 3.8 percent in Dawes County and 5.0 percent in Box Butte County. Unemployment rates for both counties increased between 1994 and 2002. In 1994, unemployment levels declined from February 1987 levels. These rates were a little higher than the statewide rate of 3.5 percent. Dawes County was close to the state unemployment rate, while the Box Butte rate was higher.

The major economic sectors in the project area have changed little in recent years, although individual sectors have shifted in their relative proportion in the overall economy. The area continues to depend on trades, government, and services. Economic activities in the Crawford area include farming, ranching, cattle feed lots, tourism, and retail sales.

Agriculture accounts for slightly more than 1 percent of the total employed labor force in Dawes County, while farm employment was 14 percent of total employment in Box Butte County. Government employment in Dawes County makes up 37 percent of total non-farm employment, followed by trade (16 percent), leisure and hospitality services (14 percent), and education and health services (9 percent). Construction and mining account for 5 percent. In Box Butte County, the largest four non-farm employment sectors are transportation (25 percent), government (22 percent), trade (16 percent), and manufacturing (9 percent).

Agriculture employment has a small share of total employment in both counties. However, agriculture provides the economic base for the counties, as other economic sectors support the agricultural industry. Events that affect agriculture are generally felt throughout rural economies. According to the Nebraska Department of Economic Development (NDED 2002b), farm employment in Nebraska is expected to decline by nearly 14,000 jobs (20 percent) between 2000 and 2045, while overall non-farm employment will increase by nearly 26 percent. The decrease in jobs in the agricultural sector could continue to fuel migration from rural counties to urban areas, resulting in overall declines in other sectors of the local economy as dollars spent from personal income and agricultural business expenditures move out of the counties.

Per capita personal income is the income received by persons from all sources, including wages and other income, over the course of 1 year. In 2002, personal income in Dawes County was

$19,760, which was 68 percent of the state average of $29,182. The county ranks 84th out of 93 counties in the state (BEA 2004).

I.2.2.2 Housing

Between 1970 and 1980, total housing units increased by 17 percent in Dawes County from 3,388 to 3,965 units. By 2002, the growth of the preceding decades had slowed, and total housing units increased by 2.4 percent to 4,004 units from 3,909 units in 1990. Chadron, the largest community in Dawes County and within 25 miles (40 km) of the project site, experienced a 25 percent increase in housing stock between 1970 and 1980, and a 5 percent increase between 1990 and 2000. Crawford housing stock decreased by nearly 7 percent from 576 units in 1990. By 2000, there were 2,441 housing units in Chadron and 537 units in Crawford. Alliance, in Box Butte County (approximately 45 miles [72 km] from the project site) exhibited a 1 percent loss in total housing units between 1990 and 2000. In 2000, there were 4,062 housing units in Box Butte County (U.S. Census 1981, 1990d, 2004).

In 2000, Dawes and Box Butte Counties had homeowner vacancy rates of 1.7 and 1.4 percent, respectively. A June 2004 listing of property for sale revealed two ranch properties near Crawford. Housing prices averaged $53,915 in 1999. According to the Dawes County Tax Assessor, no new houses are being built, as current housing needs are being met.

A local Crawford realtor indicated in 1999 that rental property in Crawford was scarce. The rental housing stock has not increased in 2000, as rental vacancy rates were 4.4 percent in Dawes County and 4.7 percent in Box Butte County (USBC 2004), compared with rental vacancy rates in 1990, which were 12.6 percent in Dawes County and 14.9 percent in Box Butte County (USBC 1990).

High interest rates and tax rates were the major deterrents for potential homebuyers in the project area in the past. Current deterrents are economic uncertainty and unemployment. Recent interest rates on most home mortgages have ranged between 5 and 7 percent.

Population projections for Dawes County indicate an average annual growth rate of 10 percent between 2000 and 2020. Most of this growth is likely to occur in Chadron, as suggested by population growth between 1990 and 2000, rather than Crawford, which lost population. The majority of housing demand expected over the next two decades is most likely to occur in Chadron. However, housing stock in Crawford has decreased so that homeowner vacancy rates have also decreased. In the event that the various scenic and recreational amenities of the region stimulate the local tourist economy, it is likely that both population and housing stock would increase in Crawford.

The purchase of homes by Crow Butte employees provides the City of Crawford with ad valorem property taxes. The City of Crawford levies taxes at a dollar per hundred of valuation. In 2001, the total levy was 0.43346, which would result in taxes on a $50,000 property of approximately $217 per year (NDPAT 2001).

I.2.3 Evaluation of Socioeconomic Impacts

I.2.3.1 Current Operations

The preliminary evaluation of socioeconomic impacts of the existing commercial facility was completed in 1987 as reported in the Class III UIC Permit Application submitted to the Nebraska Department of Environmental Quality (NDEQ) and the original NRC commercial license application. The preliminary evaluation was divided into two phases – construction and operation. The evaluation concluded that the construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services, such as roads, housing, schools, and energy costs, would be minor or non-existent and temporary.

Since the inception of the operational phase, the overall effect of the current commercial facility operations on the local and regional economy has been beneficial. Purchases of goods and services by the mine and mine employees contribute directly to the economy. Local, state, and the federal governments benefit from taxes paid by the mine and its employees. Indirect impacts resulting from the circulation and recirculation of direct payments through the economy are also beneficial. These economic effects further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the current operation would continue for the life of the mine, which is estimated to be an additional 14 years.

The current mine operation has not resulted in any significant impact to the community infrastructure (including schools, roads, water and sewage facilities, law enforcement, medical facilities, and any other public facility) in the City of Crawford or in Dawes County. The mine employs a workforce of approximately 60 employees and 20 contractors. The majority of these employees are hired from the surrounding communities.

CBR projects that the current staffing level will increase by 10 to 12 full-time CBR employees for each active satellite facility. These new employees will be needed for satellite facility and wellfield operator and maintenance positions. Contractor employees (e.g., drilling rig operators) may also increase by four to seven employees depending on the desired production rate.

I.2.3.2 North Trend Expansion Area

CBR expects that construction of the main satellite facility at the NTEA will provide approximately 10 to 15 temporary jobs for a period of up to 1 year. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR projects that the current staffing level will increase by 10 to 12 full-time CBR employees. These new employees will be needed for satellite facility and wellfield operator and maintenance positions. Contractor employees (e.g., drilling rig operators) may also increase by four to seven employees depending on the desired production rate at the current processing facility and at the NTEA. The majority if not all of these new positions will be filled with local hires. CBR will begin staff expansion and training during construction to ensure that a trained staff is available for commissioning the satellite facility.

I.2.4 References

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I.3 Cultural Resources

I.3.1 Past Cultural Investigations

Previous cultural resource investigations in the general area surrounding Crawford indicate that a variety of prehistoric and historic resources of potential significance exist in the vicinity. Resources include the Hudson-Meng prehistoric bison kill to the north of the area, several prehistoric camps and artifact scatters in the general areas, fur trade period sites associated with the early history of Chadron, Fort Robinson to the west of Crawford, the Sidney-Deadwood Trail, the two historic railroads that cross where the City of Crawford emerged, and the City of Crawford itself. There has been extensive farming around Crawford, which may have disturbed many earlier sites, but has also created historic farming sites and features.

I.3.2 North Trend Expansion Area Cultural Survey

The proposed NTEA is on private lands north of the City of Crawford. A cultural resource survey area of approximately 1,190 acres was initially identified to cover an area as having potential for development over the next 10 years. The permit boundary of the NTEA was revised, resulting in a total acreage of approximately 1,165 acres. The cultural survey included this revised acreage. The survey area extends from about 0.5 mile to 3 miles immediately north of the City of Crawford. It spans from the banks of the White River on the south to Spring Creek on the north, and from about 0.25 mile west of Nebraska State Highway 2 on the east to the BNSF tracks on the west. This area was inventoried by Greystone (now ARCADIS) archaeologists between August 16 and August 18, 2004 (Späth 2006).. The archaeological review area was surveyed for the presence of cultural resources that may be impacted by the proposed mine development.

An architectural and structural properties search was completed at the Nebraska State Historic Preservation Office (SHPO), and an archaeological site search was completed at the Archaeology Division of the Nebraska State Historical Society in July 2004. No previous cultural resources inventories have been documented for this area, and the State Historic Preservation Office has no record of documented standing structures in the area.

Systematic cultural resource survey of the NTEA documented six cultural resources (Späth 2006). The resources were three historic sites, one isolated protohistoric artifact, and two isolated prehistoric artifacts. None of the historic, archaeological, and cultural resources within the NTEA are recommended as eligible for the National Register of Historic Places (NRHP), and therefore, none of them are historic properties. The proposed North Trend Expansion will have no effect on historic properties, and no further cultural resource work is recommended.

I.3.3 Confidentiality of Survey Information

Specific information included in cultural resource investigations falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)). Additionally, disclosure of such information is protected under Nebraska State Statute Section 84-712.05 (13 and 14). Therefore, under separate correspondence, the following information pertaining to the cultural resource investigations for the NTEA is being submitted to the NDEQ as "CONFIDENTIAL" information for the purpose of public disclosure of this Class III UIC Permit Application:

- A copy of the Cultural Resource Inventory Report and supporting correspondence including the Nebraska SHPO concurrence letter and the correspondence to the tribal authorities
- Site location map
- Nebraska State Historical Society Archeological Site Survey forms

I.3.4 References

Späth, Carl. 2006. *Crow Butte Resources North Trend Expansion Area Class III Cultural Resource Inventory, Dawes County, Nebraska*, February.

I.4 Ecology

I.4.1 Introduction

This section describes the existing ecological resources within the NTEA, identifies potential impacts associated with the proposed project, and presents mitigation measures that would offset such impacts. The analysis consisted of a review of documents, databases, and reports in conjunction with a reconnaissance biological field survey to determine the potential impacts, if any, to the habitats for special-status plant and wildlife species in the proposed expansion area. Agency coordination has included telephone and written correspondence among Greystone/ARCADIS biologists, U.S. Fish and Wildlife Service (USFWS), and Nebraska Game and Parks Commission (NGPC) management and staff. This coordination is ongoing. The purpose of these consultations and associated correspondence was to help identify biological issues and potential occurrences and distribution of special-status plants, wildlife, and their habitats.

I.4.2 Regional Setting

The project area occurs at the confluence of two Nebraska ecoregions – the Western High Plains and the Northwestern Great Plains (Chapman et al. 2001). The transition from Central Great Plains in the eastern part of the state to Western High Plains westward is primarily a factor of reduced effective precipitation. There is a general conformity in the composition of the plant cover, as many species are common to both ecoregions. Physiographically, this area comprises smooth to slightly irregular plains that support either cropland or grassland and grazing.

The Western High Plains ecoregion is characterized by a semi-arid to arid climate, with annual precipitation ranging from 13 to 20 inches. Higher and drier than the Central Great Plains to the east, much of the Western High Plains comprises a smooth to slightly irregular plain with a high percentage of dryland agriculture. Potential natural vegetation is dominated by drought-tolerant, short-grass prairie and large areas of mixed-grass prairie in the northwest portion of the state.

The Northwestern Great Plains ecoregion encompasses the Missouri Plateau section of the Great Plains. It is a semi-arid rolling plain of shale and sandstone punctuated by occasional buttes. Native grasslands persist in areas of steep or broken topography, but they have been largely replaced by spring wheat and alfalfa over most of this ecoregion. Agriculture exists on level to rolling hills and is generally limited by erratic precipitation patterns and limited opportunities for irrigation.

The Chadron State College herbarium contains 468 species from Dawes County (WFC 1983). In addition, the Institute of Agriculture and Natural Resources lists 603 native and 123 introduced species that occur in Dawes County. More than 400 species of plants were collected during the 1982 baseline study (WFC 1983) (see Section 8-1 of **Appendix 8).**

I.4.3 Local Setting - North Trend Expansion Area

The proposed 1,165-acre Crow Butte NTEA (permit boundary) is located in west-central Dawes County, Nebraska, just north of Crawford. The proposed NTEA is located within portions of Sections 21, 22, 27, 28, and 34 of Township 32 North, Range 52 West. **Figure B.2-1** of Chapter B shows the general location of the current permit area and the proposed NTEA.

I.4.4 Climate

The climate of the region is characterized by wide seasonal and day-to-day variations in temperature and precipitation. Dawes County is usually warm in the summer, with frequent spells of hot weather and occasional cool days interspersed, although sporadically, throughout the summer. These changes in weather can generate thunderstorms, which deliver a majority of the total annual precipitation.

Climate data was collected at the Chadron 1 NW site (latitude 42° 50' north, longitude 103° 01' west with a ground elevation of 3,350 ft [1,021 m] above mean sea level). The monitor is 0.9 mile (1.4 km) west northwest of Chadron, 23 miles (37 km) east-northeast of Crawford, and 22 miles (35 km) east-northeast of the proposed license area. The monthly climate summary for June 2, 1948 through June 30, 2007 is presented in **Table I.4-1** (HPRCC 2008). The average maximum temperature was 61.8 °F, and the average minimum temperature was 34.2 °F. Average total precipitation was 15.98 inches (HPRCC 2008). Precipitation occurs throughout the year, with yearly averages ranging from a low of 0.41 inch in December to a high of 2.91 inches in May (HPRCC 2008). Winter precipitation is typically relegated to storms with snow and the occasional blizzard. In this portion of Nebraska, the average annual seasonal snowfall is approximately 42 inches (HPRCC 2008).

I.4.5 Baseline Data

An ecological study was performed for a commercial CBR Uranium Project application in 1982 (Radioactive Source Materials License SUA-1534). Baseline flora and fauna data were collected to fulfill the objectives specified in USNRC Regulatory Guide 3.46, *Standard Format and Content of License Applications, Including Environmental Reports, for In-situ Uranium Solution Mining*. The 1982 baseline study focused on conducting intensive research within the principal study area, which included both the commercial study area and the 5-mile adjacent area, and less intensive research within the 50-mile outer area. Additional baseline data were collected within the three areas in 1987, 1995, 1996, and 1997. During 2004, a field reconnaissance, agency contacts, and literature searches were conducted to obtain new baseline data for the NTEA. In 2007 and 2008, the 2004 and earlier baseline data were reviewed, with the conclusion that the established database will prove sufficient to assess the probable impacts of the NTEA and could serve as a reference against which to measure impacts as they occur. The threatened and endangered (T&E) species list was revised in 2007 and 2008 due to recent changes in some of the T&E species status.

I.4.6 Terrestrial Ecology

The information presented in this section summarizes the findings of the ecological baseline studies in 1982, 1987, 1995, 1996, and 1997 and field reconnaissance surveys conducted in 2004.

I.4.6.1 Methods

Reconnaissance-level investigations were used to describe the principal floral and faunal species of the area. General observations were used to generate a species list for the NTEA and to obtain information about faunal distribution.

I.4.6.2 Existing Disturbance

The agricultural value of the two ecoregions has tremendously impacted mixed-grass prairie grasslands, and the resulting landscape has been substantially altered since settlement in the late

1800s. Economic incentives to convert natural landscapes to agriculture have been intensive and resulted in the loss of significant mixed-grass prairie grassland. Substantial areas of vegetation have been altered from their natural condition by past and current human activities. Agriculture, intensive grazing, haying, sand and gravel mining, road and railroad construction, and rural and urban development are the primary sources of surface disturbance to vegetation communities.

I.4.6.3 Vegetation and Land Cover Types

The vegetation/habitat classification system detailed in *Crow Butte Uranium Project Application and Supporting Environmental Report for NRC Research and Development Source Material License* (WFC 1983) was combined with pedestrian surveys to identify and map vegetation community types within the project area.

Six dominant plant communities were identified in the project area: deciduous forest, tree plantings, mixed-grass prairie, range rehabilitation, cultivated lands, and urban/development land. These broad categories often represent several vegetation community types that are generally defined by both species composition and relative abundance. The acres of occurrence and relative distribution of plant communities within the project area are presented in **Table I.4-2**.

The plant communities associated with the project area have been summarized into four general types and are briefly described below (woodlands (110, 130), grasslands (410, 420), cultivated (500) and human biotypes (600). **Figure I.4-1** details the distribution of the four principal plant communities within the project area.

Woodlands (100 – 160)

Woodlands are generally defined as vegetation communities that contain structure dominated by trees where canopy foliage covers 10 to 30 percent of the ground area (Butler et al. 1997).

Deciduous Streambank Forest – 110

The deciduous streambank forest community type occupies streamside sites adjacent to the White River. Eastern cottonwood (*Populus deltoides*) is the dominant upper canopy species within this vegetation community. Other species in the canopy include green ash (*Fraxinus pennslyvanica*), boxelder (*Acer negundo*), American elm (*Ulmus americana*), peachleaf willow (*Salix amygdaloides*), narrowleaf willow (*S. exigua*), shining willow (*S. lucida*), American plum (*Prunus americana*), and chokecherry (*P. virginiana*). Understory vegetation varies widely, depending primarily on the amount of grazing pressure.

Tree Plantings – 130

The tree plantings community type includes hand- or mechanically-planted trees adapted to the soils of a site. Typically, they include a mixture of trees and shrubs that are planted in a multi-row approach, allowing at least 10 feet between rows. The mixture of vegetation provides food (e.g., fruits, nuts, acorns, seeds, foliage) and cover for wildlife.

Grasslands (410)

Grasslands are characterized by grasses and other erect herbs, usually without trees or shrubs (Butler et al. 1997).

Mixed-Grass Prairie – 410

The mixed-grass prairie vegetation community is dominated by cool- and warm-season midgrasses, short-grasses, and sedges. Short-grasses typically occur on the drier sites, such as on ridgetops and south-facing slopes, with blue grama (*Bouteloua gracilis*), hairy grama (*B. hirusuta*), little bluestem (*Schizachyrium scoparium*), and threadleaf sedge (*Carex filifolia)* as dominant species. On the more mesic sites, blue grama, green needlegrass (*Nassella viridula*), Indian grass (*Sorghastrum nutans*), needle and thread grass (*Hesperostipa comata*), and western wheatgrass (*Pascopyrum smithii*) occur as the dominant species. Characteristic forbs include sand sagebrush (*Artemisia filifolia*), Nuttall's violet (*Viola nuttallii*), prickly-pear cactus (*Opuntia spp.*), and yucca (*Yucca glauca*).

Range Rehabitation/Perm. Pasture – 420

Range rehabilitation areas are previously cultivated fields subjected to intensive grazing or seasonal haying. Species common to this type are smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), intermediate wheatgrass (*Thinopyrum intermedium*), tall wheatgrass (*Thinopyrum ponticum*), and crested wheatgrass (*Agropyron cristatum*). The quality and composition of the community type varies greatly depending on the interval between the intense periods of grazing and haying. In addition, the aspect varies from pure to sparse grass stands, to annual weed complex or bare ground.

Cultivated – 500

This type is composed of cultivated fields that are in summer fallow – crop rotation and alfalfa fields used for hay production. Primary crops include spring wheat, oats, and barley.

Disturbed/Urban/Developed Land – 630

This is defined as any man-made feature that includes farmsteads and associated buildings, gravel and dirt roads, and highways and associated rights-of-way. Urban or developed land includes areas of intensive use with much of the land covered by structures (e.g., houses and farm outbuildings). Included in this category are towns and cities; transportation infrastructure, including roads and railways; communication facilities; areas occupied by industrial and commercial complexes; and industrial infrastructure that may, in some instances, be isolated from the urban areas. Dominant species include smooth brome (*Bromus inermis*), cheatgrass (*Bromus tectorum*), white sweetclover (*Melilotus alba*), yellow sweetclover (*Melilotus officinalis*), and numerous mustard (*Brassicaceae* family) species. Cultivated agricultural crops include spring wheat (*Triticum spp.*), oats (*Avena spp.*), and alfalfa (*Medicago sativa*). The 1982 study (WFC 1983) estimated that 30 percent of species and more than 50 percent of plant cover consisted of exotics.

I.4.6.4 Mammals

Thirty-six species of mammals were documented during the 1982 baseline study, and another 28 species (mostly bats and small rodents) were deemed likely to occur in the region (WFC 1983) (see Section 8-2 of **Appendix 8**).

Big Game

Big game species that are expected to occur in suitable habitats throughout the project area include pronghorn antelope (*Antilocapra americana*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*Odocoileus hemionus*). Elk (*Cervus elaphus*) and bighorn sheep (*Ovis canadensis*) may occur as transient species because of their known distribution in the Pine Ridge area (Nordeen 2004).

Pronghorn

Pronghorn typically inhabit grasslands and semi-desert shrublands of the western and southwestern United States. This species is most abundant in short- and mixed-grass habitats and is less abundant in more xeric habitats. Home ranges for pronghorn can vary between 400 and 5,600 acres, according to several factors including season, habitat quality, population characteristics, and local livestock occurrence. Typically, daily movement does not exceed 6 miles. Some pronghorn migrate seasonally between summer and winter habitats, but these migrations are often triggered by availability of succulent plants and not local weather conditions (Fitzgerald et al. 1994).

Nebraska is on the eastern fringe of the pronghorn's range, and there are large areas within the range boundary where pronghorns do not occur. The highest densities of pronghorn are in the northern and southern panhandle, primarily in the short-grass prairies and badlands. According to Nordeen (2004), a large herd of approximately 60 to 100 antelope may use the area north of Crawford as winter range.

The NGPC allows pronghorn hunting in 11 units, and the project area is within the North Sioux unit. Pronghorn harvest information available from the NGPC (2004a) reveals that 310 firearm permits were issued in 2002, followed by a decrease to 264 permits issued in 2003. The population trend for the pronghorn inhabiting the region has seen an overall decline in herd numbers (Hams 2004). This trend is attributed to extreme drought that has limited forage availability along with low breeding success (Hams 2004).

Mule Deer

Mule deer occur throughout western North America from central Mexico to northern Canada. Typical habitats include shortgrass and mixed-grass prairies, sagebrush and other shrublands, coniferous forests, and forested and shrubby riparian areas. In Nebraska, mule deer occur in foothills, broken hill country, prairie grasslands, and shrublands. Browse is an important component of the mule deer's diet throughout the year, making up as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). This species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. Fawn mortality is typically caused by predation or starvation. Adult mortality often occurs from hunting, winter starvation, and automobile collisions. Typical predators may include coyotes, bobcats, golden eagles, mountain lions, bears, and domestic dogs (Fitzgerald et al. 1994).

In the project area, mule deer typically occur in the foothills and escarpments, ranging outward into mixed-grass prairie and cultivated land. According to Nordeen (2004), approximately 100 to 200 mule deer and white-tailed deer may occupy a 1- to 2-square-mile area within the project area.

Because of concerns with over-harvesting of buck deer, the NGPC conducted a study (based on aged sample projected by total kill) of adult bucks 2.5 years or older during the 1987, 1992, and 1997 regular firearm hunting seasons (NGPC 2004b). Numbers of adult mule deer buck harvested in the Pine Ridge unit for 1987, 1992, and 1997 were 202, 446, and 385, respectively. According to Hams (2004), the mule deer population in the Nebraska panhandle is stable to increasing.

White-tailed Deer

White-tailed deer occur throughout North America from the southern United States to Hudson Bay in Canada. Across much of its range, this species inhabits forests, swamps, brushy areas, and nearby open fields. White-tailed deer are found throughout the State of Nebraska, typically concentrated in riparian woodlands, mixed shrub riparian, and associated irrigated agricultural lands, and are generally absent from dry grasslands and coniferous forests (Clark and Stromberg 1987). Their diet is diverse, capitalizing on the most nutritious plant matter available at any time. In addition to native browse, grass, and forbs, this species would rely on agricultural crops, fruits, acorns, and other nuts. Mortality to white-tailed deer is typically related to hunting, winter starvation, collisions with automobiles, and predation. Predators may include coyotes, mountain lions, wolves, bears, bobcats, and eagles (Fitzgerald et al. 1994).

In the project area, white-tailed deer are expected to be more widely distributed than mule deer. However, because of the high amount of cultivated land, white-tailed deer distributions may be primarily associated with riparian habitats along the White River and associated intermittent and ephemeral stream drainages. In addition, white-tailed deer may be absent from large expanses of mixed-grass prairie and shrub land habitats because of overlap of mule deer range in this part of the state.

Results of the white-tailed deer buck harvest for the Pine Ridge area were 186, 318, 363 in 1987, 1992, 1997, respectively. In addition, the numbers of the overall deer (including both white-tailed and mule deer) harvest for the Pine Ridge unit in 2002 and 2003 season were 1,732 of 2,970 tags issued and 1,724 of 3,186 tags issued, respectively. According to the NGPC (2004c), the state's population of deer (including white-tailed and mule deer) is estimated between 300,000 and 350,000 animals.

Elk

Elk formerly ranged over much of central and western North America from the southern Canadian Provinces and Alaska south to the southern United States, and eastward into the deciduous forests. In Nebraska, this species occurs primarily in the northwestern region in a variety of habitats including coniferous forests, meadows, short- and mixed-grass prairies, and sagebrush and other shrub lands. Similar to other members of the deer family, this species relies on a combination of browse, grasses, and forbs, depending on their availability throughout the seasons. Elk tend to be migratory, moving between summer and winter ranges. Typically, mortality is a result of predation on calves, hunting, and winter starvation. Predators may include coyotes, mountain lions, bobcats, bears, and golden eagles.

Elk ranges are concentrated in the Pine Ridge area and associated habitats in the Bordeaux and Hat Creek units. There are an estimated 200 to 250 elk in the state, with most of the herd concentrated in the Pine Ridge area (Nordeen 2004). Occasionally, elk may occur within the project area as transients primarily between the summer and winter range movements.

Bighorn Sheep

Prior to the 1900s, the Audubon bighorn sheep inhabited parts of western Nebraska including the Wildcat Hills, the Pine Ridge, along the North Platte River to eastern Lincoln County, and along the Niobrara River. It is thought that the Audubon bighorn probably became extinct in the early 1900s, with its last stronghold being the South Dakota badlands.

In 1981, the NGPC began introducing bighorn sheep in the Pine Ridge area. A dozen bighorns were released into a 500-acre enclosure at Fort Robinson State Park near Crawford. In December 1988, 21 sheep were released from the pen, and in January 1993, the remaining 23 sheep were released. Nebraska's bighorn sheep population is now estimated to be between 80 and 140 animals (Nordeen 2004). A few bighorn sheep are known to have ranged from the Fort Robinson area as far east as the Bordeaux Creek drainage southeast of Chadron, south near Belmont, west near the Gilbert-Baker Wildlife Management Area, and north into the Oglala grasslands (Nordeen 2004).

Carnivores

Low numbers of coyotes (*Canis latrans*), red fox (*Vulpes vulpes*), and long-tailed weasel (*Mustela frenata*) are expected to range freely and widely throughout the project area. Bobcat (*Lynx rufus*), badger (*Taxidea taxus*), and striped skunk (*Mephitis mephitis*) may also occur in the project area, but they are less common.

Small Mammals

The deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), meadow jumping mouse (*Zapus hudsonius),* northern pocket gopher (*Thomomys talpoides*), and meadow vole (*Microtus pennsylvanicus*) are expected to occur in the highest abundances. The highest densities of these small mammals are expected to occur in the deciduous forests areas, whereas the lowest abundance of small mammals would most likely occur in the cultivated fields. According to results of the 1982 baseline study (WFC 1983), the greatest diversity of small mammals was detected in the mixed- and short-grass community, and the lowest diversity was observed in the non-wooded riparian and lower deciduous forest areas.

Muskrat (*Ondatra zibethicus*) may occur along watercourses, and beaver (*Castor canadensis*) may occur in the White River Basin. Porcupine (*Erethizon dorsatum*), fox squirrel (*Sciurus niger*), white-tailed jackrabbit (*Lepus townsendii*), black-tailed jackrabbit (*Lepus californicus*), and eastern cottontail (*Sylvilagus floridanus*) are also expected to occur throughout the project area.

I.4.6.5 Birds

The Nebraska Ornithologists' Union's (NOU) "Official" lists 434 bird species (including two extinct species – passenger pigeon and Carolina parakeet) as occurring in Nebraska (NOU 1997). Accordingly, Johnsgard (1979) lists 430 species (including 54 apparently "accidental" [vagrant] species) and nine extinct, extirpated, or probably extirpated species. In addition, Johnsgard (1979) lists 27 "hypothetical" species, and four unsuccessfully introduced species. Researchers documented 201 species during the 1982 baseline study (WFC 1983) (see Section 8-3 of **Appendix 8**).

Of the 434 NOU birds reported for Nebraska, approximately 200 species nest in the state. Most species that nest in the state (approximately 45 percent) are associated with forested habitats. Aquatic and shoreline adapted species make up the second largest component (32 percent) of breeding birds in Nebraska (Johnsgard 1979). Species primarily associated with grasslands comprise a still smaller breeding component, or approximately 10 percent of the state's total avifauna. Bird species associated with semi-desert scrub are the least numerous.

Common bird species likely to occur within the cultivated fields include the American robin (*Turdus migratorius*), red-winged blackbird (*Agelaius phoeniceus*), mourning dove (*Zenaida macroura*), house wren (*Troglodytes aedon*), violet-green swallow, (*Tachycineta thalassina*), and horned lark (*Eremophila alpestris*). Birds associated with riparian and woodland habitats include pine siskin (*Carduelis pinus*), red crossbill (*Loxia curvirostra*), black-capped chickadee (*Poecile atricapillus*), rufous-sided towhee (*Pipilo erythrophthalmus*), yellow warbler (*Dendroica petechia*), and house wren (*Troglodytes aedon*).

Upland Game Birds

The wild turkey's range now includes most major river drainages in the state and the Pine Ridge area. Populations of turkeys in the Pine Ridge and Niobrara River valley are primarily Merriam's turkey (*Meleagris gallopavo*). Fair numbers of turkeys may exist within the White River basin (Nordeen 2004), which is close to the project area. In addition, small, isolated populations may be found in suitable habitats outside of the White River basin.

Ring-necked pheasants (*Phasianus colchicus*) range from fairly abundant to common throughout the project area with preferred habitats occurring in shelterbelts, drainages, and edges of cultivated fields. However, regional pheasant populations are subject to extreme fluctuation primarily resulting from the availability of suitable cover and the severity of winter weather.

Sharp-tailed grouse (*Tympanuchus phasianellus*) are most commonly found in short- and mixed-prairie grassland areas interspersed with serviceberry (*Amelanchier spp.*), chokecherry (*Prunus virginiana*), and snowberry (*Symphoricarpos albus*). Shrubs and small trees play an important role in sharp-tailed grouse ecology, especially in winter, when they provide both food and cover.

Weed-grass types and cultivated crops (wheat and alfalfa) may be utilized in spring and summer. Sharp-tailed grouse may utilize agricultural fields, feed on waste grain, and associated insects. Within the project area, sharp-tailed grouse are expected to be distributed primarily in the north end of the expansion area, where mixed-grass prairie is predominant.

Waterfowl

Waterfowl may occur throughout the region, primarily during both the spring and fall migrations. However, because of the lack of wetlands and their associated habitats, the diversity and abundance is extremely low in the project area. Outside of the reaches of open water associated with the White River, impoundments and wetland habitats are absent from the project area. Researchers observed 24 species of waterfowl during the 1982 baseline surveys and mallard (*Anas platyrhnchos*) was the most commonly observed species (WFC 1983).

Raptors

Several raptor species are expected to occur in the project area, a reflection of the diversity in habitat types and the existence of many suitable nesting sites, such as tall trees. The golden eagle is a permanent resident of the area, occurring in a variety of habitats. The most common permanent resident raptors occurring in the cultivated fields and mixed-grass prairies may include red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), turkey vulture (*Cathartes aura*), and great horned owl (*Bubo virginianus*). In addition, the rough-legged hawk (*Buteo lagopus*) is a common winter resident of the Pine Ridge area (WFC 1983).

I.4.6.6 Reptiles and Amphibians

Of the 22 species of reptiles and amphibians recorded in Dawes and Sioux Counties (Ferraro 2004) (see Section 8-4 of **Appendix 8**), 13 were documented during the 1982 baseline investigation. Documented toads and frogs included Woodhouse's toad (*Bufo woodhousii*), Great Plains toad (*Bufo cognatus*), plains spadefoot (*Spea bombifrons*), western striped chorus frog (*Pseudacris triseriata*), northern leopard frog (*Rana pipiens*), and bullfrog (*Rana catesbeiana*). Two species of turtles observed were the snapping turtle (*Chelydra serpentina*) and painted turtle (*Chrysemys picta*). Snakes identified included the bullsnake (*Pituophis catenifer*), plains garter snake (*Thamnophis radix*), red-sided garter snake (*Thamnophis sirtalis*), and yellow-bellied racer (*Coluber constrictor*).

I.4.7 Threatened, Endangered, or Candidate Species

Several species that could potentially occur within the project area are considered "threatened or endangered" because of their recognized rarity or vulnerability to various causes of habitat loss or population decline. These designated species receive specific protection defined in the Federal Endangered Species Act of 1973, as amended, and the Nongame and Endangered Species Conservation Act (Neb. Rev. Stat. §37-430 et seq.). Other species have been designated as "candidate or sensitive" on the basis of adopted policies and expertise of state resource agencies or organizations with acknowledged expertise. A list of potentially occurring special-status species, along with specific occurrence records, was developed from an original list of target species based on records of the NGPC and the USFWS. **Table I.4-3** summarizes the known or potential occurrence of each species within the project area. The information in this table was updated in 2007 and 2008 to address recent changes in some of the T&E species status.

Bald Eagle

On June 28, 2007, the USFWS removed the bald eagle (*Haliaeetus leucocephalus*) from the list of threatened and endangered species (USDI 2007). Even though the bald eagle has been delisted, it is still protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The NGPC currently lists the bald eagle as threatened. Any changes in the status of the bald eagle in the state will have to be approved by the NGPC following public hearings. It is anticipated that a decision about the state delisting of the bald eagle will occur in the next several months (Fritz 2008).

Bald eagles occur throughout North America from Alaska to Newfoundland and from the southern tip of Florida to southern California. In Nebraska, this species builds large nests in the crowns of large mature trees such as cottonwoods or pines. Fish and waterfowl are the primary sources of food where eagles occur along rivers and lakes. Big game and livestock carrion, as well as larger rodents (for example, prairie dogs) can also be important dietary components where these resources are available (Ehrlich et al. 1988).

This species is an uncommon breeding resident in Nebraska, using mixed coniferous and mature cottonwood riparian areas near large lakes or rivers as nesting habitat (NGPC 2008a). In recent years, bald eagles have attempted to nest every summer near large bodies of water, and in 1996, there were ten documented nests in Nebraska (NGPC 2008a). Data from the BBS Trend Analysis (Sauer et al. 2004) indicate a non-significant trend for populations of this species in Nebraska between 1966 and 2003. However, the trend for the United States during the same period is highly significant and positive.

Eagles are expected to winter in areas of suitable habitat within the region, especially in the Pine Ridge area. Feeding areas, diurnal perches, and night roosts are fundamental elements of bald eagle winter habitats. Although eagles can fly as far as 15 miles (24 km) to and from these elements, they occur primarily where all three elements are available in relatively close proximity (Swisher 1964). The availability of food is probably the single most important factor in the winter distribution and abundance of the eagle (Steenhof 1978).

In Nebraska, the diet of bald eagles is more varied than in other regions where fish are the primary food source. Nebraska grassland and shrub land habitats support a variety of suitable bald eagle prey species including prairie dogs, lagomorphs, and big game and livestock carrion. They also prey on fish and waterfowl when available.

Swift Fox

The swift fox (*Vulpes velox*) was petitioned for listing under the Endangered Species Act in 1992. The 90-day finding from USFWS concluded that a species listing may be warranted range-wide. However, the 12-month finding issued in 1995 by the USFWS resulted in a "warranted, but precluded decision," concluding that the magnitude of threats to the species is low to moderate although the immediacy of threats remains imminent. Within Nebraska, the swift fox is listed as threatened under the Nongame and Endangered Species Conservation Act.

The swift fox is found in short- and mid-grass prairie habitats. It appears to prefer flat to gently rolling terrain. Swift fox feed primarily on lagomorphs, but arthropods and birds are also included in their diets. They mate between late December and February. A mating pair can bear two to five pups late March to early May, and pups emerge from the den in June. Dens are generally located along slopes or ridges that offer good views of the surrounding area (Fitzgerald et al. 1994). In a study completed in southeastern Colorado, the home range size of an adult swift fox was approximately 3.6 square miles at night, and their day ranges are typically much smaller (Schauster et al. 2002).

The swift fox is found in native shortgrass in northwestern Nebraska. Unlike coyotes or red fox, the swift fox uses dens in the ground the entire year. Some characteristics of swift fox dens differentiate them from other dens. Swift fox den entrances measure about 8 inches in diameter, similar to the size of a badger den. However, swift fox usually have more than one entrance, whereas badgers and most other animals have only one. Swift fox tend to spread excavated soil over a larger area than most other animals, resulting in a less prominent mound near the burrow's entrance. Dens are located on relatively flat ground away from human activity. Where coyotes are abundant, predation by coyotes is a significant cause of mortality for swift fox, and den availability is an important aspect of swift fox survival (Schauster et al. 2002).

Numerous natural and anthropogenic factors influence swift fox populations. Natural factors include fluctuating prey availability, interspecific competition, disease, and landscape physiography. Anthropogenic factors include habitat loss from agricultural, industrial, and urban conversion; competing land uses on remaining habitat including hydrocarbon production, military training, and grazing; and pesticide use. Of these, prey availability and habitat loss appear to have the most profound effects on swift fox populations.

Sightings of swift fox have been documented in northwestern Nebraska since the late 1970s (Godberson 2004). Most of these sightings have occurred in and around Oglala National Grasslands, primarily in large tracts of native prairie. Swift fox may occur in the project area using rolling uplands between drainages and mixed-grass prairie habitats in Sections 15 and 21.

Black-footed Ferret

The black-footed ferret (*Mustela nigripes*) is listed as endangered by the USFWS and NGPC, and has the potential to occur in Dawes County (NGPC 2008b, USFWS 2008a). However, no recent confirmed populations of the black-footed ferret have been observed in the State of Nebraska. The last known specimen was an individual killed on a road near Overton in Dawson County in 1949, and no wild ferrets have been verified in Nebraska since the 1940s (NGPC 2008c). Therefore, the black-footed ferret is not expected to occur in the project area.

Whooping Crane

The whooping crane (*Grus americana*) is listed as endangered by the USFWS and NGPC, with the potential to occur in Dawes County (NGPC 2008a, USFWS 2008b). The whooping crane is an occasional spring and fall migrant along the Platte Valley in the state, which accounts for approximately 90 percent of the observations in Nebraska. The Platte Valley is located in central Nebraska, a considerable distance from the project area. Additionally, suitable habitat is lacking within the project area (e.g., rivers and streams with associated sandbars and islands, marshlands, wet meadows and croplands). The whooping crane is not expected to occur in the project area.

I.4.8 Aquatic Resources

Spring Creek and White River are the primary drainages in the project area. These two surface waters are characterized by incised channels, small stream slopes, and relatively low basin elevations. Spring Creek is tributary to the White River, which is tributary to the Missouri River.

The project area is primarily contained within the White River basin. The White River originates on the Pine Ridge Escarpment in northwestern Nebraska. The river flows northeast into South Dakota, passing through boundaries of the Pine Ridge and Rosebud Sioux Indian reservations. It then turns east and empties into the Missouri River near Chamberlain, South Dakota. The entire drainage basin is approximately 10,200 square miles and 313 square miles within Dawes County. The White River basin is characterized as a larger basin with flat stream slopes that typically has high flows characterized by rapidly rising and gradually receding flows. The White River is primarily regulated by periods of snowmelt, direct precipitation, surface runoff, and groundwater discharge from seeps and springs.

The White River has a shifting sand and silt substrate with few riffle areas and poorly defined pools. Depths typically range from 1.6 to 6.6 feet (ft). Eroding streambanks are present along most sections. Stream width varies from about 9.8 to 16.4 ft. Cover for fish is provided by deep water, log jams, and undercut tree roots. Some relatively undisturbed riparian areas exist along the river, especially around Fort Robinson State Park. Other riparian areas are heavily grazed and typically lack understory vegetation. The White River is subject to fluctuating water levels and flooding. The White River drains portions of the project area.

Spring Creek originates in the Fort Robinson State Park, and flows through the plains and open high hills of Sioux and Dawes Counties. The stream is ephemeral, flowing primarily during spring runoff, generally following winters with above-average snowfall. Much of the upper watershed is forested, mainly because it is within the Fort Robinson State Park. In contrast, the middle and lower watershed consists of heavily grazed rangeland or cultivated small grain fields. Spring Creek is tributary to the White River. On-stream impoundments, where they exist, and pools created by washouts below culverts may provide the only suitable fish habitat. The watershed in this lower area is unstable and, as evidenced by high-water debris, is subjected to periodic high-volume surface flows.

In general, the aquatic habitats within the project area suffer from ongoing environmental stresses. Naturally occurring stresses include unstable substrates and banks, low flows, and periodic high-volume surface flows. Overgrazing on adjacent rangelands and riparian areas combined with farming practices along the stream courses further compound these problems.

Livestock grazing and agricultural watering uses add to the stressed stream conditions. These conditions are reflected in a fishery mostly consisting of non-game, stress-tolerant species. Periodic stocking by the NGPC has created some put-and-take sport fisheries in the area, but these are not self-sustaining because of environmental factors.

Aquatic Ecology

Aquatic ecology baseline data were collected in 1982 and 1996 to assess aquatic resources including fish and macroinvertebrates. (CBR 2007a).

Fish

During the 1982 and 1996 baseline studies, fish were collected in various streams, including the White River, to document their occurrence. Fifteen species of fish were collected during the 1982 and 1996 collection periods (Section 8-5 of **Appendix 8**). Game fish collected in the White River included rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and white sucker (*Catostomus commersoni*). Minnow species collected in the White River include longnose dace (*Rhinichthys cataractae*), common shiner (*Luxilus cornutus*), fathead minnow (*Pimephales promelas*), and creek chub (*Semotilus atromaculatus*).

There is a regionally important put-and-take fishery in the White River within and around Fort Robinson State Park. However, fluctuating flows, periodic flooding, sand and silt substrates, and warm water temperatures are probably the most important factors limiting natural trout production in the White River, especially in areas of intense agriculture and grazing.

Macroinvertebrates

Macroinvertebrate density, diversity, and number of taxa for various streams including the White River were sampled in 1982 and 1996 (Section 8-6 of **Appendix 8**). Macroinvertebrate analyses of the samples indicate that, in general, most aquatic streams have stressed environments. Stress-tolerant organisms accounted for more than 90 percent of the total species count for all sampled areas. Of these tolerant species, the most abundant groups were: chironomidae - 34 percent, simulidae - 20 percent, oligochaeta - 19 percent, and ceratopogonidae - 15 percent. Exceptions occurred within the upper White River, where caddisflies and mayflies dominated the riffle habitat. These two taxa typically represent less-stressed environments than those of the above listed organisms.

Although densities of macroinvertebrates were high at most sampling stations, diversity values were low. Many forms of stress reduce diversity by making the environment unsuitable for some species or by giving other species a competitive advantage. The White River showed low diversity, indicating relatively lower water quality and degraded stream habitats.

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I.5 Environmental Effects

This section discusses and describes the degree of unavoidable environmental impacts, the short- and long-term impacts associated with operations and the consequences of possible accidents at the NTEA, as well as associated activities at the current Crow Butte project.

I.5.1 Environmental Effects of Site Preparation and Construction

The initial site preparation and construction associated with the NTEA will include the following:

- Construction of a satellite process facility located approximately 3 miles west and 5 miles north of the current process plant. This satellite facility will be housed in a building approximately 130 feet long by 100 feet wide and will contain ion exchange and associated equipment capable of processing 4,500 gpm of production flow and 500 gpm of restoration flow.

- Construction of solar evaporation ponds located in conjunction with the satellite facility to be used as feed ponds for the deep injection well.
- Expansion of the main process facility in response to the increase in the ion exchange resin handling, elution, precipitation, thickening, and drying circuits to handle the additional production from North Trend.
- A deep well injection building(s).
- Access roads, as required.

Site preparation and construction activities will include topsoil salvaging, pond excavation, building erection, and access road construction. Note that wellfield construction activities and completion of injection, production, and monitor wells are discussed in Section I.5.2 because these are ongoing activities at an ISL facility. This section strictly discusses the short-term impacts of initial site preparation and construction where they differ from the impacts of operations.

Environmental impacts of construction projected for the NTEA are based on the studies conducted by CBR and discussed in this section. The impacts are also projected based on experience with the current operation and the impacts that have been associated with this type of construction at the Crow Butte Project over the past 15 years of commercial operation.

The total area impacted by initial construction activities is approximately 30 acres. All areas disturbed will be reclaimed during final decommissioning activities. The planned schedule for construction, production, restoration, and decommissioning was presented in Chapter A.

I.5.1.1 Air Quality Effects of Construction

Construction activities at the NTEA site would cause minimal effects on local air quality. Effects to air quality would include increased suspended particulates from vehicular traffic on unpaved roads, in addition to existing fugitive dust caused by wind erosion, and diesel emissions from construction equipment. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short-term only, ceasing once the operational phase begins.

The detailed assessment and impact analysis of air emissions associated with the construction and operation of the facilities are discussed in detail in technical and environmental support documents for an NRC license application amendment request (CBR 2007a, 2007b).

I.5.1.2 Land Use Impacts of Construction

The principal land use for the 30-acre site associated with the proposed North Trend Satellite Facility is as cropland, primarily for raising alfalfa for livestock feed. As a result of site preparation and construction, crop production will be excluded from the area under development. In 2001, Dawes County had 77,000 acres harvested for 123,800 tons of hay. This harvest resulted in yields of 1.6 tons of hay per acre harvested. Based on this average yield, construction activities in a 30-acre area would result in a loss of up to 48 tons of hay per year. Considering the relatively small size of the area impacted by construction, the exclusion of agricultural activities from this area over the course of the North Trend Project should not have a significant impact on local agricultural production.

I.5.1.3 Population Impacts of Construction

The effects of construction of the proposed North Trend Satellite Facility on the immediate population will be an unavoidable, although temporary, impact. Construction activities will require additional temporary construction workers. Many of these positions will likely be filled by local labor. Any additional workers that may not be from the immediate area will cause a short-term increase in housing demand. The population impacts of construction are discussed in more detail in Section I.6.

I.5.1.4 Surface Water Impacts of Construction

When stormwater drains off a construction site, it carries sediment and other pollutants that can harm lakes, streams, and wetlands. The USEPA estimates that 20 to 150 tons of soil per acre is lost every year to stormwater runoff from construction sites. For this reason, stormwater runoff is controlled by National Pollutant Discharge Elimination System (NPDES) regulations.

Construction activities at the Crow Butte Project to date have had a minimal impact on the local hydrological system. CBR conducts construction activities under NDEQ permitting regulations for control of construction stormwater discharges contained in Title 119 (NDEQ 2005). CBR is required by NDEQ General Construction Stormwater NPDES Permit NER 100000 to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in CBR's EHSMS Volume VI, Environmental Manual and require active engineering measures (such as berms) and administrative measures (such as work activity sequencing) to control runoff and sedimentation of surface water features. CBR must annually submit a construction plan for the coming year and obtain authorization from the NDEQ under the general permit.

In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from initial site preparation and construction of the North Trend Satellite Facility and related facilities will be minimal because there are no nearby surface water features.

I.5.1.5 Social and Economic Impacts of Construction

The social and economic impacts to the City of Crawford and surrounding areas during the construction of the original facility were slight given the relatively small scale of activities. The future construction activities for the North Trend Satellite Facility will be even smaller in scope. CBR estimates that 10 to 15 temporary construction workers will be involved in constructing the North Trend Satellite Facility. The social and economic impacts of construction are discussed in more detail in Section I.6.

I.5.1.6 Noise Impacts of Construction

Increased vehicle travel during the construction phase of the project may result in a slight increase in noise impacts to residents. However, noise from construction would not be generated during nighttime hours, and increases in noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction traffic (including movement of heavy equipment, which would be much less dense and slower than highway traffic) would be barely perceptible over the existing ambient noise that is dominated by vehicle noise from State Highway 2/71 and the BNSF railroad. Noise from construction would be temporary and would briefly add to existing highway noise. Construction would be completed in a timely manner. A detailed assessment of noise levels during construction is presented in CBR's Technical Report in support of the 2007 NRC license application for amendment of Source Material License SUA-1534 North Trend Expansion Area (CBR 2007a).

I.5.2 Environmental Effects of Operations

The major environmental concerns during the operation of the North Trend Satellite Facility discussed in this section are land use and water quality impacts, ecological impacts, and radiological impacts.

I.5.2.1 Air Quality Impacts of Operations

A summary of typical air emissions from an uranium in-situ satellite facility is shown in **Table I.5-1**. The types of emissions associated with construction, operations, aquifer restoration and decommissioning are presented.

The primary new emission source of non-radiological pollutants will be tailpipe emissions of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), non-methane-ethane volatile organic compounds (VOC) and particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the NTEA. Approximately 6 to 8 vehicle trips per day (VTPD) are anticipated as part of regular operations. These vehicles are expected to be light duty pick-up style trucks. Heavy equipment in the form of drill rigs, equipment haulers or water trucks will be used as necessary and are anticipated to average less than one VTPD. These emissions are expected to be minor and should not affect the local ambient air quality.

Although there are no ambient air quality monitoring data for these non-radiological pollutants in the NTEA, PM_{10} concentrations have been measured in Rapid City, South Dakota and Badlands National Park in South Dakota. Both locations are geographically similar to the NTEA.

The Rapid City data were collected at the National Guard Camp Armory site about 2 miles west of the city. This area is classified as suburban. The Badlands data were collected in an area classified as rural. Because of the degree of urbanization, the air quality at the NTEA would probably fall somewhere between the air quality at these two locations. These data were obtained from the USEPA air quality monitoring database (USEPA 2007), and are presented in **Table I.5-2.**

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (ug/m^3) (24-hour average), and 50 ug/m^3 (annual average). All counties within the 80 km radius of the project are in attainment of NAAQS.

There will be an increase in the total suspended particulates (TSP) in the region as a result of the NTEA. This increase in TSP will be greatest during the site preparation phase of the satellite facility. Revegetation will be performed where possible to mitigate the problems associated with the resuspension of dust and dirt from disturbed areas. All areas disturbed during construction will be revegetated with the exception of plant pad areas, roads and areas covered by the pond liners. Of these, the only significant source of TSP is dust emissions from unpaved roads. The amount of dust can be estimated from the following equation taken from "Supplement No. 8 for Compilation of Air Pollutant Emission Factors" (USEPA 1978).

$$E = 0.81s \quad X \quad \left(\frac{S}{30}\right) \quad X \quad \left(\frac{365 - w}{365}\right)$$

Where:

E = emission factor, lb per vehicle-mile
s = silt content of road surface material, 40%
S = average vehicle speed (miles per hour), 30 mph
w = mean number of days with 0.01 inches or more of rainfall, 85

Using the values stated above, the emission factor is equal to 0.249 lb/vehicle-mile. The distance from the City of Crawford to the North Trend Satellite Plant is approximately 7.6 miles. Approximately 4 miles of this distance is on improved roads and 3.6 miles is on dirt roads. CBR expects that most employees at the North Trend Satellite Plant will be from the City of Crawford. Assuming ten employees and a 7 day workweek, there will be 140 trips per week and the weekly mileage on dirt or trail roads will be 504 miles. Deliveries and other travel may require up to 50 trips per week which will be an additional 360 miles per week on dirt or trail roads.

The planned transport route between the North Trend facilities and the current CSA is depicted in **Figure I.5-4** of Section I.5.5.4.3. The distance from the satellite facility to the Crow Butte Main Plant is approximately 9.46 miles of which approximately 6.4 miles are on unpaved roads and approximately 3 miles on paved roads (U.S. Hwy. 20 and Nebraska State Hwy. 2/71). Assuming 2 trips per day for resin transfer and an additional 10 trips per day for plant personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1600 miles per week. This estimate is based on a 7 day work week.

The total distance traveled on dirt and trail roads for personnel, resin transfer, deliveries and incidental travel will be approximately 2,500 miles per week. With an emission factor of 0.249 lb TSP per vehicle-mile there will be a total dust emission of approximately 16.2 tons per year as a result of increased traffic on dirt and trail roads.

Any increase in fugitive dust emissions resulting from operational activities within the NTEA will be minimal. Implementation of mitigation measures such as the application of water or dust control chemicals to unpaved roads will ensure that the ambient air quality standards of the State of Nebraska will not be exceeded at any time during the life of the project.

Other operational activities may have impacts on surrounding air quality. The primary atmospheric emission from the production and process facilities will be radon gas, which is discussed at length in Section I.5.3.

The NRC has reported that uranium in-situ leach milling facilities are not considered as major non-radiological air emission sources and the impacts would be classified as SMALL (USNRC 2008), assuming the following conditions are met:

- Gaseous emissions are within regulatory limits and requirements.
- Air quality in the region of influence is in compliance with NAAQs.
- The facility is not classified as a major source under the New Source Review or operating (Title V) permit programs

The NRC's definition of a SMALL Impact is: *The environmental effects are not detectable or are so minor that they will nether destabilize or noticeably alter any important attribute of the resource considered.*

The proposed North Trend Satellite Facility, as well as the existing CBR processing facility, meets these conditions.

In summary, the majority of emissions generated during construction will be fugitive dust and vehicle combustion emissions. CBR will use best management practices to reduce fugitive dust and emissions (e.g., wetting of unpaved roads and control of vehicle speeds). Impacts associated with fugitive emissions will be classified as SMALL by the NRC (USNRC 2008). The primary combustion emission will be diesel emissions, but such emissions are expected to be limited in duration during construction activities and result in small, short-term effects (USNRC 2008). Impacts associated with operations will be less than the construction phase impacts and considered SMALL by the USNRC (USNRC 2008). During restoration, there will be fugitive dust and combustion emissions associated with the plugging and abandonment of production and injection wells. Impacts are not be expected to exceed emissions generated during construction, and therefore aquifer restoration phase impacts will be SMALL (USNRC 2008). During decommissioning, emissions are expected to be similar to the construction phase, but will decrease as decommissioning proceeds. The decommissioning phase impacts to air quality will be expected to be SMALL (USNRC 2008).

I.5.2.2 Land Use Impacts of Operations

The principal land uses for the NTEA and the 2.25-mile review area is livestock grazing. Rangeland accounted for 47 percent (9,531.8 acres) of the land use in the NTEA, and the review area as discussed in Section I.1.2. The secondary land use within this area is cropland, primarily for wheat, although a small proportion is used for alfalfa. Cropland accounted for 39 percent (7,876.5 acres) of the land use in the NTEA and the review area. Recreational areas account for

10% (2,105.6) of the land use in the NTEA and review area. Land use was discussed in detail in Section I.1.2 and summarized in Table I.1-2.

For the 372-acre proposed wellfield areas, cropland accounts for 363 acres or 97 percent of the total area. Rangeland accounts for 9.1 acres or 3 percent of the total area. **Figure I.5-1** depicts the proposed wellfield areas and the current types of land use.

I.5.2.2.1 North Trend Wellfield Land Use

Major land use activities within and adjacent to the proposed NTEA wellfield areas is shown in **Figure I.5-1**.

As a result of site preparation and construction, cattle production will be excluded from the areas that are under development. The total estimated area that will be impacted during the course of the project is the 402 acres associated with the satellite facility (30 acres) and wellfields (372 acres). As discussed in Section I.1.2, livestock and livestock products carry a value of $28.81 per acre, indicating that livestock production on rangeland (total of 39.1 acres) within the impacted wellfield areas and satellite facilities will only have a potential value of $1,126.

As a result of site preparation and construction, crop production will be excluded from the areas that are under development. The total estimated cropland area that will be impacted during the course of the project is the approximate 393 acres associated with the satellite facility and wellfields. In 2001, 77,000 acres were harvested in Dawes County for 123,800 tons of hay and 33,700 acres were harvested for 1,198,700 bushels of winter wheat. These harvests resulted in yields of 1.6 tons of hay and 35.6 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the NTEA would be up to 629 tons of hay and up to 13,991 bushels of wheat.

Considering the relatively small size of the area impacted by operations, the exclusion of agricultural activities from this area over the course of the North Trend Project should not have a significant impact on local agricultural production. These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation.

The current operations in the licensed area have shown that CBR can successfully restore the land surface following mining operations. Surface reclamation activities, including contouring and revegetation, have been performed routinely following initial mine unit construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of Mine Unit 1 following approval of groundwater restoration. These areas have been successfully recontoured, and revegetation has been completed in accordance with NDEQ requirements.

I.5.2.3 Geologic and Soil Impacts of Operations

I.5.2.3.1 Geologic Impacts of Operations

Geologic impacts are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the Basal Chadron Sandstone will be on the order of 1 percent or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10 percent of the available head or less. Further, once mining and restoration operations are completed and restoration approved, groundwater levels will return to near original conditions under a natural gradient.

If the White River structural feature is in fact a fault, changes in aquifer pressure potentially could impact activity related to the fault and the transmissive characteristics of the fault (e.g., resistance to flow). There are numerous documented cases where injection in the immediate vicinity of a fault has caused an increase in seismic activity. However, such response typically occurs when injection operations have increased the pressure in the aquifer by a significant amount (e.g., 40 to 200 percent pressure increase over initial conditions). The pressure in the Basal Chadron will be increased on a localized scale by injection operations during mining and restoration operations, and will be more than offset by production within each wellfield pattern.

I.5.2.3.2 Soil Impacts of Operations

Construction of the facilities at the NTEA site will affect soils. Effects to soils would be significant on approximately 30 fenced acres of the 1,165 acres that will be disturbed by construction of the North Trend Satellite Facility and associated facilities. Much of the remaining 1,135 acres will be devoted to wellfield production where effects to soils would be much lower.

The severity of soil impacts would depend on the number of acres disturbed and the type of disturbance. Potential impacts include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Effects to soils at the NTEA site would result from the clearing of vegetation, excavating, leveling, stockpiling, compacting, and redistributing soils during construction and reclamation. Disturbance related to the construction and operation of the North Trend Satellite Facility would be long-term.

Wind erosion is a concern at the NTEA site. Various soils meet the criteria for severe wind erosion hazard (NRCS 1977). These soils have one or more major constituents that are fine sand or sandy loam that can easily be picked up and spread by wind. Construction presents the greatest threat to soils with potential for wind erosion. Wind erosion will be controlled by removing vegetation only where it is necessary, avoiding clearing and grading on erosive areas, surfacing roads with gravel, and timely reclamation.

Water erosion is also a concern at the NTEA. Various soils meet the criteria for severe water erosion hazard (NRCS 1977). These soils have low permeability and high K-factors, making them susceptible to water erosion. The K-factor is used to describe a soil's erodibility; it represents both susceptibility of soil to erosion and the rate of runoff. It is determined by soil texture, organic matter, and soil structure. Construction and operation would increase soil loss through water erosion. Removal of vegetation for any activity exposes soils to increased erosion. Excavation could break down soil aggregates, increasing runoff and gully formation. Soil loss will be reduced substantially by avoiding highly erosive areas such as badlands and steep drainages. Locating roads in areas where cuts and fills would not be required, surfacing roads, installing drainage controls, and reseeding and installing water bars across reclaimed areas will also aid in reducing soil loss.

Sedimentation in streams and rivers at the NTEA could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of drainages in the area. Installation of appropriate erosion control measures as required by CBR's Construction Stormwater NPDES authorization (see Section I.5.1.4) and avoidance of erosive soils will aid in reducing sedimentation.

Activity on the site has the potential to compact soils. While soils sensitive to compaction, such as clay loams, do not exist on the site, the intense volume and degree of activity at the NTEA could damage soil properties and cause compaction. Compaction of the soils could decrease infiltration, promoting high runoff. If compaction occurs, reduced infiltration capacity could persist for more than 50 years in some soils. Construction and traffic will be minimized where possible, and soils will be loosened for reseeding during reclamation to control the effects of soil compaction.

Any soil on the site can be saline depending on site-specific soil conditions, such as permeability, clay content, quality of nearby surface waters, plant species, and drainage characteristics. Saline soils are extremely susceptible to soil loss caused by development. Soil erosion in areas with high salt content would contribute to salinity in the White River Basin. Reclamation of saline soils can be difficult, and no method has yet been found that works in all situations.

Facility development would displace topsoil, which would adversely affect the structure and microbial activity of the soil. Loss of vegetation would expose soils and could result in a loss of organic matter in the soil. Excavation could cause mixing of soil layers and breakdown of the soil structure. Removal and stockpiling of soils for reclamation could result in mixing of soil profiles and loss of soil structure. Compaction of the soil could decrease pore space and cause a loss of soil structure as well. This would result in a reduction of natural soil productivity.

A number of erosion and productivity problems resulting from construction at the North Trend site may cause a long-term declining trend in soil resources. Long-term impacts to soil productivity and stability would occur as a result of large-scale surface grading and leveling until successful reclamation could be accomplished. Reduction in soil fertility levels and reduced productivity would affect diversity of reestablished vegetative communities. Moisture infiltration would be reduced, creating soil drought conditions. Vegetation would undergo physiological drought reactions.

Surface spillage of hazardous materials could occur at the NTEA. If not remediated quickly, these materials have the potential to adversely impact soil resources. In order to minimize potential impacts from spills, a Spill Prevention, Control, and Countermeasure Plan (SPCC) will be implemented. The SPCC plan will include accidental discharge reporting procedures, spill response, and cleanup measures.

I.5.2.3.3 Soil Impact Mitigation Measures

Best Management Practices (BMPs) have been included in the project description and will be followed for site preparation to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the NTEA. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document.

Sediment Control:

- Divert surface runoff from the undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Do not direct surface drainage over the unprotected face of the fill.
- Design and implement appropriate sediment controls for operations and disturbance on slopes greater than 40 percent.
- Avoid continuous disturbance that provides continuous conduit for routing sediment to streams.
- Inspect and maintain all erosion control structures.
- Repair significant erosion features, clogged culverts, and other hydrological controls in a timely manner.
- If BMPs do not result in compliance with applicable standards, modify or improve such BMPs to meet the controlling standard of surface water quality.

Topsoil:

- Remove topsoil prior to any development activity to prevent loss or contamination.
- When necessary to substitute for or supplement available topsoil, use overburden that is equally conducive to plant growth as topsoil.
- To the extent possible, directly haul (live handle) topsoil from the site of salvage to concurrent reclamation sites.
- Avoid excessive compaction of topsoil and overburden used as plant growth medium by limiting the number of vehicle passes, handling soil while saturated, and scarifying compacted soils.
- Time topsoil redistribution so seeding or other protective measures can be readily applied to prevent compaction and erosion.

Roads:

Construct and maintain roads to minimize soil erosion by:

- Restricting the length and grade of roadbeds;
- Surfacing roads with durable material (i.e., locally obtained native gravel);
- Creating cut and fill slopes that are stable;
- Revegetating the entire road prism including cut and fill slopes; and
- Creating and maintaining vegetative buffer strips and constructing sediment barriers (e.g., straw bales, wire-backed silt fences, check dams) during the useful life of roads.

Regraded Material:

- Design regraded material to control erosion using activities that may include slope reduction, terracing, silt fences, chemical binders, seeding, mulching, etc.
- Divert all surface water above regarded material away from the area and into protected channels.
- Shape and compact regraded material to allow surface drainage and ensure long-term stability.
- Concurrently reclaim regraded material to minimize surface runoff.

Potential long-term effects include soil loss, sedimentation, compaction, salinity, loss of soil productivity, and soil contamination. Potential short-term effects include reduced soil productivity, erosion, compaction, and soil contamination. Implementation of BMPs, SPCCs, and SWPPPs will minimize effects to soils associated with the construction of the North Trend production facilities.

I.5.2.4 Cultural Resources Impacts of Operations

Field investigations were conducted in July 2004 on a 1,165-acre area of anticipated potential development. Three historic sites and three isolated prehistoric artifacts were located and identified. As noted in Section I.3, these resources are not likely to yield information important in prehistory or history and are considered not eligible for the NRHP. Because these resources are considered not eligible, they are not historic properties, and the proposed NTEA will have no effect on historic properties.

There is specific information included in the cultural resource investigations that falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w – 3(a)). Additionally, disclosure of such information is protected under Nebraska State Statute Section 84-712.05 (13 and 14). Therefore, under separate correspondence, the Cultural Resource Inventory Report is being submitted to the NDEQ as "CONFIDENTIAL" for the purpose of public disclosure of the Class III UIC Permit Application.

I.5.2.5 Groundwater Impacts of Operations

Potential impacts to water resources from mining and restoration activities include the following:

I.5.2.5.1 <u>Groundwater Consumption</u>

Groundwater impacts and consumption related to the North Trend operation will be fully assessed in an Industrial Groundwater Permit application that is required by NDEQ. Information from the existing Groundwater Permit for the current license area indicates that the drawdown from mining operations in the Basal Chadron Formation is minimal (e.g., less than 10 percent of the available head). Based on drawdown data from years of operation in the current license area, and on the formation characteristics from the North Trend Pumping Test, the drawdown effect on the Chadron aquifer as a result of operations has been and is expected to remain minimal.

Groundwater consumption from the North Trend operation is expected to be on the order of 0.5 to 1.5 percent of the total mining flow (4,500 gpm). Additional consumptive volume will be used during aquifer restoration, especially the groundwater sweep phase. However, it is expected that the net consumption for the entire operation will be on the order of 50 to 100 gpm.

I.5.2.5.2 Potential Declines in Groundwater Quality

Excursions represent a potential effect on the adjacent groundwater as a result of operations. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high-permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, and hydrofracturing of the ore zone or surrounding units.

To date, there have been several confirmed horizontal excursions in the Chadron sandstone in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In all but one case, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent upper control limits (UCLs). In no case did the excursions threaten the water quality of an underground source of drinking water because the monitor wells are located well within the aquifer exemption area approved by the USEPA and the NDEQ. **Table I.5-3** provides a summary of excursions reported for the current license area.

I.5.2.5.3 Potential Groundwater Impacts from Accidents

Groundwater quality could potentially be impacted during operations due to an accident such as evaporation pond leakage or failure, or an uncontrolled release of process liquids due to a wellfield accident. If there should be an uncontrolled pond leak or wellfield accident, the shallow aquifer (Brule), as well as surrounding soil, could become contaminated. This could occur as a result of a slow leak or a catastrophic failure, a shallow excursion, an overflow due to excess production or restoration flow, or due to the addition of excessive rainwater or runoff.

To mitigate the likelihood of pond failure, all ponds at NTEA will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all ponds will be inspected regularly. In the event that a problem is detected, the contents of any given pond can be transferred to another pond while repairs are made.

Over the course of the current licensed operation, CBR has experienced several leaks associated with the top pond liner on the commercial evaporation ponds. These small leaks are virtually unavoidable because the liners are exposed to the elements. In each case, these leaks were quickly discovered during routine inspections, primarily due to a response in the underdrain system. Corrective actions included lowering the pond level and locating the leak to allow repairs. In none of these situations was the shallow groundwater affected because the bottom pond liner functioned as designed, allowing for the recovery of any leakage back into the pond, and preventing a release of the pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ.

With respect to potential overflow of a pond, current standard operating procedures require that pond levels be closely monitored as part of the daily inspection. Process flow to the ponds will be minimal in comparison to the pond capacity; thus, it can easily be diverted to another pond if necessary. In addition, sufficient freeboard will be maintained on all ponds to allow for a significant addition of rainwater with no threat of overflow. Finally, the dikes and berms around the ponds will channel runoff away from the ponds.

Another potential cause of groundwater impacts from accidents could be released as a result of a spill of injection or production solutions from a wellfield building or associated piping. In order to control these types of releases, all piping is either polyvinyl chloride (PVC), high-density polyethylene (HDPE) with butt welded joints, or equivalent. All piping is leak tested prior to production flow and following repairs or maintenance.

I.5.2.6 Surface Water Impacts of Operations

I.5.2.6.1 Surface Water Impacts from Sedimentation

Protection of surface water from stormwater runoff during ongoing wellfield construction related to operations is regulated by the NDEQ as discussed in Section I.5.1.4.

I.5.2.6.2 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as an evaporation pond leakage or failure or an uncontrolled release of process liquids due to a wellfield accident. Section I.5.2.5.3 discussed the operation of the ponds and measures to prevent and control wellfield spills. An additional measure to protect surface water is that wellfield areas are installed with dikes or berms to prevent spilled process solutions from entering surface water features. Process buildings are constructed with secondary containment, and a regular program of inspections and preventive maintenance is in place.

I.5.2.7 Ecological Impacts of Operations

I.5.2.7.1 Impact Significance Criteria

The following criteria were used to determine the significance of construction and operation of the proposed project on wildlife and vegetation resources within the project area. These criteria were developed based on professional judgment, involvement in other National Environmental Policy Act (NEPA) projects throughout the west, and state and federal regulations.

- Whether or not the removal of vegetation following reclamation could result in disturbed area(s) not having adequate cover (density) and species composition (diversity) that would support pre-existing land uses including wildlife habitat;
- Whether or not there could be an unauthorized discharge of dredged or fill materials into, or excavation of, waters of the U.S. including special aquatic sites, wetlands, and other areas subject to the Section 404 of the Clean Water Act, Executive Order 11988 - flood plains, and Executive Order 11990 - wetlands and riparian zones;
- Whether or not reclamation could be accomplished in compliance with Executive Order 13112 (Invasive Species);
- Whether or not the introduction and establishment of noxious or other undesirable invasive, non-native plant species could occur to the degree that such establishment results in listed invasive, non-native species occupying any undisturbed rangeland outside

of established disturbance areas or hampers successful revegetation of desirable species in disturbed areas;

- Whether or not a substantial increase in direct mortality of wildlife caused by road kills, harassment, or other causes could occur;
- Incidental take of a special-status species to the extent that such impact could threaten the viability of the local population;
- Whether or not an officially designated critical wildlife habitat was eliminated, sustained a permanent reduction in size, or was otherwise rendered unsuitable;
- Whether or not any effect, direct or indirect, results in a long-term decline in recruitment and/or survival of a wildlife population; and
- Construction disturbance during the breeding season or impacts to reproductive success which could result in the incidental loss of fertile eggs or nestlings, or otherwise lead to nest abandonment in accordance with regulations prescribed by the Migratory Bird Treaty Act.

I.5.2.7.2 Vegetation

As described in detail in Chapter A, a total of nine wellfields and the satellite processing facility will be constructed during the next 11 years with an expected mine life operation of 15 years. Well placement within the project area is not known at this time; however, it was assumed that agricultural fields within Sections 21, 22, 27, 28, and 34 (Township 32N, Range 52W) will be developed to contain a significant amount of project-related infrastructure. Production facilities are not anticipated to be constructed within the mixed-grass prairie vegetation community, which is primarily located in the north ½ of Section 21 (Township 32N, Range 52W).

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) from soil disturbance and grading. Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

Vegetation removal and soil handling associated with the construction and installation of wellfields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, because most project-related infrastructure will be constructed within cultivated agricultural fields, vegetation impacts will be negligible. If the mixed-grass prairie vegetation community were to be developed, direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics.

An estimated 1,014 acres of cultivated agricultural fields would be affected by potential surface-disturbing production facilities within the NTEA over the long-term operation of the mine. The proposed project facilities (satellite facilities and five wellfields) would have short-term surface disturbance of approximately 393 acres of cropland (approximately 39 percent of the total cultivated agricultural fileds acreage within the NTEA). The majority of potential long-term surface disturbance would be associated with the cultivated field community type because this community occupies 87 percent of the NTEA area. As stated above, clearing of mixed-grass prairie vegetation community types is not anticipated.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in western states. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. Currently, the project area is relatively free of noxious and other unwanted invasive, non-native species.

Previously planted agricultural fields would be recontoured and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts were disturbed by surface activities, these areas would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) complete cleanup of the disturbed areas (wellfields and access roads); (2) restoring the disturbed areas to the approximate ground contour that existed before construction; (3) replacing topsoil, if removed, over all disturbed areas; (4) ripping disturbed areas to a depth of 12 to 18 inches; and (5) seeding recontoured areas with a locally adapted, certified weed-free seed mixture.

I.5.2.7.3 Surface Waters and Wetlands

Surface disturbances associated with the proposed facilities would not affect either Spring Creek or the White River. In addition, no wetlands have been identified within the project area. Therefore, impacts to wetlands and surface waters are not anticipated.

I.5.2.7.4 Wildlife and Fisheries

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of some individuals of some wildlife species, loss of wildlife habitats, and an increase in the potential for collisions between wildlife and motor vehicles. Other potential effects include a rise in the potential for illegal kill, harassment, and disturbance of wildlife because of increased human presence primarily associated with increased vehicle traffic. The magnitude of impacts to wildlife resources would depend on a number of factors, including the time of year, type and duration of disturbance, and species of wildlife present.

I.5.2.7.5 Small Mammals and Birds

The direct disturbance of wildlife habitat in the project area likely would reduce the availability and effectiveness of habitat for a variety of common small mammals, birds, and their predators. The initial phases of surface disturbance and increased noise would result in some direct mortality to small mammals and would displace some bird species from disturbed areas. In addition, a slight increase in mortality from increased vehicle use of roads in the project area would be expected.

The temporary disturbances that occur during the construction period would tend to favor generalist wildlife species, such as ground squirrels and horned larks, and would have more impact on specialist species such as western meadowlarks, lark buntings, and grasshopper sparrows. Overall, the long-term potential disturbance of 1,165 acres would have a low effect on common wildlife species. Songbirds that may be affected by the reduction in cultivated fields would be horned larks, sage sparrows, sage thrashers, and vesper sparrows. Although there is no way to accurately quantify these changes, the impact is likely to be low in the short term and reduced over time as reclaimed areas begin to provide suitable habitats.

Because of the high reproductive potential of these species, they would rapidly repopulate reclaimed areas as habitats become suitable. Birds are highly mobile and would disperse into surrounding areas and utilize suitable habitats to the extent that they are available. The primary small mammals found on the project area include, but are not limited to, eastern cottontail, deer mice, thirteen-lined ground squirrel, white-footed mouse, meadow jumping mouse, and northern pocket mouse. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be low, and the high reproductive potential of these small mammals would enable populations to quickly repopulate the area once reclamation efforts are initiated.

I.5.2.7.6 Big Game Mammals

In general, direct removal of habitat used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Because a substantial proportion of the project area is used for seasonal crop production, only a small proportion of the available wildlife habitat in the project area would be affected. The capacity of the project area to support big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat because of the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect utilization of the habitat immediately adjacent to these areas. However, big game mammals are adaptable and may adjust to non-threatening, predictable human activity. It is likely that most big game individual responses will consist of avoidance of areas proximal to the operational facilities, with most individuals carrying out normal activities of feeding and bedding within adjacent suitable habitats. In addition, the magnitude of displacement would decrease over time as: (1) the animals have more time to adjust to the operational circumstances, and (2) the extent of the most intense activities, such as drilling and road building, diminishes and the wellfields are put into production. By the time the wellfields are under full production, construction will have ceased, and traffic and human activities in general would be greatly reduced. As a result, this impact would be minimal and it is unlikely that displacement of big game mammals would have a lasting and noteworthy effect. The level of big game mammal use of the project area is more likely to be determined by the quantity and quality of forage available.

The potential for vehicle collisions with big game mammals would increase as a result of increased vehicular traffic associated with the presence of construction crews and would continue (although at a reduced rate) throughout all phases of the wellfield operations. Development of new roads would allow greater access to more areas and may lead to an increased potential for poaching of big game animals.

Based on the current occurrence and use patterns of big game in the project area and the description of the project, long-term effects to big game populations associated with individual and population status and health are not expected.

I.5.2.7.7 Upland Game Birds

The potential effects of the operation and maintenance of project facilities on upland game birds may include nest abandonment and reproductive failure caused by project-related disturbance and increased noise for activities occurring in suitable and occupied habitats. Other potential effects involve increased public access and subsequent human disturbance that could result from new construction and production activities.

Sharp-tailed Grouse

No sharp-tailed grouse leks are known to occur within the project area. However, noise related to drilling and production activities may affect sharp-tailed grouse utilization of leks or reproductive success. Reduction of noise levels in areas near leks would minimize this potential impact. If leks are found, surface disturbance should be avoided within 0.25 mile of leks. If disturbance within the buffer areas is avoided, no impacts are expected.

Areas with large tracts of mixed-grass prairie would provide the best quality nesting habitat. To protect sharp-tailed grouse nesting habitats, construction should be limited within a 1-mile radius of an active lek between March 1 and June 30. Significant impacts to leks and subsequent reproductive success are not expected if these guidelines are implemented.

I.5.2.7.8 Raptors

Potential impacts to raptors within the project area include: (1) nest desertions or reproductive failure as a result of project activities and increased public access, (2) short-term changes in small mammal prey distribution and populations, and (3) mortality associated with potential vehicle collisions.

The primary potential impact to raptors from project activities is disturbance during nesting that might result in reproductive failure. To minimize this potential, construction would not be allowed during the critical nesting season (Feb. 1 through July 31, depending on species) within 0.5 mile of an active nest of listed or sensitive raptor species, and 0.25 mile (depending on species or line of sight) of an active nest of other raptor species. The nature of the restrictions, exclusion dates, and the protection radii would vary, depending on activity status of nests, species involved, and natural topographic barriers; and line-of-sight distances should be developed in coordination within the NGPC or USFWS.

Nests not used in 1 year may potentially be used in subsequent years. Development within close proximity to these nests may preclude use of the nest in following years. Therefore, protection of nests that may potentially be used in the future may require limiting construction within 984 feet (300 meters) (depending on species or line of sight) to minimize impacts. If "take" of an inactive nest were unavoidable, development of artificial nesting structures would mitigate for the loss of the nest. In some instances, during the production phase when human activity is reduced, raptors may actually nest on artificial above-ground structures. Significant impacts to raptor nesting activities are not expected.

The development of proposed wellfields and satellite facilities would initially disturb an estimated 402 acres of potential habitat for several species of small mammals that serve as prey for raptors. This short-term impact would affect approximately 62 percent of the proposed license area, although this is not likely to limit raptor use within the project area. The small amount of short-term change in prey base populations created by construction is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations on the project area would likely sustain some impact during the initial phase of the project, prey numbers would be expected to soon rebound to pre-disturbance levels following reclamation or active agricultural uses. Once reclaimed or in active agricultural uses, these areas would likely promote an increased density and biomass of small mammals comparable to those of undisturbed areas. For these reasons, implementation of the project is not expected to produce any appreciable long-term negative changes to the raptor prey base within the project area.

The creation of new roads would increase public access to areas within the project area. As use of the project area increases, the potential for encounters between raptors and humans would increase and could result in increased disturbance to nests and foraging areas. Closure of roads located near active raptor nests to public vehicle use would offset this potential impact. Some raptor species feed on road-killed carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed. The potential for such collisions can be reduced by requiring drivers to follow all posted speed limits.

I.5.2.7.9 Fish and Macroinvertebrates

Suitable habitat for fish and macroinvertebrates exists within portions of Spring Creek and the White River. However, the construction, operation, and maintenance of the project are not expected to affect either of these habitats. As such, impacts to fish and aquatic macroinvertebrates are not expected to occur.

I.5.2.7.10 Threatened and Endangered Species

Bald Eagle (State Threatened)

Nebraska's wintering bald eagle population is highly variable, ranging from 409 in 1984 to 1,292 in 1992, with an average of 714 bald eagles counted in Nebraska during the annual midwinter surveys between 1980 and 1993 (NGPC 2004). Most of the wintering bald eagle population is found in close association with open water. However, bald eagles are known to occasionally occur in this region, primarily during the winter months (November through March). No bald eagle nests are known to occur within the project area. Moreover, no winter concentration areas or winter nighttime roosts have been documented within the project area (Fritz 2004).

Based on our analysis of the effects of project implementation and the current and potential status of this species in northwestern Nebraska, we conclude that the proposed alternative of developing the NTEA will have no adverse effect on the bald eagle.

Swift Fox (State Endangered)

The swift fox is widely distributed throughout the Great Plains, and there are small, disjunct populations in the western third of Nebraska and Kansas (USFWS 1995). There is high-quality swift fox habitat present within the Oglala National Grassland immediately northwest of the project area. In addition, swift fox are closely linked with lagomorph populations, prairie dog colonies, ground squirrels, and other small mammals, which exist in varying densities and abundance throughout the project area.

Because swift fox are known to occur within the region, and northern portions of the project area contain suitable mixed-grass prairie habitat, potential impacts may result from project implementation. Construction within these mixed-grass prairie habitats could affect potential swift fox denning and foraging habitats. If swift fox are denning in the immediate vicinity of a planned project facility, it is likely that construction activities would displace adults away from the den, at least during daytime periods of construction. Displacement could prevent the adults from securing adequate food for pups or prevent adults from adequately caring for their young. In addition, vehicular traffic associated with the construction and operation of project facilities could cause vehicle collisions resulting in direct mortality.

Because there is the potential for the displacement of swift fox from construction and operational activities within mixed-grass prairie, mitigation measures will be made to avoid or reduce such incidents

CBR will avoid impacting the swift fox species by selecting planned areas of disturbance (including wellfields and drills sites) that are not in suitable habitat and by avoiding certain locations during specific times of the year. Surveys shall be conducted that are consistent with the Nebraska Game and Parks Commission (NG&PC) standard protocol included in CBR's Mineral Exploration Permit Number NE0210824 as Attachment 1, issued by the Nebraska Department of Environmental Quality (NDEQ) on August 19, 2009. Although the procedures in Attachment 1 are specific to drilling of boreholes, these requirements will be expanded to include project development activities, including construction, operational activities (e.g., wellfield development, satellite facility facilities, and access roadways) and decommisioning. The survey protocol to be used for the swift fox at the NTEA is presented in **Appendix 10** of Volume II of this application.

Based on our analysis of the effects of project implementation, the current and potential status of this species in the project area, and more suitable habitats in the region, we conclude that the proposed project and planned mitigation measures will result in no adverse effect on the swift fox.

Black-Footed Ferret and Whooping Crane

There have been no observations or reports of the black-footed ferret in the project area, nor have there been any confirmed populations of the ferret observed in the State of Nebraska since 1959 (USFWS 1988). Black-footed ferret populations coincide closely with colonies of prairie dogs on which the ferret depends for food and habitat. Prairie dog colonies required for a successful ferret population are not found within the project area. Based on our analysis of the effects of project implementation and the current and potential status of this species in northwestern Nebraska, it is concluded that the proposed alternative will have no adverse effect on the black-footed ferret.

Whooping Crane

The whooping crane (*Grus americana*) is listed as endangered by the USFWS and NGPC, with the potential to occur in Dawes County (NGPC 2008, USFWS 2008). The whooping crane is an occasional spring and fall migrant along the Platte Valley in the state, which accounts for approximately 90 percent of the observations in Nebraska. The Platte Valley is located in central Nebraska, a considerable distance from the project area. Additionally, suitable habitat is lacking within the project area (e.g., rivers and streams with associated sandbars and islands, marshlands, wet meadows, and croplands). The whooping crane is not expected to occur in the project area.

Reptiles, Amphibians, and Fish

No threatened or endangered reptiles, amphibians, or fish species have been recorded in the project area, and none are expected to occur. Therefore, the proposed project would not affect threatened or endangered reptiles, amphibians, or fish species.

I.5.2.7.11 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated, as no substantive impairment of ecological stability or diminishing of biological diversity is expected within the project area.

I.5.2.8 Noise Impacts of Operations

Noise sources during operation are expected to increase due to increased vehicle travel and increased numbers of employees traveling to and from Crawford for work and from resin transfer to the main plant. Train usage would not increase as a result of operation. Processing equipment at the satellite facility would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be lower than noise levels generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise dominated by vehicle traffic from State Highway 2/71 and the BNSF railroad.

I.5.3 Radiological Effects

CBR is proposing to develop a satellite facility with a production flow of approximately 4,500 gpm and an average restoration rate of 500 gpm. An assessment of the radiological effects of the North Trend Satellite Facility and related facilities must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

On May 30, 2007, CBR submitted a request to the NRC for an amendment of Radioactive Source Materials License SUA-1534 concerning development of additional uranium ISL mining resources. The proposed development area is for a new satellite facility (i.e., the NTEA) additional to the current main CBR plant. This license request was accompanied by a Technical Report and an Environmental Report, and it addresses impacts to environmental effects, including radiological exposure pathways, impacts, and applicable mitigation measures. The detailed assessment and impact analysis of the radiological emissions and exposures associated with the construction and operation of the facilities are discussed in detail in technical and environmental support documents for an NRC license application amendment request (CBR 2007a, 2007b).

The assumptions and methods used to arrive at an estimate of the potential radiological impacts of the North Trend Satellite Facility are discussed briefly in the following sections. Detailed discussions of radiological impacts can be found in the technical and environmental reports referenced above. The discussions in this section focus on potential impacts associated with air, surface, and groundwater exposure pathways; population dose; and exposure to flora and fauna associated with the proposed project.

I.5.3.1 Exposure Pathways

The proposed North Trend Satellite Facility is an ISL uranium facility. The only source of planned radioactive emissions from the satellite is radon gas, which is dissolved in the leaching solution. Radon gas may be released as the solution is brought to the surface and processed in the satellite facility. Unplanned emissions from the site are possible as a result of accidents and engineered structure failure but are not addressed in the NRC MILDOS-Area modeling. A human exposure pathway diagram addressing planned and unplanned radiological emissions is presented in **Figure I.5-2.**

The North Trend Satellite Facility will have pressurized downflow ion exchange columns capable of processing 4,500 gpm of production solution. The satellite facility will also have ion exchange and reverse osmosis equipment with a capacity of 500 gpm to process restoration solutions. Within the pressurized columns, the radon will remain in solution and will be returned to the formation. It will not be released to the atmosphere. There will be minor releases of radon gas during the air blowdown prior to resin transfer to the resin trailer. The air blowdown and the gas released from the vent during column filling will be vented into the exhaust manifold and discharged via the main radon exhaust stack. It is estimated that less than 10 percent of the radon contained in the process solutions will be vented to the atmosphere.

In the source term calculation, CBR estimates that 10 percent of the contained radon found in the 4,500 gpm flow processed by pressurized downflow ion exchange (IX) columns will be released to the environment.

After the IX resin is loaded, it will be transferred to a resin trailer. The trailer will transfer the resin to the main process facility for additional processing. The stripped and regenerated resin will be transferred to the trailer, returned to the satellite facility, and transferred into a process column. It is anticipated that two round trips will occur per day.

The injection wells will generally be closed and pressurized, but periodically vented releasing radon to the atmosphere. Production wells would be continually vented to the surface, but water levels will typically be low and radon venting would be minimal. It is estimated that 25 percent of the radon will be released in the wellfield. The primary source of the radon is what is contained in the lixiviant solution. Radon that is released from the ore body will be readily removed by the process water (lixiviant) moving through the wellfield by injection and production wells.

Atmospheric emission of radon will lend its presence to all quadrants of the area surrounding the NTEA and the current Crow Butte Project. Radon itself impacts human health or the environment marginally, because it is an inert noble gas. Radon has a relatively short half-life (3.8 days) and its decay products are short-lived, alpha-emitting, non-gaseous radionuclides.

These decay products have the potential for radiological impacts to human health and the environment. **Figure I.5.2** shows that all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon were evaluated using MILDOS-Area modeling.

I.5.3.2 Exposures from Water Pathways

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

The North Trend Satellite Facility will have evaporation ponds used to store waste solutions prior to deep well injection. The ponds will be double-lined with impermeable synthetic liners. A leak detection system will be installed to provide a warning if the liner develops a leak. The ponds, therefore, are not considered a source of liquid radioactive effluents.

The primary method of waste disposal at the North Trend Satellite Facility will be by deep disposal well injection. The deep disposal well will be completed at an approximate depth of 3,500 to 4,000 ft, isolated from any underground source of drinking water by approximately 2,500 feet of shale (Pierre and Graneros Shales). The well will be constructed under a Class I UIC Permit issued by the NDEQ and will meet all requirements of the NDEQ UIC program.

The North Trend Satellite Facility will be located on a curbed concrete pad to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and be pumped to the ponds. The pad will be of sufficient size to contain the contents of the largest tank if a rupture should occur.

Because no routine liquid discharges of process water are expected from the North Trend Satellite Facility, there are no definable water-related pathways.

I.5.3.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon released into the atmosphere through a vent system or from the wellfields. As shown in **Figure I.5-4**, atmospheric releases of radon can result in radiation exposure via three pathways: inhalation, ingestion, and external exposure.

Based on the site-specific data and the method of estimation of the source term discussed in this section, the modeled emission rate of radon from the North Trend Satellite Facility is 1,662 Curies per year (Ci/yr) which includes releases from ion exchange, production, and restoration activities. The detailed results from MILDOS are discussed in the environmental support document for an NRC license application amendment request (CBR 2007b).

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the North Trend Satellite Facility and main processing site was also estimated using MILDOS-Area modeling. To show compliance with the annual dose limit found in 10 Code of Federal Regulations (CFR) § 20.1301, CBR has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the North Trend Satellite Facility operation is less than 100 millirem (mrem) per year. The results of the MILDOS-Area simulation are presented in **Table I.5-4**. The coordinates of all receptors are listed in CBR's License Amendment Environmental Report for the North Trend Expansion Area (CBR 2007b), along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown on **Figure I.5-3**. **Table I.5-4** shows the estimated TEDE from operation of the main Crow Butte Project and the North Trend Satellite Facility.

No TEDE limits were exceeded. An evaluation of the TEDE follows:

1. The maximum TEDE is 31.7 mrem/yr.
2. Receptor #31 (NT-1) is the closest resident in the downwind direction for the North Trend Satellite Facility. The estimated TEDE at this location is 5.8 mrem/yr.
3. The effect of the North Trend Satellite operation on the nearby residents of the existing Crow Butte facility is less than 1 mrem/yr.
4. Because radon-222 is the only radionuclide emitted, public dose limits in 40 CFR 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 are not applicable to the CBR facility.

I.5.3.4 Population Dose

The annual population dose commitment to the population in the region within 50 miles of the Crow Butte Project is also predicted by the MILDOS-Area code. The results are listed in **Table I.5-5**, where the dose to the bronchial epithelium is expressed in person-rem. For comparison, the dose to the population within 50 miles of the facility due to natural background radiation is included in the table. These figures are based on the 1980 population and average radiation doses reported for the Western Great Plains.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming during the year 1978. The results of these calculations are included in **Table I.5-5** and also combined with dose to the region within 50 miles of the facility to arrive at the total radiological effects of one year of operation at the Crow Butte Project.

For comparison of the values listed in **Table I.5-5**, the dose to the continental population as a result of natural background radiation has been estimated. This estimate is based on a North American population of 346 million and a dose to each person of 500 mrem/yr to the bronchial epithelium. The maximum radiological effect of the combined operation of the North Trend Satellite Facility and the Crow Butte Project would be to increase the dose to the bronchial epithelium of the continental population by 0.0023 percent.

I.5.3.5 Exposure to Flora and Fauna

The exposure to flora and fauna was evaluated in the Environmental Report submitted to NRC in September of 1987 (Ferret Exploration 1987) and the doses were found to be negligible. The proposed satellite facility will have no measurable impact on dose to flora and fauna.

I.5.4 Nonradiological Effects

There are two effluents expected from the North Trend Satellite Facility.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and from process vessels and tanks. This gaseous effluent will contain radon gas as discussed in Section I.5.3. The gaseous and airborne effluent will not contain any non-radiological wastes.
- The liquid effluent will be managed in the solar evaporation ponds and the deep disposal well. There is no discharge from the evaporation ponds. The deep disposal well will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the NDEQ. The current Class I UIC Permit for the deep disposal well located at the Central Plant implements injection limits and requires monthly monitoring for Resource Conservation and Recovery Act (RCRA) Metals to ensure that hazardous waste is not injected. Based on the monitoring for the current deep disposal well, there is no non-radiological impact expected due to the liquid effluents from the North Trend Satellite Facility.

I.5.5 Effects of Accidents

Accidents involving human safety associated with the in-situ uranium mining technology typically have far less severe consequences than accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for personnel and neighboring communities when compared to conventional mining methods or other energy-related industries. Accidents that may occur would generally be quite minor when compared to other industries, such as an explosion at an oil refinery or chemical plant. Radiological accidents that might occur would typically manifest themselves slowly and are, therefore, easily detected and mitigated. The remote location of the facility and the low level of radioactivity associated with the process both decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at uranium milling facilities in NUREG–0706 and specifically at ISL facilities in NUREG/CR-6733. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The CBR emergency management procedures contained in CBR's EHSMS Program Volume VIII, *Emergency Manual* (CBR 2005a) have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in CBR's EHSMS Volume VII, *Training Manual* (CBR 2005b) have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. CBR's EHSMS Program Volume II, *Management Procedures* (CBR 2005c), requires periodic testing of emergency procedures and training by conducting drills.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Incidents involving radioactivity were analyzed and classified as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 apply to ISL facilities, such as transportation accidents; however, much of the analyses do not apply due to the significantly different mining and processing methods. ISL facilities do not handle large quantities of radioactive materials such as crushed ore and tailings, so the quantity of material that could be affected by an incident is significantly less than at a mill site.

NUREG/CR-6733 specifically addressed risks at ISL facilities and identified the following "risk insights".

I.5.5.1 Radiological Risk

I.5.5.1.1 Tank Failure

A spill of the materials contained in the process tanks at the North Trend Satellite Facility will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the process plant or in outside storage tanks. The tanks at the North Trend Satellite Facility will contain injection and production solutions and ion exchange resin. Elution, precipitation, and drying will be performed at the Central Plant. The satellite facility will be designed to control and confine liquid spills from tanks should they occur. The plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, or double-walled tanks will perform a similar function for process vessels located outside the satellite building.

All tanks will be constructed of fiberglass, high-density polyethylene (HDPE) or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

I.5.5.1.2 Plant Pipe Failure

The rupture of a pipeline within the process plant is easily visible and can be repaired quickly. Spilled solution will be contained and removed in the same fashion as for a tank failure.

Response procedures for the radiological risk from releases are currently contained in CBR's EHSMS Volume VIII, *Emergency Manual.*

I.5.5.2 Groundwater Contamination Risk

I.5.5.2.1 Lixiviant Excursion

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

CBR controls lateral movement of lixiviant by maintaining wellfield production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution is either recycled in the plant or is sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the Mine Unit, the wellfield is said to be balanced.

CBR monitors for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. The current NRC License and NDEQ Class III UIC Permit require that Chadron aquifer monitor wells be located no more than 300 feet from the nearest mineral production wells and no more than 400 feet from each other. These spacing requirements have proven effective for monitoring horizontal excursions at the Central Plant and will be employed at the North Trend Satellite Facility. Monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite Facility. The program is discussed in detail in Chapter Q.

Section I.5.2.4 provided a discussion of horizontal excursions reported at the current Crow Butte Operation. The historical experience indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. CBR controls vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the NDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing is conducted in accordance with NDEQ regulations contained in Title 122 (NDEQ 2002) and methods approved by NRC and NDEQ. Construction and integrity testing methods are discussed in detail in Section N.1. Well abandonment is conducted in accordance with methods approved and monitored by the NDEQ and discussed in detail in Chapter N. Procedures for these activities are contained in EHSMS Program Volume III, *Operating Manual* (CBR 2005d).

CBR monitors for vertical excursions in the overlying aquifers using shallow monitor wells. These wells are located within the wellfield boundary at a density of one well per 4 acres. Shallow monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the North Trend Satellite Facility. The program is discussed in detail in Chapter Q.

I.5.5.2.2 Pond Failure

A leak in a pond is detectable either from the regular visual inspections or through monitoring the leak detection system. The current pond operation and inspection program is contained in CBR's EHSMS Program Volume VI, *Environmental Manual,* and consists of daily, weekly, monthly, and quarterly inspections in conjunction with an annual technical evaluation of the pond system. The CBR monitoring program was developed to meet the guidance contained in US NRC Regulatory Guides 3.11 and 3.11.1. Any time 6 inches or more of fluid is detected in the standpipes, it is analyzed for specific conductance. If the water quality is degraded beyond the action level, it is sampled again and analyzed for chloride, alkalinity, sodium, and sulfate. In addition, monitor wells are installed downgradient of the pond in the first water-bearing zone. These monitor wells are sampled and analyzed quarterly for the excursion parameters. The pond operation and monitoring program is discussed in detail in Chapter Q.

In the event of a leak, the contents of any one pond can be transferred to another pond cell while repairs are made. Freeboard requirements may be waived during this period. Catastrophic failure of a pond embankment is unlikely given the design and inspection requirements of the pond and the freeboard limitations.

I.5.5.3 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield or a trunkline between a wellfield and the North Trend Satellite Facility would result in a release of either barren or pregnant lixiviant solution, which would contaminate the ground in the area of the break. All piping from the plant to and within the wellfield will be buried for frost protection. Pipelines are constructed of PVC, HDPE with butt-welded joints, or equivalent. All pipelines are pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each mine unit will have a number of wellhouses where injection and production wells will be continuously monitored for pressure and flow. With the control system currently employed at Crow Butte Resources, individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the satellite control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building. High and low flow alarms have been proven effective at the current operation in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the wellhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. CBR currently implements a program of continuous wellfield monitoring by roving wellfield operators and required periodic inspections of each well that is in service. Based on experience from the current operation, small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination based on monitoring using field survey instruments and soil samples for radium-226 and uranium. Following repair of a leak, CBR procedures require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

I.5.5.4 Transportation Accident Risk

Transportation of materials to and from the North Trend Satellite Facility can be classified as follows:

- Shipments of process chemicals or fuel from suppliers to the site;
- Shipment of radioactive waste from the site to a licensed disposal facility; or
- Shipments of uranium-laden resin from the satellite facility to the central plant and return shipments of barren, eluted resin from the central plant back to the satellite facility.

The first two types of transportation risks do not represent an increase over the risks associated with operation of the current Crow Butte facility because production from NTEA is planned to replace declining production at the current facility. The shipment of loaded ion exchange resin from NTEA and the return of barren, eluted resin represent an additional transportation risk that was not considered for the current operation.

NUREG-0706 concluded that the probability of a truck accident in any year is 11 percent for each uranium extraction facility or mill. This calculation used average accident probabilities (4.0 x 10^{-7}/km for rural interstate, 1.4 x 10^{-6}/km for rural two-lane road, and 1.4 x 10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative with respect to probability distributions used in a later NRC transportation risk assessment (USNRC 2000). For NTEA, uranium-loaded and barren resin will be routinely transported by tank truck from the Satellite Facility to the Central Plant. For the Crown Point site in New Mexico, NRC determined that the probability of an accident involving such a truck was 0.009 in any year (NRC 1997).

Accident risks involving potential transportation occurrences and mitigating measures are discussed below:

I.5.5.4.1 Accidents Involving Shipments of Process Chemicals

Based on the current production schedule and material balance, it is estimated that approximately 150 bulk chemical deliveries per year will be made to the North Trend Satellite Facility. This averages about one truck per working day for delivery of chemicals throughout the operational life of the project. Types of deliveries include carbon dioxide, oxygen, and soda ash.

I.5.5.4.2 Accidents Involving Radioactive Wastes

Low-level radioactive 11(e)2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential impact in the event of an accident.

I.5.5.4.3 Accidents Involving Resin Transfers

One of the potential additional risks associated with operation of a Satellite Facility is the transfer of the ion exchange resin to and from the Satellite Facility.

Resin will be transported to and from the North Trend Satellite Facility in a 4,000-gallon capacity tanker trailer. It is currently anticipated that one load of uranium-laden resin will be transported to the Crow Butte Central Plant for elution, and one load of barren eluted resin will be returned to the North Trend Satellite Facility on a daily basis. The transfer of resin between the two sites will occur on county and private roads. The planned transport route is depicted in **Figure I.5-4**. The total mileages for unpaved and paved roads (one way trip) for this route as shown in **Figure I.5-4** are as follows:

- CBR Unpaved Roads 1.24
- County Unpaved Roads 5.17
- Highway Paved Roads 3.05

9.46

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and NRC regulations. Shipments will be handled as Low

Specific Activity (LSA) material for both uranium-laden and barren eluted resin. Pertinent procedures, which Crow Butte will follow for a resin shipment, are listed as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.
- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.
- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.
- Trained CBR drivers will transport the resin between the North Trend Satellite Facility and the central plant.
- Crow Butte's current emergency response plan for yellowcake and other transportation accidents to or from the Crow Butte site is contained in CBR's EHSMS Program Volume VIII, *Emergency Manual*. This plan will be expanded to include an emergency resin transfer accident procedure. Personnel at both the Satellite Facility and the central plant will receive training for responding to a resin transfer transportation accident.

Currently, Crow Butte Resources intends to treat the eluted resin the same as the uranium loaded resin. It is possible that the eluted resin may be clean enough to be transported as non-radioactive material, as defined by DOT regulations. Operating experience will aid in the determination of the most practical and efficient way of dealing with the shipment of barren resin. Regardless, compliance with all applicable DOT and NRC regulations will be the primary determining factor.

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

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

- Each resin-hauling truck will be equipped with a radio which can communicate with either the Crow Butte central plant or the North Trend Satellite Facility. In the event of an accident and spill, the driver can radio to both sites to obtain help.

- A check-in and check-out procedure will be instituted where the driver will call the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, a crew would respond and search for this vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.
- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material.
- Both the satellite and central process facilities will be equipped with emergency response packages to quickly respond to a transportation accident.
- Personnel at the satellite and central process facilities, as well as the designated truck drivers, will have specialized training to handle an emergency response to a transportation accident.

I.5.5.5 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISL facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike, failure of chemical storage facilities, and the possible reaction of process chemicals during either event. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities. CBR is committed to following these standards.

The project area along with most of Nebraska is in seismic risk Zone 1. Most of the central United States is within seismic risk Zone 1, and only minor damage is expected from earthquakes that occur within this area. Seismology was discussed in detail in Chapter F.

The Crow Butte Operation is located in an area that is subject to tornadoes. CBR emergency procedures currently contained in EHSMS Program Volume VIII, *Emergency Manual,* provide instructions for response and mitigation of natural disasters and spills or radioactive materials.

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I.6 Cost-Benefit Analysis

I.6.1 General

The general need for production of uranium is assumed in the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against environmental costs including a prorated share of the environmental costs of the uranium fuel cycle. The incremental impacts of typical mining and milling operations required for the fuel cycle are justified in terms of the benefits of energy generation to the society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility, such as the Crow Butte Project and the proposed NTEA, must be reasonable compared to that typical operation.

I.6.2 Economic Impacts

Monetary benefits accrue to the community from the presence of the Crow Butte Project such as local expenditures of operating funds and the federal, state, and local taxes paid by the project. Against these monetary benefits are the monetary costs to the communities involved such as those for new or expanded schools and other community services. While it is not possible to arrive at an exact numerical balance between these benefits and costs for any one community, or for the project, because of the ability of the community (and possibly the project) to alter the benefits and costs, this section summarizes the economic impact of the project to date and projects the incremental impacts from operation of the proposed North Trend Satellite Facility.

I.6.3 Tax Revenues

Table I.6-1 summarizes the tax revenues from the Crow Butte Project.

Future tax revenues depend on uranium prices which cannot be forecast with any accuracy; however, these taxes also depend somewhat on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around \$60 per pound U_3O_8 in mid-June 2008), the increased production from the Satellite Facility should contribute to higher tax revenues as well.

The present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the Satellite Facility should be about 600,000 pounds per year. This additional production will eventually be offset by declining production from the original plant; however, the incremental contribution to taxes would be on the order of $1.0 million to $1.2 million per year in combined taxes.

I.6.4 Temporary and Permanent Jobs

Current Staffing Levels

CBR currently employs approximately 52 employees and 20 contractors on a full-time basis. Short-term contractors and part-time employees are also employed for specific projects and/or during the summer months and may add up to 10 percent to the total staffing. This level of employment is significant to the local economies. Employment in private industries in Dawes County in the third quarter of 2007 was 2,547 out of a total labor force of 4,577 (USDL 2008). Based on these statistics, CBR currently provides approximately 2.3 percent of the private employment in Dawes County. In 2007, CBR's total payroll was more than $3,087,340. Of the total Dawes County wage and salary payments of $76,006,000 in 2006, the CBR payroll represented about 3.4 percent.

Total CBR payroll for the past 4 years was:

2003:	$2,102,000
2004:	$2,213,000
2005:	$2,382,000
2006:	$2,543,000
2007	$3,087,340

The average annual wage for all workers in Dawes County was $22,350 for 2006. By way of comparison, the average wage for CBR was about $52,530. Entry-level workers for CBR earn a minimum of $16.00 per hour or $33,280 per year, not including bonus or benefits.

Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future Satellite Facility(s) will provide approximately 10 to 15 temporary construction jobs for a period of up to 1 year for each satellite. It is likely that the majority of these jobs will be filled by skilled construction labor brought into the area by a construction contractor, although some positions could be filled by local hires. Permanent CBR employees will perform all other facility construction (e.g., wells and wellfields).

CBR actively pursues a policy of hiring and training local residents to fill all possible positions. Due to the technical skills required for some positions, a small percentage of the current mine staff (less than 5 percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2007, total unemployment in Dawes County was 126 individuals, or 2.6 percent of the total work force of 4,848. CBR expects that any new positions will be filled from this pool of available labor.

CBR projects that the current staffing level will increase by 10 to 12 full-time CBR employees for each active Satellite Facility. These new employees will be needed for Satellite Facility and wellfield operator and maintenance positions. Contractor employees (e.g., drilling rig operators) may also increase by four to seven employees depending on the desired production rate. The majority, if not all, of these new positions will be filled with local hires.

These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

I.6.5 Impact on the Local Economy

In addition to providing a significant number of well-paid jobs in the local communities of Crawford, Harrison, and Chadron, Nebraska, CBR actively supports the local economies through purchasing procedures that emphasize obtaining all possible supplies and services that are available in the local area.

Total CBR payments made to Nebraska businesses for the past 4 years were:

2003:	$3,602,000
2004:	$3,597,000
2005:	$4,570,000
2006	$5,000,000
2007	$6,326,000

The vast majority of these purchases were made in Crawford and Dawes County.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the Satellite Facility, although not in strict proportion to production. While there are some savings due to some fixed costs (central plant utilities for instance), there are additional expenses that are expected to be higher (wellfield development for the satellites is expected to be more expensive). Therefore, it can be assumed that the overall effect on local purchases will be proportional to the number of pounds produced. In addition, mineral royalty payments accrue to local landowners. This should translate to additional purchases of $3.65 to $4.35 million per year.

I.6.5.1 Economic Impact Summary

As discussed in this section, the Crow Butte Project currently represents a significant economic impact to the local Dawes County economy. Approval of this Class III Underground Injection application would have a positive impact on the local economy as summarized in **Table I.6-2.**

I.6.5.2 Estimated Value of North Trend Resource

CBR is currently continuing to develop the reserve estimates for the NTEA. Based on the current recoverable resource estimate of 2,000,000 pounds U_3O_8 and the current spot market price of uranium ($45.50 per pound as of November 30, 2009 [UxC 2009]), the total estimated value of the energy resources at North Trend is $91,000,000. This value will fluctuate as the market price and realized price vary.

I.6.5.3 Short-Term External Costs

Housing Impacts

The available housing resources should be adequate to support the short-term needs during facility construction. According to the Nebraska Department of Economic Development (NDED) 2006, in 2000, a total of 492 housing units were vacant in Dawes County out of a total housing base of 4,004 units. Of the vacant units, 176 were available for rent. In addition, there are two small motels in Crawford that generally have vacancies and routinely provide units for itinerant workers such as railroad crews.

Noise and Congestion

CBR projects an increase in the noise and congestion in the immediate area of the North Trend Satellite Facility during initial construction of the facility. This will include heavy truck and equipment traffic and access to the jobsite by construction workers. These impacts will be most noticeable to residents in the immediate vicinity of the facility and will be temporary in nature. The increase in noise should be considered in light of the project location, which is bounded on the west by the BNSF rail line and on the east by Nebraska State Highway 2/71. The rail line along the western boundary is used for combining local "pusher" engines with southbound trains to assist them in climbing the Pine Ridge south of Crawford. As a result, there is a significant amount of noise generated by this activity including trains parked for extended periods. Dust from construction activities will be controlled using standard dust suppression techniques used in the construction industry.

Local Services

As previously noted, CBR actively recruits and trains local residents for positions at the mine. CBR expects that the majority of permanent positions at the new North Trend Satellite Facility will be filled with local hires. As a result of using the local workforce, the impact on local services should be minimal. In many cases, these services (e.g., schools) are underutilized due to population trends in the area.

I.6.5.4 Long-Term External Costs

Housing and Services

Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of long-term positions that will be created by the expansion to the proposed NTEA will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. In 2007, total unemployment in Dawes County was 126 individuals, or 2.6 percent of the total work force of 4,848. CBR expects that the new positions at the North Trend Satellite Facility will be filled from this pool of available labor.

Noise and Congestion

CBR projects a minor increase in the long-term noise and congestion in the immediate area of the North Trend Satellite Facility. Most of this will consist of increased traffic from employees commuting to and from the work site and performing work in the wellfields. Some increase in heavy truck traffic will occur due to deliveries of process chemicals such as oxygen and the shipment of ion exchange resin from the North Trend Satellite Facility to the Central Processing facility. Delivery and ion exchange shipments should average two per day. These impacts will be most noticeable to residents in the immediate vicinity of the facility. As noted in Section I.6.5.3, there is significant existing noise in the immediate area generated by the adjacent rail line and highway.

In the area around Crawford, the increased traffic will be unnoticeable due to the presence of U.S. Highway 20 and Nebraska State Highway 2/71, which are both significant transport routes. The annual average 24-hour total and heavy vehicle count for U.S. Highway 20 at the eastern approach to Crawford for 2006 was 1,795 and 235, respectively (NDOR 2006). The limited additional traffic related to the NTEA operation will not significantly affect these main routes.

Aesthetic Impacts

The visible surface structures proposed for the NTEA include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing plant. The project will use existing and new roads to access each wellhouse and the Satellite Facility. Project development would alter the physical setting and visual quality of portions of the landscape, which would affect the overall landscape to some degree, as viewed from sensitive viewing areas. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture, which characterize the existing landscape. The project would primarily affect croplands.

In foreground-middleground views, the Satellite Facility, wellhouses, and associated access road clearings would be the most obvious features of development. Clearings and access roads would be visible as light tan exposed soils in geometrically shaped areas with straight, linear edges that provide some textural and color contrasts with the surrounding cropland. The Satellite Facility, wellhouses, and wellhead covers would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from State Highway 2/71 and the Crawford Cemetery, but would be subordinate to the rural landscape. Most of the occupied housing units are located near the south end of the project area, and would be screened from views of the facilities by riparian vegetation along the White River.

The electric distribution line poles would be an estimated 20 feet tall, and would be located throughout the project area to connect wellhouses with existing lines. The distribution lines are similar in appearance to those typical of the rural landscape, but would occur at a higher density than on adjacent lands. The lines would be obvious to viewers at the viewing areas, but would not change the rural character of the existing landscape.

Wellhead covers would be difficult to discern in the landscape from any sensitive viewing area. The form and textural contrast would be very weak because the relatively low profile (3 feet high) and small size of the facilities would disappear into the surrounding textures of soil and vegetation. Generally, color contrasts are most likely to be visible in foreground-middleground distance zone; however, the wellhead covers would be painted a tan color that would harmonize with the surrounding vegetation and soil colors. Therefore, contrast of line, form, texture, and color would be low. The facilities would not be noticeable to the casual observer. Wellhead covers would be visually subordinate to the landscape in foreground-middleground distance zone.

Land Access Restrictions

Property owners of land located within the immediate wellfield and plant boundaries will lose access and free use of these areas during mining and reclamation. The areas impacted are all used for agricultural purposes and the owners will lose the ability to use the areas for production purposes. Offsetting these land use restrictions are the surface lease and mineral royalty payments to the landowners.

I.6.5.5 Most Affected Population

The expected impacts from the proposed North Trend Satellite Facility can be characterized as an incremental increase in the impacts from operation of the current facility. For the most part, the impact from operation of the current Crow Butte Uranium Project has been positive for Crawford and the surrounding communities. CBR has provided much-needed well-compensated employment opportunities for the local population. Additionally, the policy of purchasing goods and services locally to the extent possible has had a positive economic impact on an area facing economic challenges. Tax expenditures, and particularly the recent increases in local property taxes paid due to the increase in the price of uranium, have had a significant economic impact on local government-provided services.

Offsetting these positive impacts to the local population are increases in noise, congestion, and aesthetic impacts for residents in and adjacent to the proposed North Trend Satellite Facility. Most residents located in the proposed license area are landowners that have mineral and/or surface leases with CBR and will benefit economically from the presence of the facility.

I.6.5.6 Plant Decommissioning Costs

Approval of the proposed North Trend Satellite Facility will result in CBR incurring additional decommissioning liabilities for the installed facilities. The actual estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

I.6.6 The Benefit-Cost Summary

The benefit-cost summary for a fuel-cycle facility such as the Crow Butte Project involves comparing the societal benefit of a constant U_3O_8 supply (ultimately providing energy) against possible local environmental costs for which there is no directly related compensation. For this project, there are basically three of these potentially uncompensated environmental costs:

- Groundwater impact
- Radiological impact
- Disturbance of the land

The groundwater impact is considered to be temporary in nature, as restoration activities will restore the groundwater to a pre-mining quality. The successful restoration of groundwater during the Research and Development (R&D) project and the commercial restoration of Mine Unit 1 have demonstrated that the restoration process can meet this criterion successfully.

The radiological impacts of the current and proposed project are small, with all radioactive wastes being transported and disposed of off site. Radiological impacts to air and water are also minimal. Extensive ongoing environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the Crow Butte Project.

The disturbance of the land for an ISL facility is quite small, especially when compared with conventional surface mining techniques. All of the disturbed land will be reclaimed after the project is decommissioned and will become available for previous uses.

I.7 Summary

In considering the energy value of the U_3O_8 produced to U.S. energy needs, the economic benefit to the local communities, the minimal radiological impacts, minimal disturbance of land, and mitigable nature of all other impacts, it is believed that the overall benefit-cost balance for the proposed NTEA is favorable, and that issuing an a Class III Underground Injection permit is the appropriate regulatory action.

I.8 References

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Table I.1-1 Land Use Definitions

Croplands (C)	Harvested cropland including grasslands cut for hay, cultivated summer fallow, and idle cropland.
Commercial and Services (C/S)	Those areas used predominantly for the sale of products and services. Institutional land uses, such as various educational, religious, health, and military facilities, are also components of this category.
Forested Land (F)	Areas with a tree-crown density of 10 percent or more are stocked with trees capable of producing timber or other wood products and exert an influence on the climate or water regime. This category does not indicate economic use.
Habitat (H)	Land dedicated wholly or partially to the production, protection, or management of species of fish or wildlife.
Industrial (I)	Areas, such as rail yards, warehouses, and other facilities, used for industrial manufacturing or other industrial purposes.
Mines, Quarries, or Gravel Pits (M)	Those extractive mining activities that have significant surface expression.
Pastureland (P)	Land used primarily for the long-term production of adapted, domesticated forage plants to be grazed by livestock or occasionally cut and cured for livestock feed.
Rangeland (R)	Land, roughly west of the 100th meridian, where the natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs; which is used wholly or partially for the grazing of livestock. This category includes wooded areas where grasses are established in clearings and beneath the overstory.
Urban Residential (UR)	Residential land uses range from high-density, represented by multi-family units, to low-density, where houses are on lots of more than 1 acre. These areas are found in and around Crawford and Ft. Robinson. Areas of sparse residential land use, such as farmsteads, will be included in categories to which they are related.
Water (W)	Areas of land mass that are persistently water-covered.
Recreational (RC)	Land used for public or private leisure, including developed recreational facilities such as parks, camps, and amusement areas, as well as areas for less intensive use such as hiking, canoeing, and other undeveloped recreational uses.

Table I.1-2 Present Land Use of the North Trend License Area and Within a 2.25-Mile (3.6-km) Radius of the Proposed North Trend License Boundary (in acres)

COMPASS SECTOR	LAND USE											TOTAL
	C	F	M	P	R	W	H	C/S	RC	UR	I	
N	543.4	0.0	0.0	0.0	571.9	0.0	0.0	0.0	0.0	0.0	0.0	1,115.3
NNE	427.8	0.0	0.0	0.0	660.9	0.0	0.0	0.0	0.0	0.0	0.0	1,088.6
NE	432.3	0.0	0.0	0.0	592.1	0.0	0.0	0.0	0.0	0.0	0.0	1,024.4
ENE	725.3	0.0	0.0	0.0	196.1	0.0	0.0	0.0	0.0	0.0	0.0	921.4
E	337.2	0.0	0.0	0.0	540.8	0.0	0.0	0.0	0.0	0.2	0.0	878.2
ESE	353.2	0.0	0.0	0.0	624.2	0.0	0.0	0.0	0.0	22.1	0.0	999.4
SE	415.4	0.0	0.0	0.0	917.1	0.0	0.0	22.5	0.0	2.7	0.0	1,357.8
SSE	696.0	0.0	0.0	0.0	1,143.7	0.0	0.0	0.0	0.0	10.4	0.0	1,850.1
S	486.2	0.0	0.0	0.0	667.2	0.0	0.0	77.7	499.8	327.7	0.0	2,058.7
SSW	326.9	0.0	0.0	0.0	375.7	0.0	0.0	0.0	1,224.8	0.0	0.0	1,927.5
SW	410.5	138.8	0.0	0.0	514.8	0.0	0.0	0.0	381.0	0.0	0.0	1,445.0
WSW	658.0	2.9	0.0	0.0	375.3	0.0	0.0	0.0	0.0	0.0	0.0	1,036.1
W	512.7	0.0	0.0	0.0	524.6	0.0	0.0	0.0	0.0	0.0	0.0	1,037.3
WNW	384.3	0.0	0.0	0.0	679.9	0.0	0.0	0.0	0.0	0.0	0.0	1,064.2
NW	707.3	0.0	0.0	0.0	434.9	0.0	0.0	0.0	0.0	0.0	0.0	1,142.2
NNW	459.9	0.0	0.0	0.0	712.7	0.0	0.0	0.0	0.0	0.0	0.0	1,172.6
TOTAL	7,876.5	141.6	0.0	0.0	9,531.8	0.0	0.0	100.3	2,105.6	363.0	0.0	20,118.9

1 22 1/2° sectors centered on each of the 16 compass points

2 See Table 4.6-1 for an explanation of land use types: C = cropland; F = forested land; M = mines, quarries or gravel pits; P = pastureland; R = rangeland; W = water; H = habitat; C/S = commercial and services; RC = recreational; UR = urban residential; I = industrial

Table I.1-3 Recreational Facilities Within 50 Miles of the Current and Proposed North Trend License areas

Name of Recreational Facility	Distance From Current License Area (miles)	Distance From North Trend Expansion Area (miles)
Fort Robinson State Park	4.0	3.0
Pine Ridge National Recreation Area	13.0	15.0
Roberts Trailhead and Campground	11.0	14.0
Toadstool Park	18.0	11.0
Warbonnet Battlefield	24.0	22.0
Gilbert Baker Wildlife Area	28.0	24.0
Oglala National Grasslands	10.0	5.0
Buffalo Gap National Grassland	30.0	26.0
Hudson-Meng Bison Kill Site	17.0	11.0
Crawford City Park	2.0	1.0
Whitney Lake	10.0	8.0
Box Butte Reservoir	24.0	21.0
Ponderosa Wildlife Area	2.0	5.0
Peterson Wildlife Area	11.0	8.0
Soldier Creek Wilderness	7.0	8.0
Soldier Creek Trailhead Campground	9.0	8.0
Chadron State Park	17.0	18.0
Agate Fossil Beds National Monument	27.0	25.0
White Clay Lake	48.0	48.0

Source: Nebraska Department of Roads (NDR). 2007a. State Highway Map.
Nebraska Department of Economic Development (NDED). 2008.
DeLorme. 2005. Nebraska Atlas & Gazetteer.
DeLorme. 2006. Wyoming Atlas and Gazetter.
South Dakota Department of Tourism. 2005. State Highway Map.

Table I.1-4 Agricultural Yields for Croplands in Dawes County, 2006

Commodity	Planted		Harvested		Yield		Production
	Acres[a]	km^2	Acres[a]	km^2	Per acre	Per km^2	
Wheat Winter All	37,000	150	35,300	143	38 bu	9,291 bu	1,325,900 bu
Corn For Grain	2,500	10	700	3	161 bu	39,784 bu	112,700 bu
Corn For Silage	na	na	1,700	7	11 ton	2,743 ton	18,900 ton
Oats	4,000	16	500	2	16 bu	3,954 bu	8,000 bu
Hay Alfalfa (Dry)	na	na	32,500	132	2 ton	381 ton	49,900 ton
Hay Other (Dry)	na	na	24,000	97	1 ton	198 ton	19,200 ton
Hay All (Dry)	na	na	56,500	229	1 ton	301 ton	69,100 ton

Notes:
bu bushels
a 1 acre = 0.0040469 km^2
Source: National Agricultural Statistics Service (NASS 2007b)

Table I.1-5 Potential Agricultural Production for Cropland in the North Trend Expansion Area and 2.25-Mile Review Area

	Percent of Total Planted[a]	Total Cropland (acres)[b]	Percent of Planted/ Harvested[c]	Harvested (acres)	Harvested (km^2)	Production[d]
Wheat	33.3	7,876.5	89.03	7,012.5	28.4	266,475 bu

Notes:
a Same as for Dawes County.
b 1 acre = .0040469 km^2.
c assume 95.4 percent is harvested, as summarized in Table I.1-4 for Dawes County in 2006
d assume 38 bushels per acre as summarized in Table I.1-4
bu bushels
Source: Nebraska Agricultural Statistics Service (NASS 2007b)

Table I.1-6 Livestock Inventory, Dawes County, 2002

	Number	Percent of Total	Animal Units [a]	
			Pounds (000s)	Percent
All Cattle, except dairy	47,258	94.7	47,258	98.8
Dairy cattle	148	0.003	148	0.003
Hogs	305	0.006	67.1	0.001
Sheep	1,740	0.03	348	0.007
Chickens	431	0.01	2.2	0.00005
Total animals	49,882	100.0	47,823.3	100.0

Notes: [a] Animal unit conversions:

1 cow	=	1,000 lb.
1 hog	=	220 lb.
1 sheep	=	200 lb.
1 chicken	=	5 lb.
1 animal unit	=	1,000 lb.

Source: Nebraska Agricultural Statistics Service (NASS 2007a)

Table I.1-7 Distance to Nearest Residence and Site Boundary from Center of Current License Area for Each Compass Sector

Compass Sector[1]	Nearest Residence (ft.)	Nearest Site Boundary (ft.)
North	5,800	4,050
North-Northeast	11,850	3,050
Northeast	1,150	3,150
East-Northeast	15,000	2,900
East	None	4,250
East-Southeast	4,800	4,400
Southeast	5,700	8,100
South-Southeast	15,700	5,900
South	6,250	5,100
South-Southwest	17,250	2,250
Southwest	9,450	1,500
West-Southwest	5,500	1,250
West	15,100	1,200
West-Northwest	2,050	3,950
Northwest	6,400	6,300
North-Northwest	11,400	5,500

[1] $22\ ^1/_2°$ sectors centered on each of the 16 compass points.

Table I.1-8 Distance to Nearest Residence and Site Boundary from Center of North Trend Expansion Area for Each Compass Sector

Compass Sector[1]	Nearest Residence (ft.)	Nearest Site Boundary (ft.)
North	None	3,761
North-Northeast	7,500	3,382
Northeast	8,400	2,613
East-Northeast	16,900	2,145
East	9,000	2,011
East-Southeast	3,400	2,198
Southeast	6,600	2,840
South-Southeast	5,000	4,840
South	4,700	9,474
South-Southwest	8,800	5,102
Southwest	11,700	3,317
West-Southwest	None	2,946
West	10,600	3,127
West-Northwest	None	3,420
Northwest	9,600	3,760
North-Northwest	5,300	4,192

[1]22 $^1/_2$° sectors centered on each of the 16 compass points

Table I.1-9 Concrete Aggregate and Sand and Gravel Facilities in Area of Review, Dawes, County, Nebraska

ID	Operator	Address	Location	Activity	Product
SG-1	Dave Moody	RR, Crawford, NE	T32N R52W S20 / / /S2	Inactive	Sand and Gravel
SG-2	City of Crawford/Birdsall Sand & Gravel	209 Elm Street, Crawford, NE	T31N R52W S10 / / / NW	Active	Sand and Gravel

Source: University of Nebraska at Lincoln. 2008. [Web page].

Table I.1-10 Summary of City of Crawford Water System

Description	Capacity
Raw Water Storage Capacity	500,000 gallons
Treated Water Capacity West Tank East Tank	 1,000,000 gallons 750,000 gallons
Average Daily Use (2006)	419,181 gallons
Maximum Daily Use	1,000,000 gallons
Supply Wells South Well #1 (100 feet deep); Reg: G-93533 NW1/4 SW1/4 Sec. 15, T31N, R52W West Well #2 (100 feet deep); Reg: G-93532 NW1/4 SW1/4 Sec. 15, T31N, R52W	 104 gpm 54 gpm
Infiltration Gallery Pump #1; 27 feet; Reg: G-93551 SE1/4 SW1/4 Sec. 8 T31N R52W Pump #2; 27 feet; Reg: G-93551 SE1/4 SW1/4 Sec. 8 T31N R52W	 420 gpm 420 gpm
Dewatering Wells; 20 to 26 feet deep SE1/4 SW1/4 Sec. 8 T31N R52W Reg Nos: 93528, 93529, 93530	33 gpm (each)

Source: Teahon 2007.

Table I.2-1 Historical and Current Population Change for Counties and Towns Within 50 Miles of the North Trend Permit Area Site, 1960 to 2000

State County City	Population					Average Annual Percent Change			
	1960	1970	1980	1990	2000	1960/ 1970	1970/ 1980	1980/ 1990	1990/ 2000
NEBRASKA									
Dawes	9,536	9,761	9,609	9,021	9,060	2.4	-1.6	-6.1	0.4
Chadron	5,079	5,921	5,933	5,588	5,634	16.6	0.2	-5.8	0.8
Crawford	1,588	1,291	1,315	1,115	1,107	-18.7	1.9	-15.2	-0.7
Box Butte	11,688	10,094	13,696	13,130	12,158	-13.6	35.7	-4.1	-7.4
Alliance	7,845	6,862	9,869	9,765	8,959	-12.6	43.8	-1.1	-8.3
Hemingford	904	734	1,023	953	993	-18.8	39.4	-6.8	4.2
Sheridan	9,049	7,285	7,544	6,750	6,198	-19.5	3.6	-10.5	-8.2
Hay Springs	823	682	794	693	652	-17.1	16.4	-12.7	-5.9
Rushville	1,228	1,137	1,217	1,127	999	-7.4	7.0	-7.4	-11.4
Sioux	2,575	2,034	1,845	1,549	1,475	-21.0	-9.3	-16.0	-4.8
Harrison	448	377	361	241	279	-15.8	-4.2	-33.2	15.8
SOUTH DAKOTA									
Fall River	10,688	7,505	8,439	7,353	7,453	-29.8	12.4	-12.9	1.4
Hot Springs	4,943	4,434	4,742	4,325	4,129	-10.3	6.9	-8.8	-4.5
Oelrichs	132	94	124	138	145	-28.8	31.9	11.3	5.1
Ardmore	73	14	16	NA		-80.8	14.3		
Shannon	6,000	8,198	11,323	9,902	12,466	36.6	38.1	-12.6	25.9
Pine Ridge CDP	NA	NA	NA	422	1,229	NA	NA	NA	191.2

Table I.2-1 Historical and Current Population Change for Counties and Towns Within 50 Miles of the North Trend Permit Area Site, 1960 to 2000

State County City	Population					Average Annual Percent Change			
	1960	1970	1980	1990	2000	1960/ 1970	1970/ 1980	1980/ 1990	1990/ 2000
WYOMING									
	1,256	2,768	3,059	2,596	3,171	120.4	10.5	-15.1	22.1
Goshen	11,941	10,885	12,040	12,373	12,538	-8.8	10.6	2.8	1.3
Niobrara	3,750	2,924	2,924	2,499	2,407	-22.0	0.0	-14.5	-3.7
Lusk	1,890	1,495	1,650	1,504	1,447	-20.9	10.4	-8.8	-3.8

Note: CDP (Census Designated Place) is a statistical entity defined for each decennial census according to Census Bureau guidelines, comprising a densely-settled concentration of population that is not within an incorporated place, but is locally identified by a name.

Sources: U.S. Bureau of the Census 1990, 2000.

Table I.2-2 Population by Age and Sex for Counties within the 50 Mile Radius of the North Trend Expansion Area, 2000

State County	Age	Male	Female	Total	Total Percent Breakdown
Nebraska					
Box Butte	Under 5	436	361	797	6.6
	5 – 19	1,530	1,409	2,939	24.2
	20 – 34	935	963	1,898	15.6
	35 – 64	2,446	2,308	4,754	39.1
	65+	707	1,063	1,770	14.6
	Total	6,054	6,104	12,158	100.0
Dawes	Under 5	213	238	451	5.0
	5 – 19	1,143	1,043	2,186	24.1
	20 – 34	1,133	1,110	2,243	24.8
	35 – 64	1,400	1,438	2,838	31.3
	65+	540	802	1,342	14.8
	Total	4,429	4,631	9,060	100.0
Sheridan	Under 5	192	167	359	5.8
	5 – 19	716	660	1,376	22.2
	20 – 34	415	403	818	13.2
	35 – 64	1,132	1,170	2,302	37.1
	65+	580	763	1,343	21.7
	Total	3,035	3,163	6,198	100.0
Sioux	Under 5	43	36	79	5.4
	5 – 19	188	132	320	21.7
	20 – 34	98	95	193	13.1
	35 – 64	324	320	644	43.7
	65+	123	116	239	16.2
	Total	776	699	1,475	100.0
South Dakota					
Fall River	Under 5	214	145	359	4.8
	5 - 19	847	661	1,508	20.2
	20 - 34	397	406	803	10.8
	35 - 64	1,596	1,513	3,109	41.7
	65+	846	828	1,674	22.6
	Total	3,900	3,553	7,453	100.0
Shannon	Under 5	676	684	1,360	10.9

Table I.2-2 Population by Age and Sex for Counties within the 50 Mile Radius of the North Trend Expansion Area, 2000

State County	Age	Male	Female	Total	Total Percent Breakdown
	5 - 19	2,460	2,294	4,754	38.1
	20 - 34	1,205	1,297	2,502	20.1
	35 - 64	1,614	1,642	3,256	26.1
	65+	265	329	594	4.8
	Total	6,220	6,246	12,466	100.0
Wyoming					
Goshen	Under 5	378	349	727	5.8
	5 - 19	1,460	1,322	2,782	22.2
	20 - 34	1,001	946	1,947	15.5
	35 - 64	2,459	2,451	4,910	39.2
	65+	936	1,236	2,172	17.3
	Total	6,234	6,304	12,538	100.0
Niobrara	Under 5	60	55	115	4.8
	5 - 19	268	219	487	20.2
	20 - 34	134	180	314	13.0
	35 - 64	507	533	1,040	43.2
	65+	205	246	451	18.7
	Total	1,174	1,233	2,407	100.0

Source: U.S. Bureau of the Census 2000

Table I.2-3 Population Projections for Counties within a 50-mile Radius of the Crow Butte Project Area, 2000-2020

County	Census 2000	Projected 2005	Projected 2010	Projected 2015	Projected 2020
Box Butte	12,158	11,759	11,387	11,048	10,662
Dawes	9,060	9,168	9,273	9,339	9,368
Sheridan	6,198	5,962	5,732	5,540	5,368
Sioux	1,475	1,424	1,364	1,294	1,215
Fall River	7,453	N/A	N/A	N/A	N/A
Shannon	12,466	N/A	N/A	N/A	N/A
Goshen	12,538	12,401	12,429	N/A	N/A
Niobrara	2,407	2,399	2,399	N/A	N/A

N/A not available

Sources: University of South Dakota, Bureau of Business Research 2004.
University of Nebraska-Lincoln, Bureau of Business Research 2004.
Wyoming Department of Administration and Information 2004.

Table I.2-4 2000 Population within a 50-mile (80-km) Radius of the North Trend Permit Area[a]

	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	Total
N	0	0	0	0	1	9	38	63	87	112	137	161	3,682	4,290
NNE	0	0	0	0	1	9	38	63	88	112	147	205	223	886
NE	0	0	0	0	1	9	38	63	88	109	116	624	679	1,727
ENE	0	0	0	0	1	9	37	58	5,039	113	132	224	3,139	8,752
E	0	0	0	0	1	9	29	48	1,007	113	587	435	1,207	3,436
ESE	0	0	0	0	1	7	29	48	69	91	117	131	107	600
SE	0	0	0	0	0	7	29	48	68	146	263	303	153	1,017
SSE	0	11	21	9	2	7	29	48	125	242	273	194	1,701	2,662
S	0	16	41	58	72	27	29	48	136	190	188	164	179	1,148
SSW	0	14	41	58	74	75	21	25	30	38	67	115	133	691
SW	0	4	39	58	74	291	13	21	29	38	46	70	112	795
WSW	0	0	6	33	60	75	13	21	29	38	53	83	98	509
W	0	0	0	0	1	3	13	21	29	38	33	39	49	226
WNW	0	0	0	0	1	4	13	21	29	38	38	32	37	213
NW	0	0	0	0	1	6	13	21	30	71	110	113	78	443
NNW	0	0	0	0	1	9	28	26	65	112	136	148	164	689
Total	0	45	148	216	292	556	410	643	6,948	1,596	2,443	3,041	11,741	28,084

Notes:
[a]Current population living between 10 and 80 km of the mine site were estimated using 2000 census data. Field reconnaissance was conducted in 2004 to verify data collected within 2.25 miles (3.6 km).

Table I.2-5 Annual Average Labor Force and Employment Economic Sectors* for Dawes and Box Butte Counties, 1994 and 2002

	Dawes		Box Butte	
	1994	**2002**	**1994**	**2002**
Labor Force	4,490	4,663	6,156	5,670
Unemployment	149	175	235	282
Unemployment Rate	3.3	3.8	3.8	5.0
Employment	4,341	4,489	5,921	5,387
Farm Employment	564	550	763	760
Non-Farm Employment Total	3,479	3,903	5,446	5,241
Manufacturing	165	201	402	465
Construction and Mining	136	179	80	0
Transportation, Communication, and Utilities	N/A	N/A	1,909	1,288
Trade	952	N/A	1,106	825
Retail	824	636	840	539
Wholesale	128	N/A	265	286
Financial, Insurance, and Real Estate	77	117	215	205
Services	548	N/A	779	N/A
Information	N/A	0	N/A	110
Professional and Business Services	N/A	N/A	N/A	219
Education and Health Services	N/A	358	N/A	424
Leisure and Hospitality	N/A	533	N/A	372
Other Services	N/A	133	N/A	203
Government	1,384	1,450	955	1,130
Federal	144	161	65	67
State	721	719	67	62
Local	519	571	824	1,001

*Industry employment estimates are based on the Standard Industry Classification System before 2001, and on the North American Industry Classification System after 2001.

N/A = not available

Table I.4-1 Monthly Climate Summary for Chadron 1 NW, Nebraska (251575)* – Period of Record: June 2, 1948 to June 30, 2007

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec	Annual
Avg. Maximum Temperature (°F)	35.9	40.9	48.5	59.3	69.8	80.9	89.4	88.4	77.4	64.6	48.1	38.6	61.8
Avg. Minimum Temperature (°F)	10.9	15.3	22.4	32.4	43.2	52.8	59.4	57.6	46.5	34.3	22.2	13.7	34.2
Avg. Total Precipitation (inches)	0.43	0.46	0.89	1.75	2.91	2.78	2.11	1.37	1.46	0.92	0.49	0.41	15.98
Avg. Total Snowfall (inches)	6.3	6.5	8.8	5.1	0.6	0.0	0.0	0.0	0.3	2.2	5.1	.9	42.0
Avg. Snow Depth (inches)	2	1	1	0	0	0	0	0	0	0	1	1	1

* HPRCC 2008

Table I.4-2 North Trend Plant Communities

Plant Community	Acreage
Deciduous Streambank Forest	15 acres
Tree Plantings	12 acres
Mixed-grass Prairie	74 acres
Range Rehabilitation	37 acres
Cultivated	1014 acres
Disturbed/Developed	12 acres

Source: CBR 2007

Table I.4-3 Federal and State Threatened, Endangered, and Candidate Species With The Potential To Occur Within The Vicinity Of The North Trend Expansion Area

Species	Listing Status		Habitat	Critical Habitat
	Federal	State		
Swift Fox (<u>*Vulpes velox*</u>)	Not Listed	Endangered	Large tracts of short- and mid-grass prairie habitats.	None designated
Bald Eagle (<u>*Haliaeetus leucocephalus*</u>)	Delisted	Threatened	Migrates spring and fall statewide, but primarily along the major river courses.	None designated
Black-footed Ferret (*Mustela nigripes*)	Endangered	Endangered	Closely associated with prairie dogs found in short and mid-grass prairies	None designated
Whooping Crane (*Grus americana*)	Endangered	Endangered	Slow-moving rivers/streams with sandbars/islands; nearby wet meadows, croplands and marshlands	None designated

Source: Anschutz 2004 and Godberson 2004. Updated in 2007/2008 (Fritz 2008; NGPC 2008a and 2008b)

Table I.5-1 Typical Non-Radiological Emissions From In-Situ leach Operations

CONSTRUCTION • Gaseous Emissions (e.g., combustion emissions associated with vehicles and heavy equipment) • Fugitive Dust (e.g., vehicle traffic, grading and other dirt handling activities)
OPERATIONS • Fugitive Dust Emissions (e.g., onsite traffic related to operations and maintenance, employee traffic to and from the site, heavy truck traffic delivering supplies to the site and loaded resin from the site to the main processing plant) • Gaseous Emissions (e.g., pressurized gaseous emissions from wellfield pipelines and equipment leaks, resin transfer, and spills and equipment leaks)
AQUIFER RESTORATION • Fugitive Dust (e.g., onsite vehicle traffic, employee traffic to and from the site, heavy truck and equipment (e.g., used for plugging and abandonment of production and injection wells) • Gaseous Emissions (e.g., vehicles and equipment used for plugging and abandonment of production and injection wells)
DECOMMISSIONING • Fugitive Emissions (e.g., vehicle traffic, dismantling of buildings and equipment, evaporation pond reclamation, removal of contaminated soils, and grading the ground surface) • Gaseous Emissions (e.g., vehicles/heavy equipment, dismantlement of processing and wellfield equipment, truck line removal, and reclamation of evaporation pond,)

Table I.5-2 PM_{10} Monitoring Summary (micrograms per cubic meter)

Year	Maximum 24-hr Average		Annual Average	
	Black Hills, SD	Rapid City, SD	Black Hills, SD	Rapid City, SD
1998	-	87.4	-	30.7
1999	-	116.9	-	28.2
2000	38.5	97.4	12.0	31.3
2001	47.9	81.5	12.6	34.6
2002	26.0	104.7	9.9	34.9
2003	74.4	91.8	16.3	36.2
2004	24.0	72.0	10.0	30.0
2005	40.0	94.00	9.0	27.0
2006	30.0	124.0	10.0	29.0

Table I.5-3 Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 20, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	May 6, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003		Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 28, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 7, 2006	Excursion of mining solutions
PR-15	September 26, 2006		See IJ-13 and PR-8
CM9-5	May 15, 2008	June 3, 2008	Excursion Mining Solution
CM9-3	May 30, 2008	June 24, 2008	Excursion Mining Solution

Table I.5-4 Estimated Total Effective Dose Equivalent (TEDE) to Receptors Near the Crow Butte Uranium Processing Facility

Receptor #	Description**	Distance from Main Plant Miles (km)	TEDE* (mrem/y)
1	R1	0.80 (1.29)	6.64
2	R2	1.71 (2.76)	4.82
3	R3	2.05 (3.30)	6.14
4	R4	2.71 (4.36)	1.92
5	R5	3.32 (5.35)	1.98
6	Crawford	3.88 (6.25)	1.65
7	R7	2.75 (4.43)	4.87
8	R8	2.55 (4.11)	5.16
9	R9	2.23 (3.59)	8.12
10	R10	1.88 (3.03)	16.0
11	R11	2.04 (3.29)	7.34
12	R12	1.46 (2.37)	17.7
13	R13	0.93 (1.49)	28.1
14	R14	0.68 (1.10)	28.3
15	R15	0.39 (0.62)	31.7
16	R16	0.83 (1.34)	9.48
17	R17	0.84 (1.35)	6.06
18	Ehlers	0.45 (0.73)	15.5
19	Gibbons	0.64 (1.03)	24.9
20	Stetson	0.81 (1.30)	19.9
21	Knode	2.04 (3.28)	6.09
22	Brott	1.19 (1.92)	16.2
23	SP1	0.47 (0.75)	18.1
24	SP2	0.55 (0.89)	26.2
25	SP3	0.70 (1.13)	24.8
26	McDowell	3.03 (4.87)	4.24
27	Taggart	3.00 (4.83)	4.87
28	Franey	3.02 (4.86)	6.55
29	Bunch	2.73 (4.39)	7.54
30	Dyer	1.55 (2.50)	3.27
31	NT-1	7.46 (12.01)	5.84
32	NT-2	6.11 (9.83)	3.41
33	NT-3	5.71 (9.19)	3.09
34	NT-4	5.51 (8.87)	2.14
35	NT-5	5.08 (8.18)	2.42
36	NT-6	8.51 (13.7)	1.63
37	NT-7	7.99 (12.86)	1.04
38	NT-8	1.73 (2.79)	15.9

* No differences in TEDE between age classes were observed.

** These receptor locations used for the MILDOS modeling are shown in Figure I.5-3.

R: Receptor SP: Sampling Point NT: North Trend

Table I.5-5 Dose to the Population Bronchial Epithelium and Increased Continental Dose from One Year's Operation at the Crow Butte Facility

Criteria	Dose (person rem/yr)
Dose received by population within 50 miles of the facility	171
Natural background by population within 50 miles of the facility	24,025
Dose received by population beyond 50 miles of the facility	224
Total continental dose	394
Natural background for the continental population	$1.73 \times 10^{+8}$
Fraction increase in continental dose	2.27×10^{-6}

Table I.6-1 Tax Revenues for Crow Butte Project

	2007	2006	2005	2004	2003
Property Taxes	1,111,322	627,000	351,000	144,000	65,000
Sales and Use Taxes	102,172	238,000	185,000	161,000	153,000
Severance Taxes	1,066,286	545,000	338,000	180,000	73,000
Total	2,279,680	1,410,000	874,000	485,000	291,000

Table I.6-2 Current Economic Impact of Crow Butte Uranium Project and Projected Impact from North Trend Expansion Area

	Current Crow Butte Operation	Estimated Economic Impact due to North Trend Expansion Area
Employment		
Full-time Employees	52	+ 10 to 12
Full-time Contractor employees	20	+ 4 to 7
Part-time Employees and Short-term Contractors	7	+ 10 to 15 (Satellite Facility Construction)
CBR Payroll, 2007	$3,087,340	+ $400,000 to $480,000
Taxes		
Property Taxes	$1,111,322	-
Sales and Use Taxes	$102,172	-
Severance Taxes	$1,066,286	-
Total Taxes	$2,279,680	+ $1,000,000 to $1,200,000
Local Purchases		
Local Purchases, 2007	$6,326,000	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts		
	$11,693,020	**+ $5,050,000 to $6,030,000**

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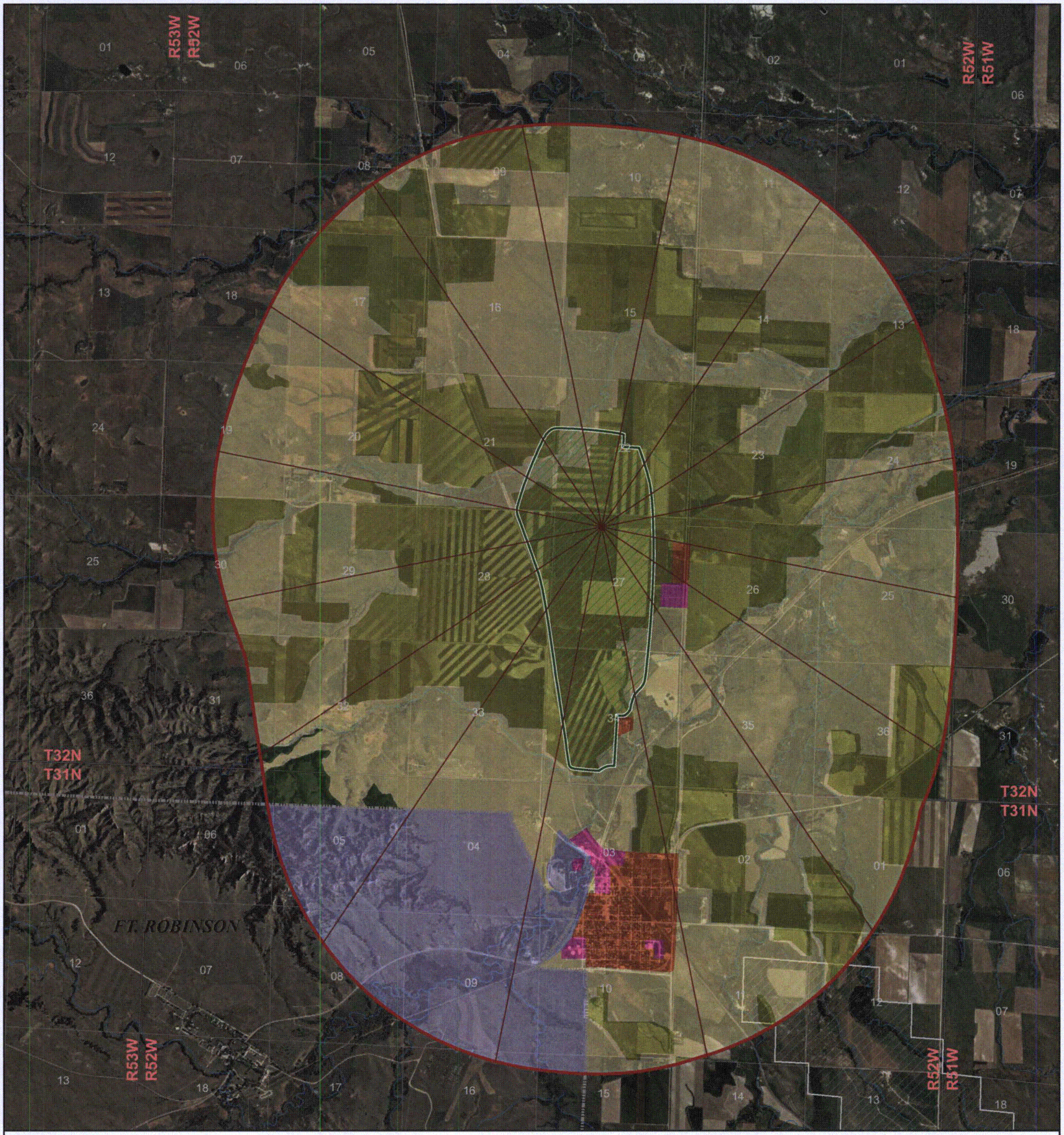

Source: Crow Butte Resources, Inc.

CROW BUTTE RESOURCES, INC.

FIGURE I. 1-1
NORTH TREND EXPANSION AREA
LAND USE

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

FILE: I_1-1_NT_LandUse.mxd - 1/4/2010 @ 3:32:50 PM

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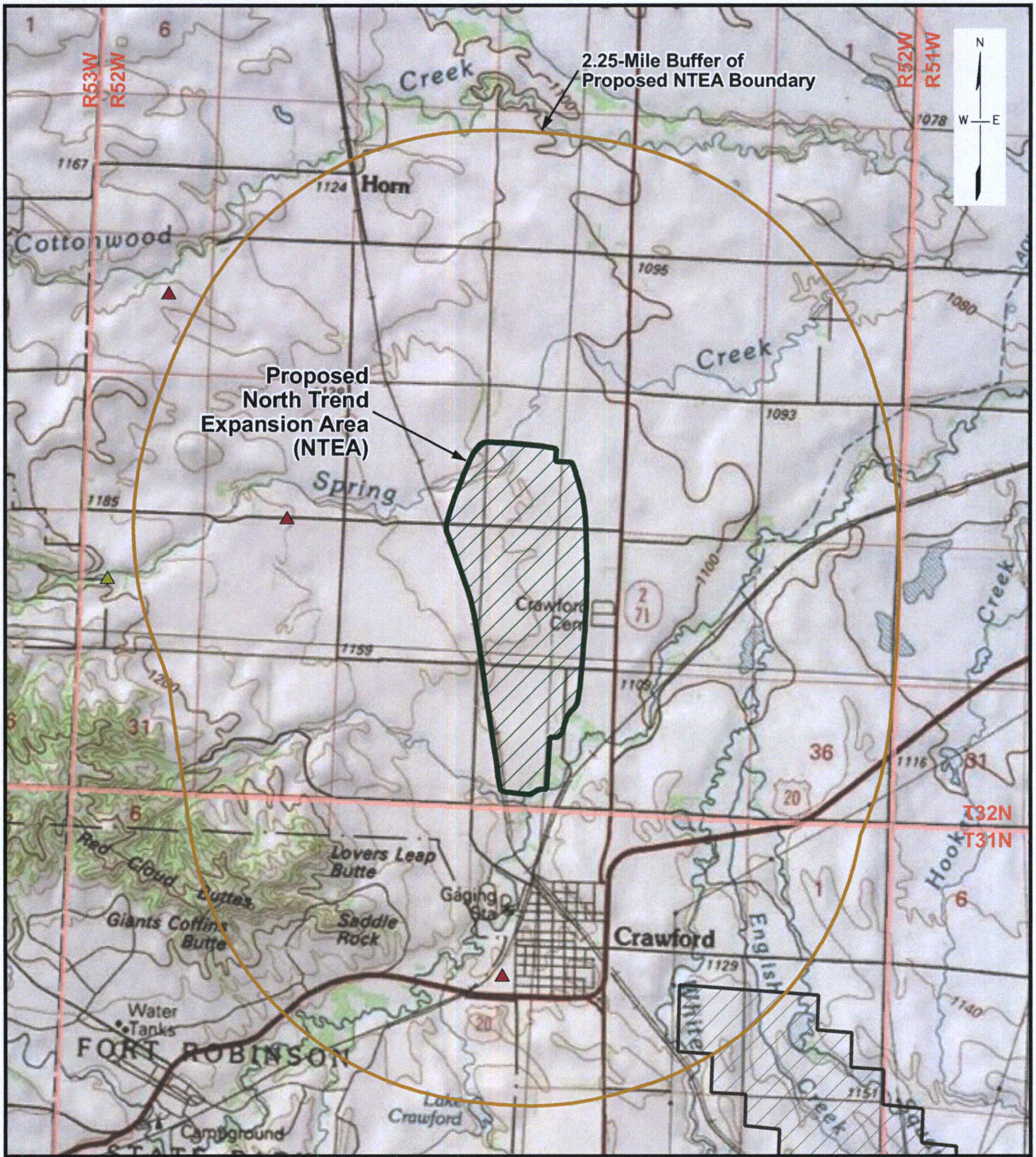

Legend

- ▲ Concrete Agg. Pit
- ▲ Sand & Grave Pit
- Proposed North Trend Expansion Area (NTEA)
- 2.25-Mile Buffer of Proposed NTEA Boundary
- Current License Area

Source:
Nebraska Oil and Gas Commission (NOGC). 2008. [Web page]. http://www.nogcc.ne.gov/ (Well data and publications). Accessed on April 01, 2008.

0 0.5 1 Miles

CROW BUTTE RESOURCES, INC.

FIGURE I. 1-2
North Trend Expansion Area
Location of Concrete Aggregate and Sand and Gravel Pits

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

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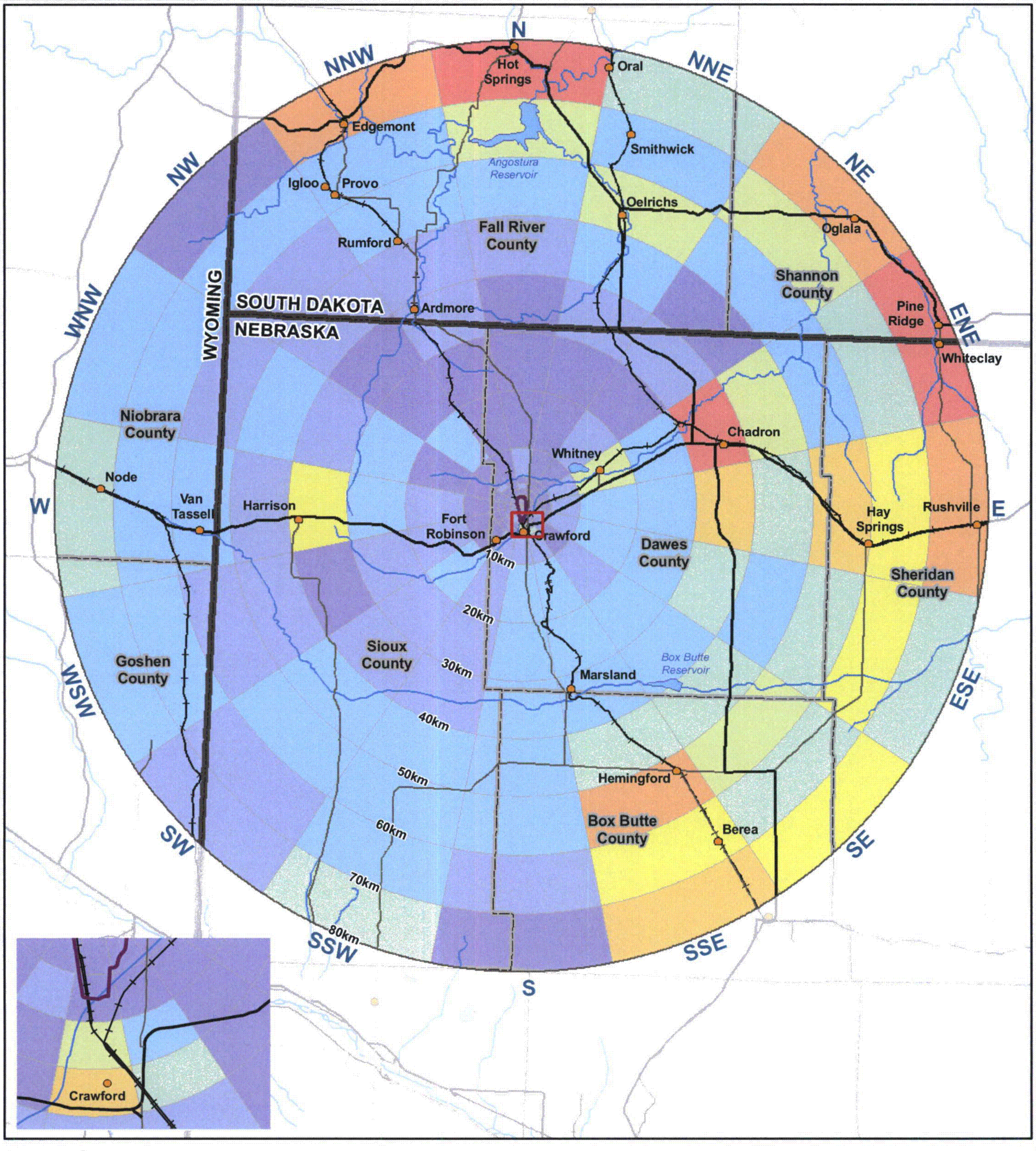

Legend

Proposed North Trend Expansion Area (NTEA)

Population (Census 2000)

0 - 8	120 - 192
9 - 23	193 - 349
24 - 38	350 - 837
39 - 61	838 - 1,597
62 - 119	1,598 - 5,970

N
W E

0 20 40
Kilometers

CROW BUTTE RESOURCES, INC.

FIGURE I.2-1
SIGNIFICANT POPULATION CENTERS
WITHIN 80 KILOMETERS

PROJECT: CO001322.0001 MAPPED: JC CHECKED: L. WELCH

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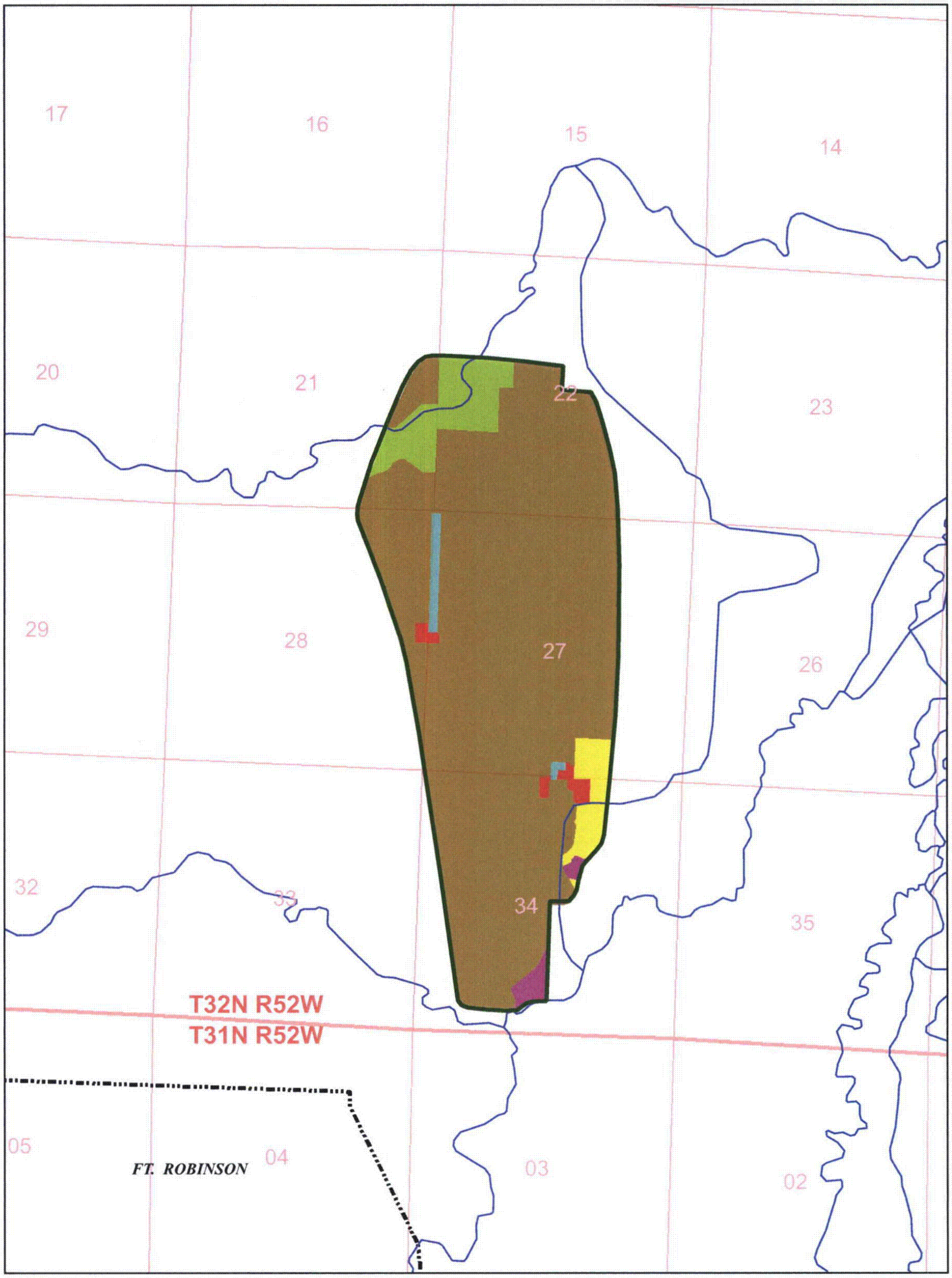

Legend

Plant Communities

- 110 Deciduous Streambank Forest
- 130 Tree Plantings - Orchards, Shelterbelts, Windbrakes
- 410 Mixed Grass Prairie
- 420 Range Rehabilitation - Permanent Pasture
- 500 Cultivated
- 630 Human Biotopes - Buildings, Towns, Farmyards, Etc.

- Proposed North Trend Expansion Area (NTEA)
- Ft. Robinson Boundary
- River/Stream

N W E

0 2,000
Scale in Feet

CROW BUTTE RESOURCES, INC.

FIGURE I. 4-1
NORTH TREND
PLANT COMMUNITIES

PROJECT: CO001322 MAPPED: JC CHECKED: MS

FILE: I_4-1_NT_PlantCommunities.mxd - 1/4/2010 @ 3:35:14 PM

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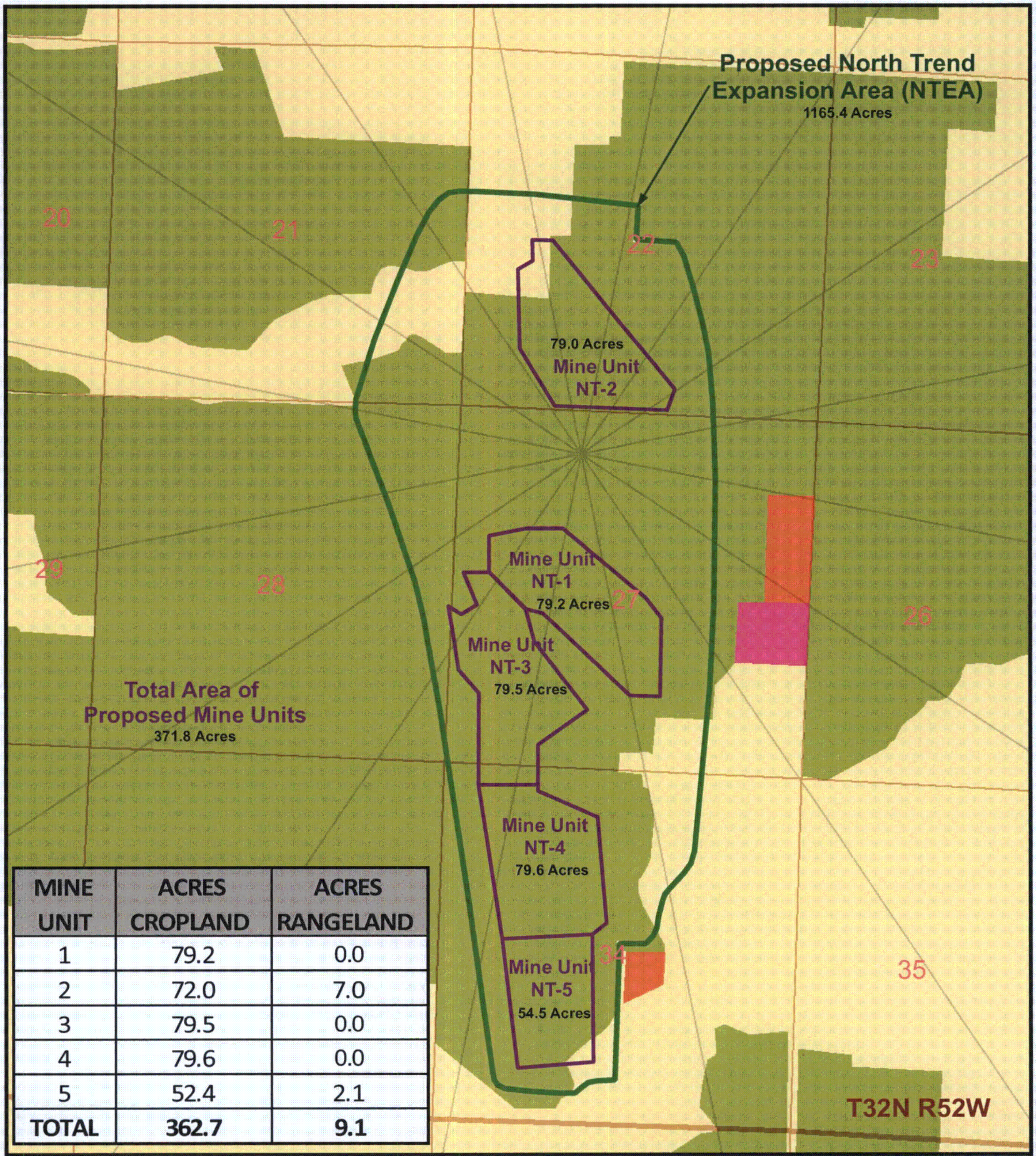

MINE UNIT	ACRES CROPLAND	ACRES RANGELAND
1	79.2	0.0
2	72.0	7.0
3	79.5	0.0
4	79.6	0.0
5	52.4	2.1
TOTAL	362.7	9.1

Legend

Land Use

- Commercial and Services
- Residential
- Crop
- Rangeland

0 1,000 2,000 Feet

N W E

CROW BUTTE RESOURCES, INC.

FIGURE I. 5-1
NORTH TREND
WELLFIELD LAND USE

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

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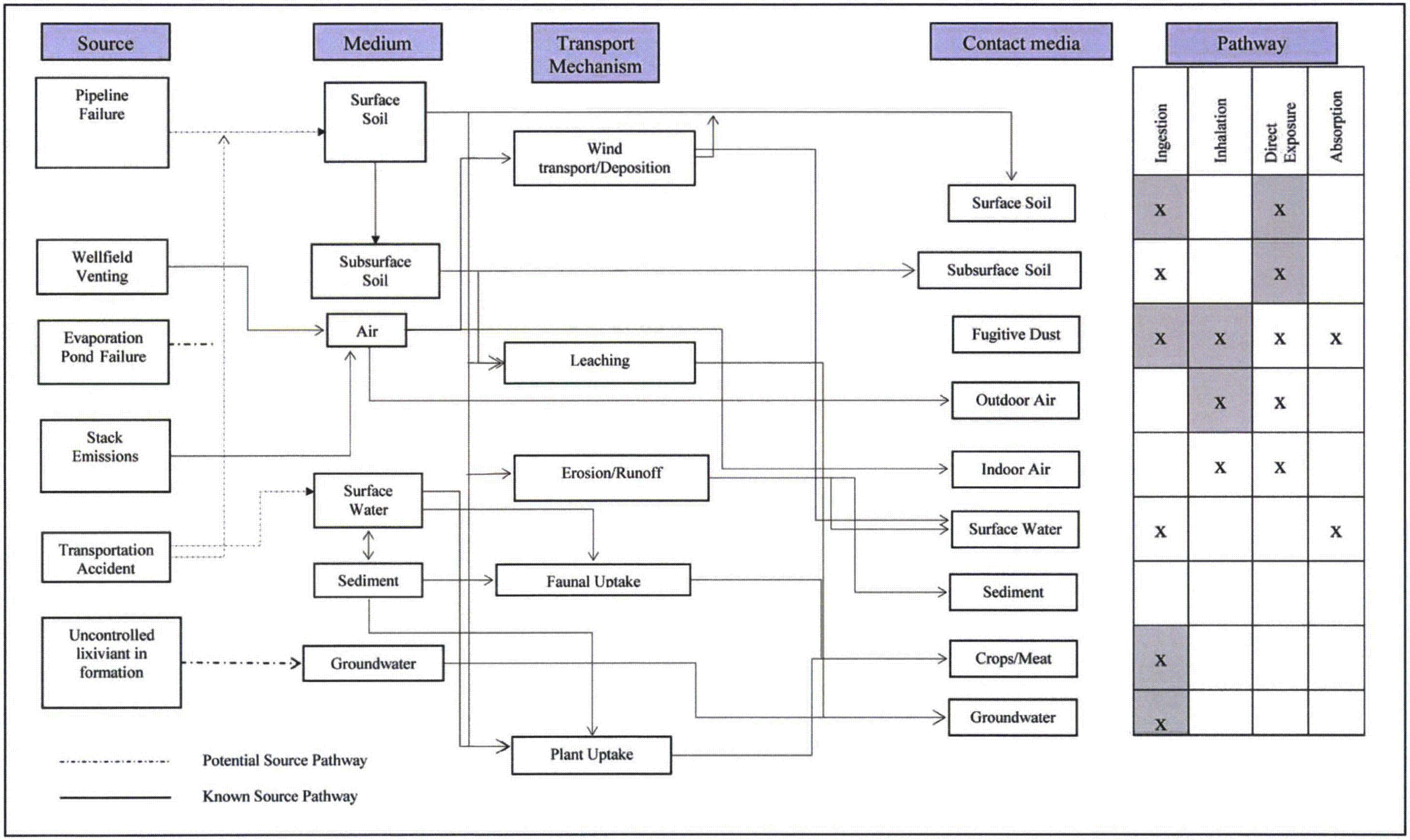

Contact media	Ingestion	Inhalation	Direct Exposure	Absorption
Surface Soil	X		X	
Subsurface Soil	X		X	
Fugitive Dust	X	X	X	X
Outdoor Air		X	X	
Indoor Air		X	X	
Surface Water	X			X
Sediment				
Crops/Meat	X			
Groundwater	X			

Note: X depicts the pathway that outlines the route which radiological emissions may follow to reach the public.
Gray shading depicts predominant pathway.

CROW BUTTE RESOURCES, INC.

FIGURE I.5-2
HUMAN EXPOSURE PATHWAYS FOR KNOWN AND POTENTIAL SOURCES OF RADIOLOGICAL EMISSIONS FROM THE NORTH TREND EXPANSION AREA

PROJECT: CO001322 MAPPED: JC CHECKED: JEC

FILE: CBR NT UIC I_5-2.psd @ 11/02/2009

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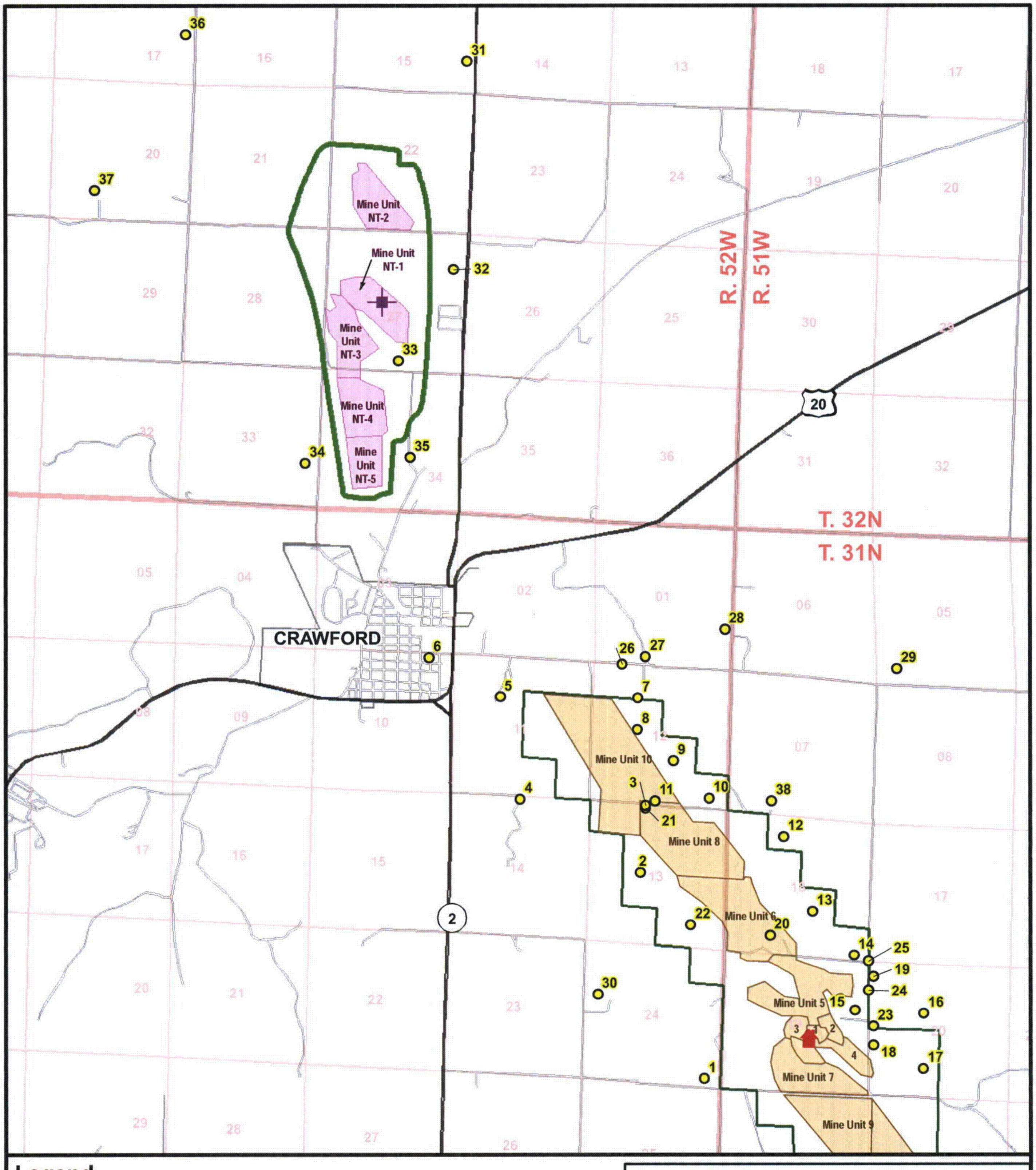

Legend

- MILDOS Receptor
- Main Plant
- North Trend Satellite Process Area
- Crow Butte Mine Units
- North Trend Mine Units
- Proposed North Trend Expansion Area (NTEA)
- Class III Permit Area
- Roads/Streets/Trails

0 0.5 1 Miles

CROW BUTTE RESOURCES, INC.

FIGURE I.5-3
MILDOS Receptors for
Main and Satellite Processing Facility

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

FILE: I_5-3_MILDOSReceptors_Letter.mxd - 1/4/2010 @ 3:25:27 PM

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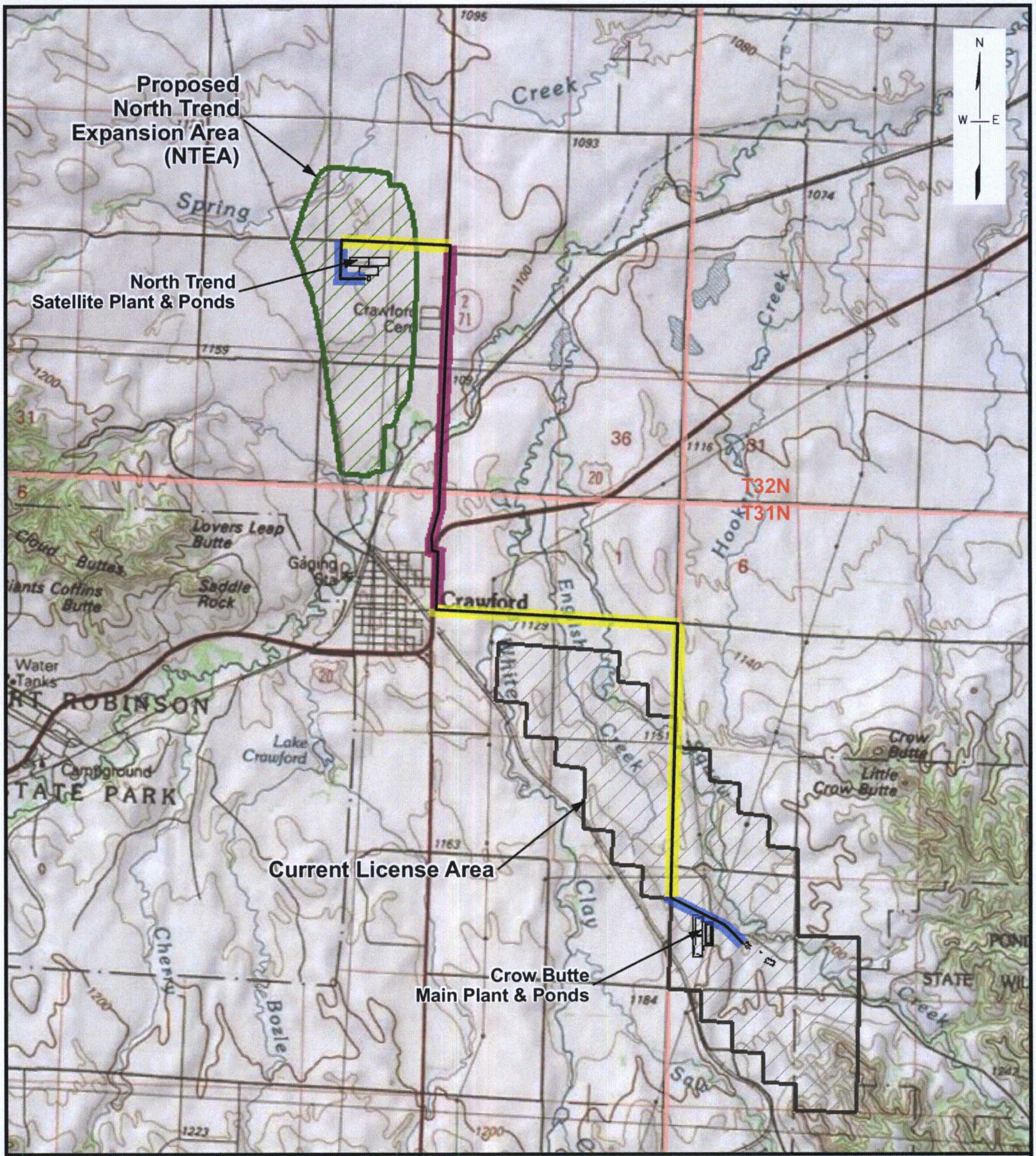

Legend

- Proposed Access Route
- Paved State/US Highway (US Highway 20 and NE State Highway 2/71)
- Unpaved CBR Road
- Unpaved County Road
- Proposed North Trend Expansion Area (NTEA)
- Current License Area

0 0.5 1
Miles

CROW BUTTE RESOURCES, INC.

FIGURE I. 5-4
Proposed Access Route Between CBR's Current License Area and North Trend Expansion Area

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

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CHAPTER J. INJECTION FLUID PROPERTIES

The chemical, physical, radiological and biological characteristics of the injection fluids (Title 122, Chapter 11, Section 006.16C).

With the startup of operations, a leach solution (injection fluid) is injected into the formation via the injection wells for recovery of uranium. Hydrogen peroxide (H_2O_2) or gaseous oxygen (O_2) is typically used as the oxidant because both revert to naturally occurring substances. Carbonate species are also added to the lixiviant solution in the injection stream to promote the dissolution of uranium as a uranyl carbonate complex. Once the injected fluids are returned from the wellfield (via the production wells) to the ion exchange columns in the North Trend Satellite Facility, treatment of the uranium-bearing leach solution results in removal of the uranium, resulting in the displacement of chloride, bicarbonate, and sulfate ions. The now barren leach solution is then reinjected into the formation. Typical lixiviant (injection fluid) concentrations of major constituents are shown in **Table J.1-1**. The basis for these values are a review of lixiviant fluid composition and concentration observed during operations at the existing Crow Butte Uranium Facility. These values are considered to be typical of current leaching operations as well as what is expected during operations at the North Trend Expansion Area (NTEA).

Routine sampling and analysis for biological constituents (e.g., coliforms) of the lixiviant is not conducted by current operations and is not planned for the NTEA. Such monitoring is not required by the Nebraska Department of Environmental Quality (NDEQ) or the Nuclear Regulatory Commission (NRC). The main concern with biological organisms during leaching operations is the potential for well screens becoming totally or partially plugged with precipitated materials such as carbonates or bacterial encrustations. Although rarely needed, CBR does occasionally use well chlorination and well acidification for treating wells that do not respond physically to stimulation techniques in order to kill bacteria slimes and encrustations. The treatment methods are discussed in Chapter L – Stimulation Program.

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Table J.1-1 Typical Lixiviant Concentrations*

SPECIES	RANGE	
	Low	High
Na	• 400	6,000
Ca	• 20	500
Mg	• 3	100
K	• 15	300
CO_3	• 0.5	2,500
HCO_3	• 400	5,000
Cl	• 200	5,000
SO_4	• 400	5,000
U_3O_8	• 0.01	500
V_2O_5	• 0.01	100
TDS	• 1650	12,000
pH	• 6.5	10.5

* All values in mg/L except pH (units).

NOTE: The above values represent the concentration ranges that could be found in barren lixiviant or pregnant lixiviant and would include the concentration normally found in "injection fluid".

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CHAPTER K. FORMATION TESTING PROGRAM

A formation testing program to obtain an analysis of the chemical, physical, and radiological characteristics of and other information on the receiving formation and formation fluids.

Because of the extensive historical operations at the current licensed mining area (referred to as the Commercial Study Area [CSA]), Crow Butte Resources, Inc. (CBR) has conducted more limited investigation/sampling for the North Trend Expansion Area (NTEA) than would have been conducted if this area were a remote property. Where the CSA is referenced, distinctions between the two areas are noted where warranted. However, site-specific data have been collected at the NTEA when warranted.

K.1 Coring And Drill Cutting Testing

CBR has historically used core samples and drill cuttings in support of efforts to better define hydrogeologic and geochemical properties of the subsurface of areas being considered for in-situ leach (ISL) mining. Core samples may be collected as needed, but coring is typically not needed during the drilling and construction of Class III wells. The types of tests that are conducted on core samples are based on the intended need (e.g., porosity, relative permeability, and lithology).

K.1.1 Ore Amenability

Coring samples have also been used in the assessment of the amenability of the ore body. Amenability of the uranium deposits in the Basal Chadron Sandstone in the Crow Butte Project to ISL mining was demonstrated initially through core studies at the original Commercial Study Area (CSA) where mining currently is being conducted. Ore amenability is discussed in Section A.1.2.

K.1.2 Sedimentologic and Petrographic Analysis

In order to obtain an aquifer exemption, the Nebraska Department of Environmental Quality (NDEQ) explicitly stipulated sedimentologic and petrographic studies of cores specific to the NTEA and further recommended sampling south-to-north across the White River Structure. Of particular importance was the proper hydraulic characterization of the upper and lower confining units for the Basal Chadron sandstone. In March 2008, an additional exploration borehole was installed in the western portion of Section 22 T32N R52W of the NTEA. Drill cuttings were collected from target screen intervals for the multiple sandstone units within the Basal Chadron:

- clay unit above Middle Chadron sandstone
- clay unit below Middle Chadron sandstone
- clay unit above Basal Chadron sandstone
- Yellow Mounds Paleosol
- Pierre Shale

The drill cuttings were analyzed for mineralogy by x-ray diffraction analyses and for grain size distribution (Appendix 3). The results of the drill cuttings sampling and analyses are discussed in Chapter G.

K.2 Hydrological Testing

The NDEQ requires the following hydrological testing as part of a formation testing program:

- Install monitor wells and perform pumping test(s) to assess site conditions.
- Analyze pumping test data.
- Submit a Hydrological Test Report for NDEQ review and approval.

During the initial permitting and development activities within the CSA, two pumping tests were conducted in the central portion of the CSA to (1) assess the hydraulic characteristics of the Chadron Sandstone and (2) demonstrate the confinement provided by the overlying and underlying aquicludes. Those tests, referred to as Test #1 and Test #2, were performed in 1982 and 1987, respectively (Wyoming Fuel 1983; Ferret Exploration of Nebraska 1987). Test #3 was conducted in September 1996 (Harlan & Associates, Inc. 1996). Test #4 was conducted from August 19 through August 25, 2002 (Petrotek 2002). Results from those tests are discussed in Chapter G.

In general, the four aquifer tests employed the following methodology:

- Review of existing geologic and hydrogeologic data for the area,
- Design of appropriate aquifer test,
- Design and construction of appropriate well array for aquifer test,
- Laboratory tests of core samples from confining layers,
- Performance of aquifer test,
- Analysis of data from aquifer test, and
- Interpretation of results of test.

Pumping tests on the Basal Chadron Sandstone aquifer were conducted in the NTEA between 2004 and 2006. The final report on pumping test activities in the NTEA (North Trend Hydrologic Testing Report - Test #6) is attached as **Appendix 5** to this UIC Class III permit application. A brief summary of the testing activities from pumping test activities in the NTEA is provided below. The findings are discussed in Chapter G.

Results from the initial testing activities conducted in 2004 to 2005 (Tests #1 through #5) were not definitive as a result of such problems including improperly abandoned old exploration holes, equipment problems, insufficient stress (drawdown) to provide usable data, and infiltration of surface water into observation wells. Prior to testing activities, CBR installed seven new wells in the Basal Chadron Sandstone (CPW-1, CPW-2, COW-1, COW-2, COW-3, COW-4, and COW-5) (**Figure H.2-8** of Chapter H). CPW-1 was installed specifically for use as a pumping well, but was subsequently abandoned due to casing problems and CPW-2 was installed as a replacement and was used for the early pumping tests. However, COW-5 was used as the pumping well for Pumping test #6. The remaining wells were used as observation wells. A pre-existing well that was screened in the Basal Chadron Sandstone (RC-2) was also used as a monitoring location. To assess the hydrogeologic isolation of the Basal Chadron Sandstone aquifer during testing, CBR also installed monitor wells in the overlying Upper/Middle Chadron (MCOW-1 and MCOW-2) and Brule Formation (BOW-1) (**Figure H.2-8** of Chapter H). Because the Basal Chadron Sandstone is underlain by the thick and relatively impermeable Pierre Shale, no underlying monitor wells were installed.

A longer pumping test was conducted in June and July 2006 (Test #6), which included the installation of new monitor wells in the Upper/Middle Chadron (MCOW-3 and MCOW-4) and Brule Formation (BOW-2) and the use of automated equipment. The pumping test was conducted in accordance with a Test Plan submitted by CBR to the NDEQ in June 2006. The locations of the wells during the 2006 pumping test and well information during the 2006 pumping test are presented in Chapter G.

The 2006 pumping test was designed to assess the following:

- the degree of hydrologic communication between the Basal Chadron Sandstone pumping well and the surrounding Basal Chadron Sandstone monitor wells;
- the presence or absence of hydrologic boundaries within the Basal Chadron Sandstone aquifer over the test area;
- the hydrologic characteristic of the Basal Chadron Sandstone aquifer within the test area; and
- the degree of hydrologic isolation between the Basal Chadron Sandstone aquifer and the overlying aquifers.

The overall findings of the pumping tests at the NTEA are discussed in Chapter G.

K.3 Baseline Groundwater Levels and Quality

Groundwater quality data were collected between 1982 and 1987 within and near the CSA to establish background conditions in the vicinity of the Crow Butte Project. Water quality information for the Alluvium, Brule Formation, and Basal Chadron Sandstone is discussed in Section G.2.2 of Chapter G. Wells sampled from the Brule Formation include RA-1, RA-2, RB-1 and RB-3 (Ferret Exploration of Nebraska 1987). Wells sampled from the Chadron Formation include RC-1, RC-2, RC-3, RC-4, RC-5, RC-6, and RC-7 (Ferret Exploration of Nebraska 1987). Note that RC-3 was abandoned May 20, 2008 (Table D.2-3).

CBR conducted a water user survey in 1996 to identify and locate all water supply wells within the 2.25-mile area of review (AOR) of the NTEA. The water user survey determined the location, depth, casing size, depth to water, and flow rate of all wells within the area that were (or could) be used for domestic, agricultural, or livestock uses. The water user survey was reviewed in 2004, 2007 and 2008 and updated as needed. Active, inactive, and abandoned water wells within the 2.25-mile AOR of the NTEA are summarized in **Table G.2-1** of Chapter G and **Appendix 6.**

K.3.1 Water Quality

A monitoring program was conducted to establish baseline groundwater quality conditions in the NTEA. The program was conducted in 1996 and 1997, and includes samples from a Basal Chadron well (Well 81A) and Brule well (Well 78) in the NTEA (**Figure H.2-1** of Chapter H). Note that Well 81A has since been abandoned. CBR collected groundwater samples from the two water supply wells during four monitoring periods, obtained from September 1996 through July 1997, to assess seasonable variability in water quality. The water quality results included a full suite of analyses such as major ions, nonmetals, trace metals, and select radionuclides. These data establish the initial water quality conditions associated with the mineralized Basal Chadron Sandstone and Brule Formation for the eastern central portion of the NTEA. The chemical analyses results, as well as the radiological results, of baseline sampling for these wells are discussed in Section G.2.2 of Chapter G.

Additional quarterly groundwater sampling was conducted in the NTEA from September 1996 to June 1997 and July 2004 to September 2005. Groundwater samples were collected from one Basal Chadron Sandstone well (Well 81A) and four Brule Formation wells (Well 77, Well 78, Well 83, and Well 107) (**Figure H.2-1** of Chapter H). The sample locations were chosen based on proximity to the proposed mining operation, use, and distribution throughout the NTEA. Groundwater samples were only analyzed for select radionuclides (natural uranium, thorium-230, radium-226, lead-210, and polonium-210), with the exception of First Quarter 2005 results, when only natural uranium and radium-226 were analyzed as a result of an error on the chain-of-custody (**Table G.1-6** of Chapter G). The analytical results are discussed in Section G.2.2. of Chapter G.

In March and April 2008, additional water samples were collected from designated wells in the NTEA. As per the NDEQ's recommendation, three bi-weekly sampling events took place in order to develop a complete "pre-mining" water quality dataset. Groundwater sample locations included one Brule Formation well (BOW-1), nine Basal Chadron monitor wells (COW-1, COW-2, COW-3, COW-4, COW-5, COW-6, CPW-2, RC-1, and RC-2), and two Basal Chadron water supply wells (Wells 97 and 123) (**Figure H.2-1** of Chapter H) Attempts were made to collect groundwater samples from a second Brule Formation well (BOW-2); however, this well was dry during each sampling event. All groundwater samples were analyzed for major ions, metals, physical properties, and radionuclides (**Table G.2-6** of Chapter G and **Appendix 7**). Groundwater samples collected in March 2008 from wells in the NTEA were analyzed for each of these daughter products.

Consistent with previous analyses of groundwater samples collected in the CSA, groundwater samples collected from all designated sampling locations were analyzed for the following parameters:

- Radionuclides (U-nat, Ra-226, Th-230, Pb-210, Po-210)
- Major ions (Ca, Mg, Na, K, CO_3, HCO_3, SO_4, Cl, NH_4 as N, NO_2 as N, NO_3 as N, F, SiO_2)

- Field parameters (TDS, conductivity, alkalinity, pH)
- Trace metals (Al, As, Ba, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, V, Zn)
- Quality assurance data (anion, cation, WYDEQ A/C Balance, Calc TDS, TDS A/C Balance)

This 2008 sampling program allowed for a more accurate characterization of the water quality and hydraulic gradient within the Basal Chadron sandstone in the NTEA. Results from the analyses listed above will be used to evaluate water quality baseline values for future restoration to groundwater standards. The results of this sampling are discussed in Section G.2.2 of Chapter G.

K.3.2 Water Level Measurements

In March and April 2008, water levels were measured for nine monitor wells screened in the Basal Chadron sandstone (COW-1, COW-2, COW-3, COW-4, COW-5, COW-6, RC-1, RC-2, RC-2, CPW-2) and two private wells (wells #97 and #123). Water level data for the Brule Formation were collected for two monitor wells (BOW-1 and BOW-2). The locations of these wells are shown in **Figure H.2-1** of Chapter H. The purpose of these measurements was to allow evaluation of the hydraulic gradient with the NTEA and in the vicinity of, and across, the White River structure. The results of these measurements are discussed in Chapter G.

K.4 Formation Gradient Pressures

NDEQ Title 122, Chapter 19, Section 002.02 requires that the injection pressure at the wellhead of Class III UIC injection wells shall not exceed a maximum, which shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause migration of injection or formulation fluids into an underground source of drinking water. CBR will operate the NTEA using maximum wellhead injection pressures that will result in "pressure at well depth" that will be significantly lower than typical default maximum formation gradient pressures allowed by the U.S. Environmental Protection Agency (USEPA). Based on the CBR's maximum injection wellhead pressure of 100 pounds per square inch (psi), and the calculated formation gradient pressure of 0.62 psi/ft, adverse impacts listed should not occur. This position is supported by historical experience of the current CBR facility operating successfully since 1991 at similar pressures. Formation gradient pressure calculations are discussed in Chapter P.

K.5 References

Ferret Exploration Company of Nebraska, Inc. 1987. *Application and Supporting Environmental Report for USNRC Commercial Source Materials License.* September.

Harlan & Associates, Inc. 1996. Groundwater Pumping Test #3: Report prepared for Crow Butte Resources, Inc. and submitted to the Nebraska Department of Environmental Quality. October 15.

Petrotek Engineering Corporation (Petrotek). 2002. *Technical Report: Ground-Water Pumping test #4 Data Evaluation Report.* Prepared for Crow Butte Resources, Inc. October 10, 2002.

Petrotek. 2006. *North Trend Hydrologic Testing Report- Test #6.* Prepared for Crow Butte Resources, Inc. December 2006.

Wyoming Fuel Company. 1983. *Crow Butte Uranium Project, Dawes County Nebraska, Petition for Aquifer Exemption for State of Nebraska Underground Injection Control Program.* July 22.

CHAPTER L. STIMULATION PROGRAM

A narrative describing the proposed aquifer/formation stimulation program (i.e. acid).

There are several processes used to clean the well bore, enlarge channels, and increase pore space in the interval to be injected, thus making it possible for fluids to move more readily into the formation including, but not limited to swabbing, surging, jetting, blasting, acidizing, and hydraulic fracturing. Crow Butte Resources, Inc. (CBR) uses stimulation techniques for cleaning the well bore, but does not use blasting or fracturing for the aquifer/formation itself. CBR frequently uses the swabbing technique for cleaning well bores, and as necessary, may periodically use other physical techniques such as surging, jetting, and pumping.

Although rarely, CBR does occasionally use well chlorination and well acidification for treating wells which do not respond to physical stimulation techniques. During the course of production, well screens may become totally or partially plugged with precipitated materials such as carbonates or bacterial encrustations. Treating a well with chlorine will kill most bacteria, and treating a well with hydrochloric acid (HCL) will kill most bacteria and remove encrustations. CBR has written procedures that describe the proper methods for treating wells with HCL or chlorine. Specific topics covered include chemical strength, holding times, physical processes, well purging, and safety. These procedures are in agreement with those described in Groundwater and Wells, Second Edition by Fletcher G. Driscoll (Driscoll 1986) and those published by the Nebraska Department of Health and Human Services (NDHHS 2008).

L.1 Well Chlorination

Treating a well with chlorine will kill most varieties of bacteria. However, chlorine cannot penetrate thick bacteria slimes and encrustations; consequently, only those bacteria on the surface are killed. For severe cases, it is better to treat the well with HCL because it can more easily penetrate the slimes and encrustations. CBR's procedure is written for using sodium hypochlorite at 5.25 percent strength.

The procedures are as follows:

- Because bacteria will likely exist from surface to total depth, it is necessary to treat the entire well. A 5.25 percent liquid chlorine solution or 65 percent dry chlorine is poured down the well bore from the surface. The total volume poured down the well bore should raise the concentration of chlorine in the water in the well bore to 1,000 parts per million (ppm). To achieve this concentration, 2.5 ounces of 6 percent liquid sodium hypochlorite or 0.175 ounces of 65 percent dry sodium hypochlorite would be added for each foot of water in the well bore.
- For best results, the water in the well bore is agitated to mix the chlorine solution. One agitation method is to turn on the pump for a few seconds and then turn it off. Repeat this process several times. Allow the water to flow back through the pump before restarting it so the impellers are not turning in the wrong direction.
- Allow the solution to sit in the well for 4 to 8 hours.

- Pour clean water down the well bore to wash residual chlorine from the casing wall. Use at least three times the volume of the sodium hypochlorite. Purge the solution out of the well and into a water truck or trailer or other appropriate container. Purge at least three casing volumes. After pumping the initial three casing volumes, continue purging until the conductivity and pH are stable. Dispose of the solution in the commercial evaporation ponds.

L.2 Well Acidification Using HCL

Acidification of a well using HCL is effective for killing bacteria, removing bacterial encrustations and slimes, and dissolving carbonate scales.

If the goal is to dissolve carbonate scales, the first step is to log the well from the total depth to surface using gamma, resistivity, and self-potential tools. Because radium co-precipitates with calcium, this oftentimes is an effective way to determine the location of scale.

- The acid is introduced to the top of the screened interval through tubing in order to prevent dilution. The pump and motor may be left downhole if they are composed of materials that are compatible with HCL for short periods of time. If the check valve is drilled out, the acid can be introduced through pumps that are compatible with the acid. When using 38 percent hydrochloric acid in a 4.5-inch diameter well, a total of 1 gallon of acid solution per foot of screened interval should be introduced. For example, if the screened interval is 20 feet, then introduce 20 gallons of 38 percent HCL.
- The acid may react violently with the carbonate in the well. Always provide a safe pathway for escaping gas and/or water. HCL fumes are toxic.
- Chase the acid with a sufficient amount of water to force the acid out of the tubing and into the screen and surrounding host formation.
- If possible, agitate the solution by swabbing or other means. Allow the acid to sit for 2 to 4 hours in order to kill bacteria. The pH must be maintained below 2.
- Using the same tubing, purge the well for at least three casing volumes and until the pH and conductivity are stable. Dispose of the purged water in the commercial evaporation ponds.
- Re-log the hole to determine if any scale remains. Test the well to see if the flow rate has improved. If significant improvement is achieved, additional acid treatment may provide additional benefit. If no significant improvement is achieved after the first treatment, it is not likely that additional treatment will help.

L.3 References

Driscoll, Fletcher G. 1986. _Groundwater and Wells_, 2nd. Edition, Johnson Division, St. Paul, MN.

Nebraska Department of Health and Human Services (NDHHS). 2007. *Water Well Disinfection*. 2007. [Web page]. Located at: http://www.hhs.state.ne.us/puh/enh/brochures.htm. Accessed on June 04, 2008.

CHAPTER M. INJECTION PROCEDURES

A narrative describing the proposed injection procedure.

Production of uranium by in-situ leach (ISL) mining techniques involves a mining step and a uranium recovery step. Mining is accomplished by installing a series of injection wells through which the leach solution is pumped into the ore body. Corresponding production wells and pumps promote flow through the ore body and allow for the collection of uranium-rich leach solution. Uranium is removed from the leach solution by ion exchange, and then from the ion exchange resin by elution. The leach solution can then be reused for mining purposes. The elution liquid containing the uranium (the "pregnant" eluant) is then processed by precipitation, dewatering, and drying to produce a transportable form of uranium.

The North Trend Expansion Area (NTEA) is being developed by Crow Butte Resources, Inc. (CBR) in conjunction with their Crow Butte Uranium Project and the Central Process Plant currently permitted under Class III UIC Permit number NE0122611 issued by the NDEQ. The NTEA will be developed by constructing independent wellfields and mining support facilities while utilizing existing processing equipment at the Central Process Plant to the greatest extent possible for uranium recovery. Transfer of recovered leach solutions from the area is prohibitive because of the distance that a relatively large stream would have to be pumped. Therefore, a satellite facility will be constructed in the NTEA to provide chemical makeup of leach solutions, recovery of uranium by ion exchange, and restoration capabilities. The ion exchange processes at the satellite facility serve to recover the uranium from the production solution in a form (loaded ion exchange resin) that is relatively safe and simple to transport by tanker truck to the Central Process Plant for elution and further processing of recovered uranium. Regenerated resin is then transported back to the satellite facility for reuse in the ion exchange circuit.

M.1 Solution Mining Process and Equipment

M.1.1 Ore Body

In the current Permit Area, uranium is recovered by ISL from the Chadron Sandstone at a depth that varies from 400 feet to 800 feet. The overall width of the mineralized area varies from 1,000 feet to 5,000 feet. The ore body ranges in grade from less than 0.05 to greater than 0.5 percent U_3O_8, with an average grade estimated at 0.27 percent U_3O_8.

In the NTEA, uranium will also be recovered from the Chadron Sandstone. The depth in the NTEA ranges from 350 to 700 feet. The width varies from 100 feet to 1,000 feet.

Typical stratigraphic intervals to be mined by the in-situ mining method were shown in the geologic cross-sections contained in Chapter E. For ISL wellfields, the production zone is the geological sandstone unit where the leaching solutions are injected and recovered.

M.1.2 Wellfield Design and Operation

The proposed North Trend Mine Unit map and mine schedule are shown in **Figure A.2-3** and **Figure A.2-4** of Chapter A. The preliminary map and mine schedule are based on CBR's current knowledge of the area. As the NTEA is developed, the mine schedule and a mine unit map will be developed further. The NTEA will be subdivided into an appropriate number of mine units. Each mine unit will contain a number of wellhouses where injection and recovery solutions from the satellite plant building are distributed to the individual wells. The injection and production manifold piping from the satellite process facility to the wellfield houses will be either polyvinyl chloride (PVC), high-density polyethylene (HDPE) with butt-welded joints, or an equivalent. In the wellfield house, injection pressure will be monitored on the injection trunk lines. Oxidizer will be added to the injection stream and all injection lines off of the injection manifold will be equipped with totalizing flowmeters, which will be monitored in the Satellite Facility control room. The NTEA wellfields will be designed in a manner consistent with the existing CBR wellfields.

The wellfield injection/production pattern employed is based on a hexagonal seven-spot pattern, which is modified as needed to fit the characteristics of the ore body. The standard production cell for the five-spot pattern contains four injection wells surrounding a centrally located recovery well.

The cell dimensions vary depending on the formation and the characteristics of the ore body. The injection wells in a normal pattern are expected to be between 65 feet and 150 feet apart. A typical wellfield layout is shown in **Figure M.1-1**. The wellfield is a repeated seven-spot design, with the spacing between injection wells ranging from 65 to 150 feet.

Other well designs include alternating single-line drives. All wells are completed so they can be used as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the groundwater in the most efficient manner. During operations, leaching solution enters the formations through the injection wells and flows to the recovery wells. Within each wellfield, more water is produced than injected to create an overall hydraulic cone of depression in the production zone. Under this pressure gradient, the natural groundwater movement from the surrounding area is toward the wellfield, providing additional control of the leaching solution movement. The difference between the amount of water produced and that injected is the wellfield "bleed." The minimum over-production or bleed rates will be a nominal 0.5 percent of the total wellfield production rate, and the maximum bleed rate typically approaches 1.5 percent. Over-production is adjusted as necessary to ensure that the perimeter ore zone monitor wells are influenced by the cone of depression resulting from the wellfield production bleed. The wellfield bleed is typically disposed in the waste disposal system.

Monitor wells will be placed in the Chadron Formation and in the first significant water-bearing sand above the Chadron Formation. All monitor wells will be completed by one of the three methods discussed in Section N, developed prior to leach solution injection. The development process for monitor wells includes establishing baseline water quality before the initiation of mining operations. The locations of monitor wells for the proposed North Trend Mine are shown in **Figure M.1-2**.

Injection of solutions for mining will be at a rate of 4,500 gallons per minute (gpm) with a 0.5 to 1.5 percent production bleed stream. Production solutions returning from the wells to the production manifold will be monitored with a totalizing flowmeter. All pipelines and trunklines will be leak tested and buried prior to production operations.

A water balance for the proposed North Trend Satellite Facility is shown on **Figure M.1-3.** The liquid waste generated at the Satellite Facility will be primarily the production bleed which, at a maximum scenario, is estimated at 1.5 percent of the production flow. At 4,500 gpm, the volume of liquid waste would be 35,478,000 gallons per year. CBR proposes to adequately handle the liquid waste through the combination of deep disposal well injection and evaporation ponds.

Prior to the injection of leaching chemicals, CBR will recirculate the natural groundwater for a time that may range from 1 day to 1 week. CBR will achieve the following during the groundwater recirculation phase:

- Calibration of the injection/recovery operational systems including surface equipment and final selection of injected procedures,
- Establishment of the circulation pathways between the injection and recovery wells,
- Development of the hydraulic gradients toward the production cells(s) to prevent outward movement of the lixiviant from the very beginning of the production phase, and
- Observation of the Basal Chadron aquifer response to the injection/pumping operations and final adjustment of the rate of overpumping.

After the initial recirculation, injection of lixiviant will be initiated in the injection wells and solution production will be initiated in the recovery wells. The recovered solutions will then be transferred to the Satellite Facility. Regional information, previous CBR permit submittals, and historical operational practices indicate that the minimum pressure that could initiate hydraulic fracture is 0.63 pounds per square inch per foot (psi/ft) of well depth. This value has historically and successfully been applied to CBR operations. In comparison, the injection pressure for the NTEA will be limited to less than 0.62 psi/ft of well depth. This later value of 0.62 psi/ft of well depth was calculated by the use of a U.S. Environmental Protection Agency (USEPA) formula where the maximum injection pressure at the wellhead is used to calculate the fracture gradient formation value (see detailed discussions in Chapter P – Injection Operating Pressures). Injection pressures also will be limited to the pressure at which the well was integrity tested. The injection pressure monitoring system will have a high pressure alarm, and if the pressure exceeds the set point, corrective action will be taken. This corrective action may include shutting down the injection pump.

Monitoring of production (extraction) and injection rates and volumes will enable an accurate assessment of water balance for the wellfields. A bleed system will be employed that will result in less leach solution being injected than the total volume of fluids (leach solution and native groundwater) being extracted. A bleed of 0.5 to 1.5 percent will be maintained during production. Maintenance of the bleed will cause an inflow of groundwater into the production area and prevent loss of leach solution.

Wellhead pressure will be monitored at the injection manifold. Pressure gauges will be installed at each injection wellhead or on the injection manifold and monitored at least daily. Wellhead pressure will be restricted to less than 0.62 psi/ft of well depth. Injection rates will be adjusted to maintain wellhead pressure below that level.

Each new production well casing (extraction and injection) will be pressure tested to confirm the integrity of the casing prior to being used for mining operations. Wells that fail pressure testing will be repaired or cemented and replaced as necessary. Wells that are abandoned will be properly plugged (i.e., cemented) and abandoned as described in Chapter T.

Water level measurements will be routinely performed in the production zone and overlying aquifer. Sudden changes in water levels within the production zone may indicate that the wellfield flow system is out of balance. Flow rates would be adjusted to correct this situation. Increases in water levels in the overlying aquifer may be an indication of fluid migration from the production zone. Adjustments to well flow rates or complete shutdown of individual wells may be required to correct this situation. Increases in water levels in the overlying aquifer may also indicate casing failure in a production, injection, or monitor well. Isolation and shutdown of individual wells can be used to identify the well causing the water level increases.

To ensure that the leach solutions are contained within the designated area of the aquifer being mined, the production zone and overlying aquifer monitor wells will be sampled once every 2 weeks as discussed in Chapter Q.

M.1.3 Process Description

Uranium solution mining is a process that takes place underground, or in-situ, by injecting lixiviant (leach) solutions into the ore body and then recovering these solutions when they are rich in uranium. The chemistry of solution mining involves an oxidation step to convert the uranium in the solid state to a form that is easily dissolved by the leach solution. Hydrogen peroxide (H_2O_2) or gaseous oxygen (O_2) are typically used as oxidants because both revert to naturally occurring substances. Carbonate species are also added to the lixiviant solution in the injection stream to promote the dissolution of uranium as a uranyl carbonate complex.

The reactions representing these steps at a neutral or slightly alkaline pH are:

Oxidation:

$$UO_{2\,(solid)} + H_2O_{2\,(in\ solution)} \longrightarrow UO_{3\,(at\ solid\ surface)} + H_2O$$

$$UO_{2\,(solid)} + \tfrac{1}{2}\,O_{2\,(in\ solution)} \longrightarrow UO_{3\,(at\ solid\ surface)}$$

Dissolution:

$$UO_3 + 2\,HCO_3^{-1} \longrightarrow UO_2(CO_3)_2^{-2} + H_2O$$

$$UO_3 + CO_3^{-2} + 2HCO_3^{-1} \longrightarrow UO_2(CO_3)_3^{-4} + H_2O$$

The principal uranyl carbonate ions formed as shown above are uranyl dicarbonate, $UO_2(CO_3)_2^{-2}$, (UDC), and uranyl tricarbonate $UO_2(CO_3)_3^{-4}$, (UTC). The relative abundance of each is a function of pH and total carbonate strength.

Solutions resulting from the leaching of uranium underground will be recovered through the production wells and piped to the Satellite Facility for extraction. The uranium recovery process utilizes the following steps:

1. Loading of uranium complexes onto an ion exchange resin,
2. Reconstitution of the leach solution by addition of carbon dioxide and/or sodium bicarbonate and oxygen,
3. Elution of uranium complexes from the resin, and
4. Precipitation of uranium.

The process flow sheet for the above steps is shown in **Figure M.1-4**. The left side of this figure depicts the uranium extraction process that is completed at the Satellite Facility. The right side of the figure shows the uranium recovery steps that will be performed at the Central Plant. Once the ion exchange (IX) resin at the Satellite Facility is loaded to capacity with uranium complexes, the resin will be transferred to the Central Plant for the completion of uranium recovery.

M.1.3.1 North Trend Satellite Facility

M.1.3.1.1 Uranium Extraction

The recovery of uranium from the leach solution in the North Trend Satellite Facility will take place in the ion exchange columns. The uranium-bearing leach solution enters the pressurized downflow ion exchange column and passes through the resin bed. The uranium complexes in solution are loaded onto the IX resin in the column. This loading process is represented by the following chemical reaction:

$$2\ R\ HCO_3 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + 2HCO_3^{-1}$$

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

$$R_2SO_4 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + SO_4^{-2}$$

As shown in the reaction, loading of the uranium complex results in simultaneous displacement of chloride, bicarbonate, or sulfate ions.

The now barren leach solution passes from the IX columns to a barren lixiviant trunk line. At this point, the solution is refortified with carbon dioxide, sodium or carbonate chemicals as required and pumped to the wellfield for reinjection into the formation. The expected lixiviant concentration and composition is shown in **Table J-1** of Chapter J.

M.1.3.1.2 Resin Transport

Once the majority of the ion exchange sites on the resin in an IX column are filled with uranium, the column will be taken out of service. The loaded resin with uranium will be transferred to a tanker truck for transport to the Central Plant for elution and final processing.

M.1.3.2 Central Plant

M.1.3.2.1 Elution

At the Central Plant, the loaded resin that has been transported from the satellite facility will be stripped of uranium by an elution process based on the following chemical reaction:

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

After the uranium has been stripped from the resin, the resin is rinsed with a solution containing sodium bicarbonate. This rinse removes the high chloride eluant physically entrained in the resin and partially converts the resin to bicarbonate form. In this way, chloride ion buildup in the leach solution can be controlled.

M.1.3.2.2 Precipitation

When a sufficient volume of pregnant eluant is held in storage, it is acidified to destroy the uranyl carbonate complex ion. The solution is agitated to assist in removal of the resulting carbon dioxide. The decarbonization can be represented as follows:

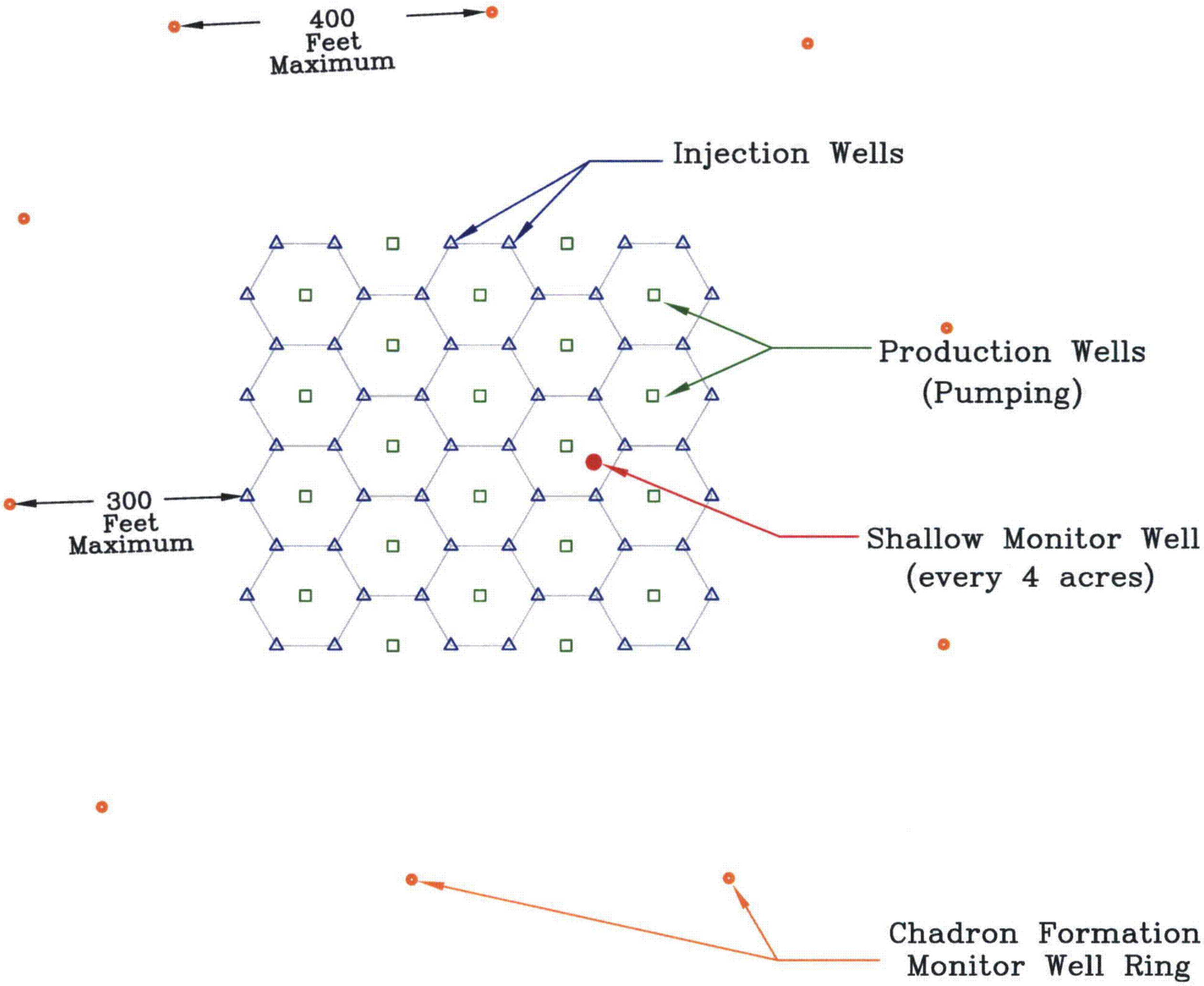
$$UO_2(CO_3)_3^{-4} + 6H^+ \longrightarrow UO_2^{++} + 3\ CO_2\uparrow + 3H_2O$$

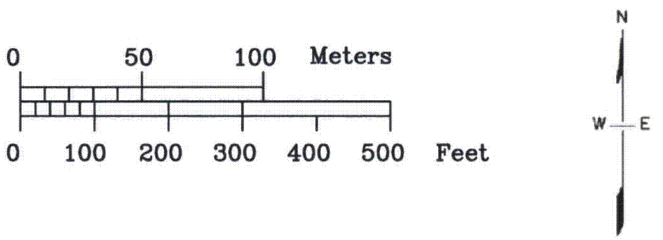
Hydrogen peroxide is then added to the solution to precipitate the uranium according to the following reaction:

$$UO_2^{++} + H_2O_2 + 2H_2O \longrightarrow UO_4 \bullet 2H_2O + 2H^+$$

Once the resin has been stripped of the uranium by the process of elution, the resin will be returned to the North Trend Satellite Facility for reuse in the ion exchange circuit.

The precipitated uranyl peroxide slurry is pH adjusted, allowed to settle, and the clear solution decanted. The decant solution is recirculated back to the barren makeup tank, sent to fresh salt brine makeup, or sent to waste. The thickened uranyl peroxide is further dewatered and washed using a filter. The solids discharge is either sent to the vacuum dryer for drying before shipping or to storage for shipment as slurry to a licensed recovery or converting facility.





CROW BUTTE RESOURCES, INC.

FIGURE M.1-1
TYPICAL WELLFIELD LAYOUT

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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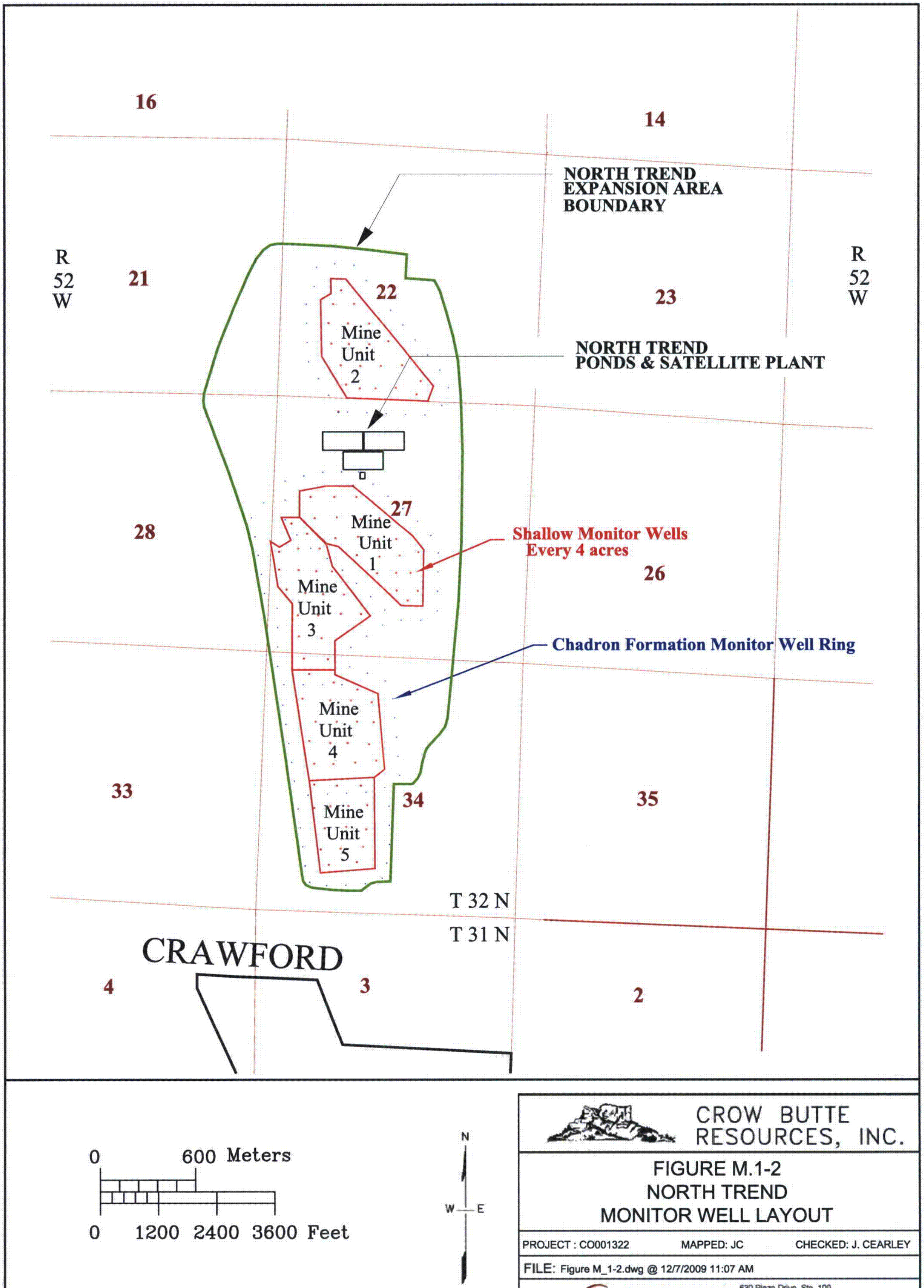

CROW BUTTE RESOURCES, INC.

FIGURE M.1-2
NORTH TREND
MONITOR WELL LAYOUT

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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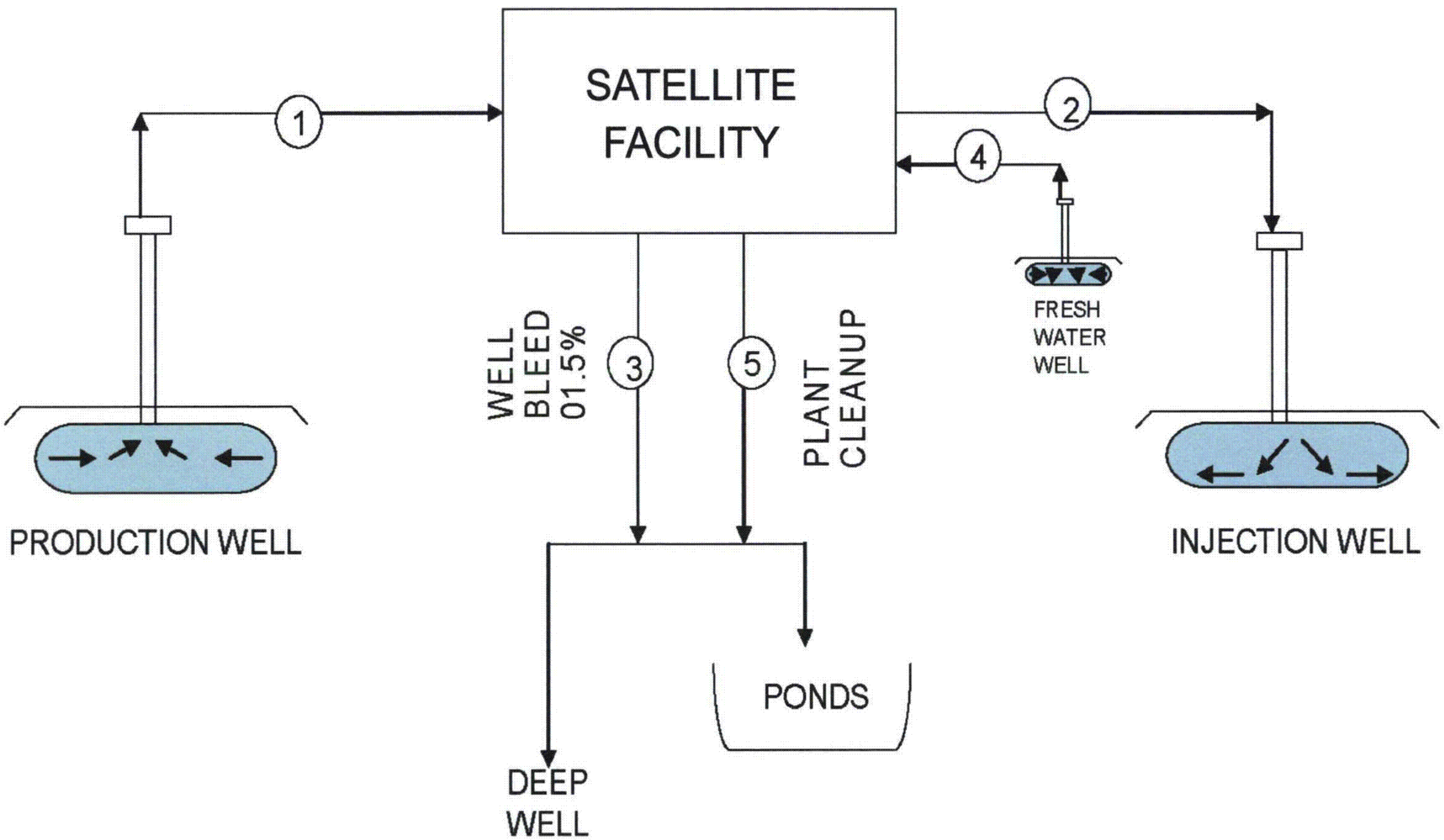
NORTH TREND WATER BALANCE

FOR 1.5% BLEED AND FULL PRODUCTION



STREAM #	1	2	3	4	5
SOLUTION GPM*	4500	4432.5	67.5	2	2

*BALANCE IS NOMINAL FOR A 1.5% BLEED. ACTUAL BALANCE MAY VARY ACCORDINGLY.

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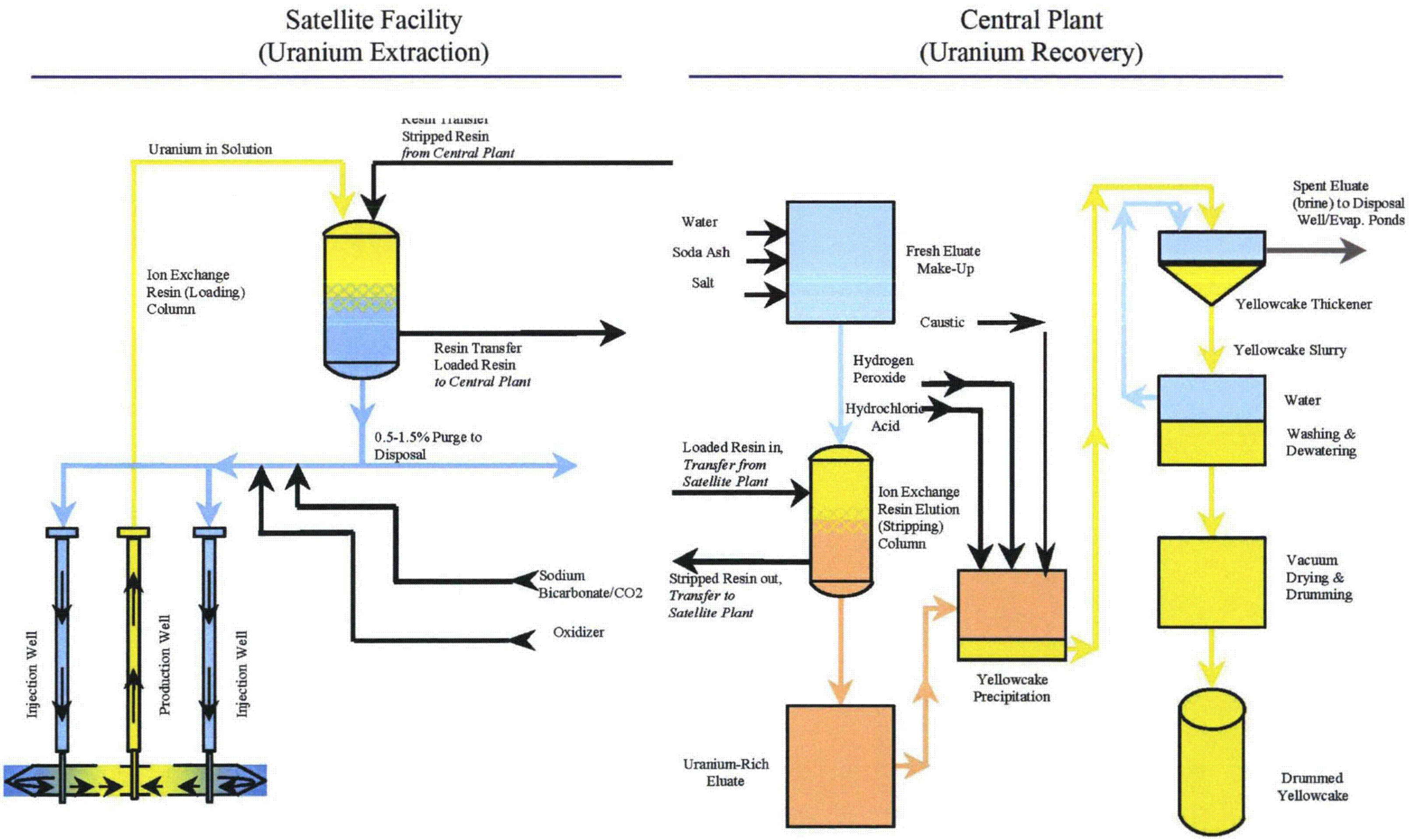
Figure M.1-4 Satellite Facility and Central Plant Process Flow Diagram



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CHAPTER N. WELL CONSTRUCTION/DESIGN AND ASSOCIATED FACILITIES

Design details of the proposed injection well as outlined in Title 122, Chapter 17. Section 002, including but not limited to a cementing and casing program, logging procedures, deviation checks, and other tests.

Engineering drawings of the surface and subsurface construction details of the system (required by Title 122, Chapter 006.20).

N.1 Well Construction and Integrity Testing

The following information concerning the injection zone (water bearing) within the North Trend Expansion Area (NTEA) is determined or calculated for newly constructed Class III wells:

- Fluid pressure,
- Temperature,
- Fracture pressure,
- Other physical and chemical characteristics of the injection zone,
- Physical and chemical characteristics of the formation fluids, and
- Compatibility of injected fluids with formation fluids.

These requirements are discussed in different chapters of this application.

In order to meet NDEQ requirements, the following criteria will be considered in developing a proposed monitoring program, including the number, location, construction and frequency of monitor wells:

- The population relying on the underground source of drinking water (USDW) affected or potentially affected by the injection operation,
- The proximity of the injection operation to points of withdrawal of drinking water,
- The local geology and hydrology,
- The operating pressures and whether a negative pressure gradient is being maintained, and
- The injection well density.

These criteria will be used in preparing and submitting a proposed monitor well program to NDEQ. The NDEQ will make the final determination of the number, location, construction, placement and frequency of monitor wells

All new Class III wells will be cased and cemented to prevent the migration of fluids into or between underground sources of water. The casing and cementing used in construction will be designed for the life expectancy of the well. All Class III well designs will be submitted to the Nebraska Department of Environmental Quality (NDEQ) by a professional engineer.

The following factors are considered when determining and specifying casing and cementing requirements:

- Depth to the injection zone;
- Injection pressure, external pressure, internal pressure, axial loading, etc.
- Hole size;
- Size and grade of all casing strings (wall thickness, diameter, nominal weight, length, joint specification, and construction material);
- Corrosiveness of injected fluids and formation fluids;
- Lithology of injection and confining zones; and
- Type and grade of cement.

Three well construction methods and appropriate casing materials are used for the construction and installation of production and injection wells.

N.1.1 Well Materials of Construction

The well casing material will be polyvinyl chloride (PVC). PVC well casing is 4.5 inch SDR-17 (or equivalent). The PVC casing joints are normally approximately 20 feet long each. With SDR-17 PVC casing, each joint is connected by a watertight o-ring seal which is located with a high-strength nylon spline.

There are two types of well screen that will be used for development of the NTEA – polyvinyl chloride (PVC) and stainless steel (SS). Both types of screens have been used historically for the existing Crow Butte production, injection and monitor wells. SS screens are tougher than PVC screens, are rated for greater depths than PVC screens and can achieve better flow. The SS screens are significantly more expensive than the PVC screens. Currently CBR primarily uses SS screens, but would maintain the option to use PVC screens as necessary based on site conditions and purpose of the borehole.

The PVC well screen consists of a perforated 3-inch PVC pipe. PVC rods run longitudinally along the sides of the pipe. Keystone shaped PVC wire is helically wrapped around the outsides of the pipe and ribs and solvent-welded to the pipe. Spacing between consecutive wraps of the wire varies depending upon the screen ordered. Slot sizes from 0.010 to 0.020 inches have been used successfully at Crow Butte. In most cases, a slot size of 0.020 inches is sufficient to prevent sand entering the screens.

The SS well screen consists of longitudinal ribs of SS with a SS "V" shaped wire wrapped helically around the interior ribbing. The wire is welded to the circular rib array for support. As with PVC screens, slot sizes of 0.010 to 0.020 inches have been used historically at Crow Butte.

N.1.2 Well Construction Methods

Pilot holes for monitor, production, and injection wells are drilled to the top of the target completion interval with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The hole is logged, reamed, casing set, and cemented to isolate the completion interval from all other aquifers. Three well construction methods are described (not necessarily in the order of their preferred use). Any of the methods is appropriate for monitor wells and has been approved by the NDEQ under the UIC Permit. **Final, detailed engineering drawings depicting the construction details of the Class III wells will be submitted to the NDEQ for approval prior to commencement of construction.**

- Method No. 1, shown in **Figure N.1-1**, involves the setting of an integral casing/screen string. The method consists of drilling a hole, geophysically logging the hole to define the desired screen interval, and reaming the hole if necessary to the desired depth and diameter. Next, a string of casing with the desired length of screen attached to the lower end is placed into the hole. A cement basket is attached to the blank casing just above the screen to prevent blinding of the screen interval during cementing. The cement is pumped down the inside of the casing to a plug set just below the cement basket. The cement passes out through weepholes in the casing and is directed by the cement basket back to the surface through the annulus between the casing and the drill hole. After the cement has cured sufficiently, the residual cement and plug are drilled out, and the well is developed by air lifting or pumping.
- Method No. 2, shown in **Figure N.1-2**, uses a screen telescoped down inside the cemented casing. As in the first method, a hole is drilled and geophysically logged to locate the desired screen interval. The hole is then reamed if necessary only to the top of the desired screen interval. Next, a string of casing with a plug at the lower end and weep holes just above the plug are set into the hole. Cement is then pumped down the casing and out the weep holes. It returns to the surface through the annulus. After the cement has cured, the residual cement in the casing and plug are drilled out, with the drilling continuing through the desired zone. The screen with a packer and/or shale traps is then telescoped through the casing and set in the desired interval. The packer and/or shale traps serve to hold the screen in the desired position while acting as a fluid seal. Well development is again accomplished by air lifting or pumping. Minor variations from these procedures may be used as conditions require.
- Method No. 3, as shown in **Figure N.1-3,** is similar to methods 1 and 2. The casing is cemented in place for the entire length, and, after the cement grout has cured, the casing and grout are cut away to expose the interval to be mined or monitored. A screen is then telescoped into the open interval.

Casing centralizers, located at a maximum 100-foot spacing, are run on the casing to ensure it is centered in the drill hole and that an effective cement seal is provided. The purpose of the cement is to stabilize and strengthen the casing and plug the annulus of the hole to prevent vertical migration of solutions. The volume of cement used in each well is determined by estimating the volume required to fill the annulus and ensure cement returns to the surface. In almost all cement jobs, returns to the surface are observed. In rare instances, however, the drilling may result in a larger annulus volume than anticipated, and cement may not return all the way to the surface. In these cases, the upper portion of the annulus will be cemented from the surface to backfill as much of the well annulus as possible and stabilize the wellhead. This procedure is called "topping off".

A well completion report is completed for each well and submitted to the NDEQ. These data are kept available on site for review. All wells constructed into groundwater are constructed by a licensed/certified water well contractor, as defined by Nebraska Health and Human Services System, Water Well Standards and Licensing Act, Article 46.

N.1.2.1 Cement/Grout Specifications

All cement will be American Society for Testing Materials (ASTM) Type I, II or American Petroleum Institute (API) Class B or G and meet the following criteria:

- A density of no less than 11.5 lbs/gal.
- A bentonite grout shall be mixed as close as possible to a concentration of 1.5 lb. bentonite per gallon of water (1 quart polymer per 100 gallons of water may be premixed to prevent the clays from hydrating prematurely) and shall have a density of 9.2 lbs./gal or higher.

N.1.2.2 Logging Procedures and Other Tests

Appropriate geophysical logs and other tests are conducted during the drilling and construction of new Class III wells. The logs and other tests are determined based on the intended function, depth, construction, and other characteristics of the well, availability of similar data in the area of the drilling site, and the need for additional information that may arise from time to time as the construction of the well progresses.

N.1.2.2.1 Logging Equipment

CBR currently owns three operational logging units. All were built by Century Geophysical Corporation in Tulsa, Oklahoma. They are a 2000 model, a 2006 model, and the newest is a 2008 model. These units are capable of logging drill holes to a depth of approximately 2,000 feet.

These trucks are capable of using a wide variety of tools. All of these tools, or probes, as used by CBR, measure Single Point Resistance (RES), spontaneous Potential (SP), Natural Gamma (GAM[NAT]), and Deviation. Some of the probes used by CBR also are capable of measuring temperature, 16-inch normal resistance, and 64-inch normal resistance. All probes used at CBR are of a Century Geophysical design, and include the 9060, 9055, 9144, and 9057 types (**Table N.1-1**). Deviation with these units is measured using a slant angle and azimuth technique. Standardized procedures are used by trained personnel to carry out the logging tasks.

N.1.2.2.2 Borehole Geophysical Logs

As of April 2008, there have been 686 exploration/development holes drilled within the NTEA boundary. A sample portion of a borehole geophysical log (boring SO-9) is shown in **Figure F.3-1 of Chapter F**. Detailed analysis of a carefully chosen suite of borehole geophysics provides a method for interpreting lithology, stratigraphy, depositional environment, and for deriving porosity values, permeability index, and water salinity. The log curves used for interpretation and parameter derivation measure resistivity, electron density, interval travel time, spontaneous potential, natural radioactivity, and hydrogen content.

Log interpretation and parameter evaluation involves analysis of the measured log curve values and responses. The measured curve and resultant analysis are affected by drilling processes, properties of the formation, and limitations of the logging tools themselves. Common hydrogeologic objectives of borehole geophysical logging include: (1) definition and correlation of aquifer or other lithologic units; (2) estimation of aquifer properties such as porosity and permeability; and (3) assessment of physical properties of formation water including conductivity, total dissolved solids, and total hardness. These objectives must be considered in the design, selection, and implementation of an effective logging program.

There are three basic parameters derived or interpreted from borehole geophysical logs: lithology, resistivity, and porosity. From these basic parameters, there are numerous variations that can provide information regarding lithologic identification, correlation, facies evaluation, delineation of permeable and porous zones, and identification of pore fluids. The type of measurements used to determine this information are:

- spontaneous potential
- natural gamma radiation (Ray)
- resistivity/induction
- acoustic velocity (Sonic)
- electron density (bulk density)
- induced radiation effects (neutron)
- caliper (hole size).

The following represent the general log suite at each borehole location.

Gamma ray (GR) tools measure naturally occurring gamma ray radiation emitted spontaneously from the formation by uranium, thorium, and the potassium 40 isotope. Natural gamma logs are powerful tools in lithologic identification and correlation, identification of potential migration pathways, and evaluation of water quality with respect to radionuclides, such as uranium salts. GR logs usually show the clay content in sedimentary rocks, because heavy radioactive elements (potassium, thorium, and uranium-radium) tend to concentrate in clays. While clays and clayey sands are higher in radioactivity, clean sands (no clay content) and carbonates usually exhibit low levels of radioactivity. The GR curve can differentiate among sands, clays, and the gradation between the two. As radioactive elements tend to concentrate in shales and clays, high gamma ray readings reflect high shale or clay content in sedimentary units. Very low levels of radioactive elements or isotopes are present in clean formations (sands, gypsum, and anhydrite) unless contaminants are present such as dissolved potassium or uranium salts, volcanic ash, or granite wash. The tool records counts per second, which should be converted to API units. Natural gamma logs should always be calibrated in API units.

The Spontaneous Potential (SP) log is a measurement of the electrical potential (voltage) that occurs in a boring when fluids of different salinities are in contact. The electrical potential is produced by the interaction of formation water, conductive drilling fluids, and certain ion-selective sediments (clay). Because clays have a very low permeability, and sands a high permeability, the SP can be a valuable lithology indicator. In general, clay-free permeable beds of moderate to low resistivity are sharply defined by the SP curve. High resistivity beds distort the SP currents, flattening the slope of the SP curve at bed boundaries. This causes poor bed boundary definition. In addition, the SP curve is also distorted (depressed or elevated) by permeable zones that contain clay, hydrocarbons, gas, or contaminants.

Single point resistance tools measure the resistance to current flow between a tool electrode and a ground electrode (conventional single point resistance), or between an electrode in the tool and the shell of the tool (differential single point resistance). Response of the log curve is attributed to lithologic units of varying resistance. Resistance increases in freshwater-filled sands or gravels and decreases in shales, clays, silts, and brine-filled sands. Curve values are recorded in ohms. Point resistance tools have a relatively small radius of investigation and poor thin bed resolution in comparison to resistivity tools. These logs are mainly used for correlation of beds.

The Neutron-Neutron (N-N) tool is a direct measurement of variations in the hydrogen content of the formation. A Neutron-Neutron probe takes a direct measurement of the variations in the hydrogen content profile. The neutron probe contains a source of high-energy neutrons (commonly americium-beryllium) with thermal neutron detectors at a fixed distance away from the source. The tool records counts per second, which should be converted to API units. A high count indicates a low porosity, while a low count indicates a high porosity. Neutron logs are influenced by changes in the hole diameter.

Borehole Deviation Logging

Deviation of boreholes is measured using a slant angle and azimuth technique. CBR uses a Century Geophysical Corporation Tool Borehole deviation log tool 9057 or equivalent to record the attitude (dip angle and dip direction) of rock layers in the borehole. Borehole deviation and pad 1 azimuth are recorded in real time, via a deviation package contained within the tool, which contains the X-Y inclinometers and the X-Y-Z magnetometers. From these sensors, the Compu-Log computes and records slant angle, (angle of the tool), and slant angle bearing (tool direction) as the tool proceeds along the borehole path. This device is aligned to correct for spatial indications with pad 1 azimuth. The deviation calibration is performed by recording two CPS rotating logs, and then using the dipmeter calibration to produce a special deviation calibration file.

N.1.2.2.3 Other Testing

Field Observations and Drill Cuttings Analysis

At CBR, subsurface formation lithology mapping and interpretation for boreholes during the drilling and construction of Class III wells are primarily based on field observations and geophysical logging. Field observations during drilling include depth, drilling rate, size of cuttings, and changes in lithology. Drill cuttings may be analyzed for physical and chemical parameters as needed in support of geophysical measurements. For example, drill cuttings were recently collected in the NTEA for four lithostratigraphic units. Sample analyses included x-ray diffraction (XRD) and sieve analysis (i.e., grain size distribution). Of particular importance for this sampling program was a better understanding of the hydraulic characterization of the upper and lower confining units for the Basal Chadron sandstone. This information was required for the Aquifer Exemption Petition.

Core samples may be collected as needed, but coring is typically not needed during the drilling and construction of Class III wells. The types of tests that are conducted on core samples are based on the intended need (e.g., porosity, relative permeability, and lithology).

Groundwater Measurements
Groundwater sampling and water level measurements are two tests typically conducted for new wells. Results of the groundwater sampling and analysis are used to evaluate water quality baseline values for future restoration to groundwater standards, and water level measurements provide for a more detailed understanding of the hydraulic gradient within the proposed NTEA. Groundwater monitoring for new wells is discussed below and in Chapter Q.

N.1.3 Well Development

Following well construction (and before baseline water quality samples are taken for restoration and monitor wells), the wells must be developed to restore the natural hydraulic conductivity and geochemical equilibrium of the aquifer. All wells are initially developed immediately after construction using air lifting techniques. This process is necessary to allow representative samples of groundwater to be collected. Well development removes water and drilling fluids from the casing, sand pack, and borehole walls along the screened interval. The primary goal for well development is to allow formation water to enter the well screen.

Initial well development is generally performed by air lifting and cleanup with a drill rig. The well is developed until the water produced is clear. This can be determined visually or with a turbidimeter. During the final stages of initial development, water samples will be collected in a transparent or translucent container and visually examined for turbidity (i.e., cloudiness and visual suspended solids). Development is continued until clear, sediment-free formation water is produced.

When the water begins to clear, the development will be temporarily stopped and/or the flow rate will be varied. Sampling and examination for turbidity will be continued. When varying the air flow rate no longer causes the sample to become turbid, the initial development will be deemed complete.

Before obtaining baseline samples from monitor or restoration wells, the well must be further developed to ensure that representative formation water is available for sampling. Final development is performed by pumping the well or swabbing for an adequate period to ensure that stable formation water is present. Monitoring for pH and conductivity is performed during this process to ensure that development activities have been effective. The field parameters must be stable at representative formation values before baseline sampling will begin.

Following well development, all well development water will be captured in water trucks specifically labeled and dedicated for such purpose, and equipped with signage indicating that these trucks may only discharge their contents to the lined evaporation ponds. As the signage requires, all well development water will be disposed of in the evaporation ponds.

N.1.4 Well Integrity Testing

Field-testing of all injection, production, and monitor wells is performed to demonstrate the mechanical integrity of the well casing. This mechanical integrity test (MIT) is performed using pressure-packer tests. Every well will be tested after well construction is completed and before it can be placed in service, after any workover with a drill rig or servicing with equipment or procedures that could damage the well casing, at least once every 5 years, and whenever there is any question of casing integrity. To assure the accuracy of the integrity tests, the field pressure gages and a calibrated test gage are periodically compared. The MIT procedures have been approved by the NDEQ and are currently contained in EHSMS Program Volume III, *Operating Manual*. These same procedures will be used at the NTEA.

The following general MIT procedure is used:

- The well is tested after the cement plug at the bottom of the casing has been drilled out. The test consists of placement of one or two packers within the casing. The bottom packer is set just above the well screen, and the upper packer is set at the wellhead. The packers are inflated with nitrogen, and the casing is pressurized with water to 125 percent of the maximum operating pressure (i.e., 125 psi).
- The well is then "closed in" and the pressure is monitored for a minimum of 20 minutes, maintaining 90 percent of the original pressure to pass the test.
- If more than 10 percent of the pressure is lost during this period, the well has failed the integrity test. When possible, a well that fails the integrity testing will be repaired and the testing repeated. If the casing leakage cannot be repaired or corrected, the well is plugged and reclaimed as described in Chapter T.

CBR submits all integrity testing records to the NDEQ for review after the initial construction of a mine unit or wellfield. Test results are also maintained on site for regulatory review.

N.2 North Trend Satellite Facility, Wellfields, and Chemical Storage Facilities

N.2.1 North Trend Satellite Plant Equipment

The process flow sheet for the North Trend Satellite Facility and associated Central Recovery Facility is shown in **Figure M.1-4** of Chapter M.

A general arrangement for the Satellite Facility is shown on **Figure N.2-1**. The North Trend Satellite Facilities will be housed in a building approximately 130 feet long by 100 feet wide. The Satellite Facility equipment includes the following systems:

- Ion exchange,
- Filtration,

- Resin transfer, and
- Chemical addition.

The North Trend Satellite Facility will be located within a 30-acre fenced area in the east ½ of the NW¼, Section 27, T32N, R52W. This area will also contain the evaporation ponds, deep disposal well, and chemical storage areas. **Figure N.2-2** shows the plan view of these facilities.

The satellite plant will house the ion exchange (IX) columns, water treatment equipment, resin transfer facilities, pumps for injection of lixiviant, a small laboratory, and an employee break room. Bulk soda ash, carbon dioxide, oxygen in compressed form, and/or hydrogen peroxide will be stored adjacent to the Satellite Facility or in the wellfield. Sodium bicarbonate and/or gaseous carbon dioxide are added to the lixiviant as the fluid leaves the Satellite Facility for the wellfields. Gaseous oxygen is added to the injection line for each injection well at the wellhouses.

The IX system consists of eight fixed-bed ion exchange columns. The IX columns will be operated as three sets of two columns in series with two columns available for restoration. The IX system is designed to process recovered leach solution at a rate of 4,500 gpm with each column sized at 11.5-foot diameter by 21-foot overall height with 500 cubic feet of resin operated downflow. Once a set of columns is loaded with uranium, the resin is transferred to a truck for transport to the central plant at the Crow Butte facility.

After the IX process, the barren leach solution recovered from the wellfield is replenished with an oxidant and leaching chemicals. The injection filtration system consists of optional backwashable filters, with an option of installing polishing filters downstream. The lixiviant injection pumps are centrifugal type.

N.2.2 Wellfield Equipment

The NTEA will be subdivided into a number of mine units (**Figure A.2-3 of Chapter A**). The typical locations of injection and production wells are shown in **Figure M.1-1** of Chapter M and are discussed in Chapters A and M. Each mine unit will contain a number of wellhouses, where injection and recovery solutions from the Satellite Facility building are distributed to the individual wells. The injection and production manifold piping from the satellite process facility to the wellfield houses will be either PVC or high-density polyethylene (HDPE) with butt-welded joints or an equivalent. In the wellhouse, injection pressure will be monitored on the injection trunk lines. Oxidizer will be added to the injection stream, and all injection lines off of the injection manifold will be equipped with totalizing flowmeters, which will be monitored in the satellite control room. The NTEA wellfields will be designed in a manner consistent with the existing CBR wellfields.

N.2.3 Chemical Storage

Chemical storage facilities at the North Trend Satellite Facility will include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, will be stored outside and segregated from areas where licensed materials are processed and stored. Other non-hazardous bulk process chemicals (e.g., sodium carbonate) that do not have the potential to impact radiological safety may be stored within the satellite facilities.

N.2.4 Process Related Chemicals

Process-related chemicals stored in bulk at the North Trend Satellite Facility will include soda ash, carbon dioxide, oxygen, and/or hydrogen peroxide. Sodium sulfide may also be stored for use as a reductant during groundwater restoration.

N.2.5 Non-Process Related Chemicals

Non-process related chemicals that will be stored at the North Trend Satellite Facility include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of process areas at the Satellite Facility. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet U.S. Environmental Protection Agency (USEPA) requirements.

N.2.6 Evaporation Ponds

The evaporation pond configuration at the North Trend Satellite Facility will be similar to the existing ponds at the current CBR license area. The exact number and capacity of the ponds will depend upon the results of the performance of the deep disposal well test as far as determining the waste water disposal rate. In addition, the pond design cannot be finalized until completion of the site geotechnical assessment. This information is currently not available due to the stage of project development.

The evaporation ponds will be designed to comply with the requirements of the NDEQ, as specified in Title 123. Prior to construction, CBR will submit a construction permit application for review and approval by the NDEQ. In addition, an NRC license amendment application with pond design and specifications, which meet the requirements of the most recent NRC pond design and construction NRC Regulatory Guide 3.11 (USNRC 2008), will be submitted to the NRC prior to pond construction.

N.2.6 Engineering Drawings

The final and detailed engineering drawings for the surface and associated subsurface facilities shall be submitted to the NDEQ for approval prior to commencement of construction.

N.3 Notice of Intent to Operate

Prior to the operation of each mine unit, or any part thereof, CBR shall submit a notice of completion of construction to the NDEQ with the following information:

1. A scaled map indicating the location of all monitoring, production, and injection wells and known archaeological sites.
2. A well completion report for all injection/production well(s).

3. A statement that each Class III well or group of wells utilizing a positive displacement pump shall be equipped with both high- and low-pressure safety switches, which will shut down the pump in case of pressure increase over the authorized pressure or sudden pressure loss.
4. A well completion report for all monitor well(s).
5. The baseline sampling data used to determine the Upper Control Limits (UCLs) and the designation of these limits.
6. The baseline sampling data used to determine the restoration values and CBR's recommendation for wells to be designated as restoration wells in the mine unit.
7. The results of testing that demonstrates the mechanical integrity for all wells by:

   Setting a packer immediately above the completion interval and a packer or wellhead at ground surface. The space between the two will then be pressurized to at least 125 percent of the maximum operating pressure specified in Section Q4. The pressure will be held for a period of 20 minutes maintaining 90 percent of the original pressure to pass the test.

In addition to item 7, the following information shall be provided:

a) A precalculated amount of cement/bentonite grout or benonite grout to fill the annular space of the well along with well records demonstrating the presence of adequate grouting material to prevent material fluid migration.

AND

b) Any other data gathered for the injection and production wells.

8. In addition, CBR shall have available on site for review upon request any other pertinent information which has been compiled, such as:
   a) All available geological and geophysical logging and testing on the well(s).
   b) The results of the formation testing program.
   c) Compatibility of injected materials with fluids in the injection zone and the minerals in both the injection zone and the confining zone.

The Notice of Intent to Operate for each mine unit or partial mine unit will be submitted at least 30 days prior to any injection.

N.4 References

U.S. Nuclear Regulatory Commission (USNRC). 2008. Regulatory Guide 3.11. Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities. Revision 3. November 2008.

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Table N.1-1 Background Information for Logging Probes Used at the North Trend Expansion Area

Logging Tool	Tool Specifications
9060	Natural gamma, Spontaneous Potential, Single Point Resistance
9055	Vertical Deviation, Natural Gamma, Neutron Detector, Neutron Porosity, Spontaneous Potential, Single Point Resistance, Radioactive Source (1 Curie Am241Be)
9144	Natural Gamma, 64 in. Normal Resistivity, 16 in. Resistivity, Fluid Resistivity, Lateral Resistivity 48 in., Spontaneous Potential, Single Point Resistance, Temperature and Delta Temperature, Slant Angle and Aximuth.
9057	Natural Gamma, 64 in. Normal Resistivity, 16 in. Normal Resistivity, Neutron-Neutron, Lateral Resisitivity 48 in., Spontaneous Potential, Single Point Resistance, Temperature and Delta Temperature, Slant Angle and Azimuth

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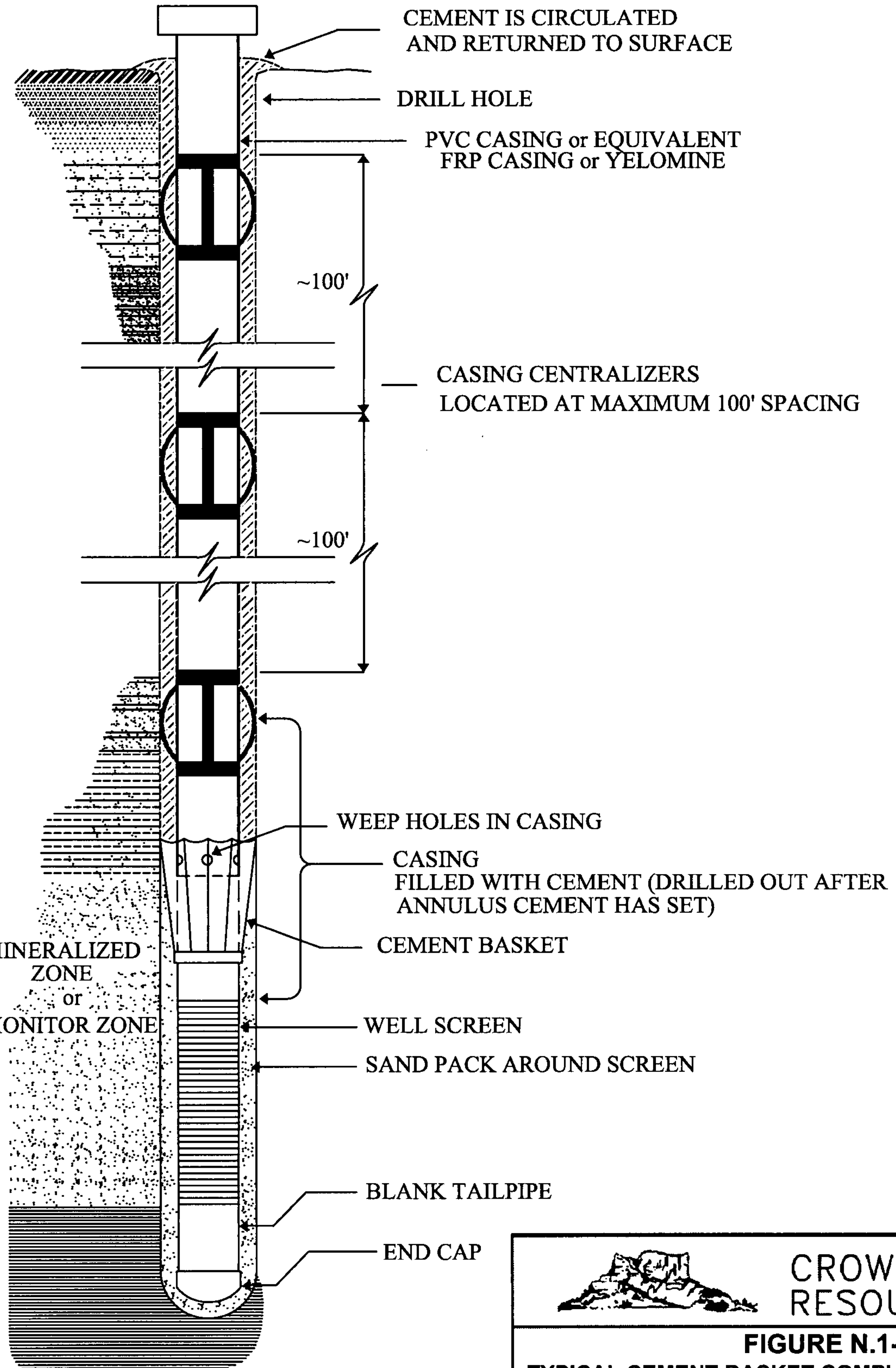

CROW BUTTE RESOURCES, INC.

FIGURE N.1-1

TYPICAL CEMENT BASKET COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS

METHOD NO.1

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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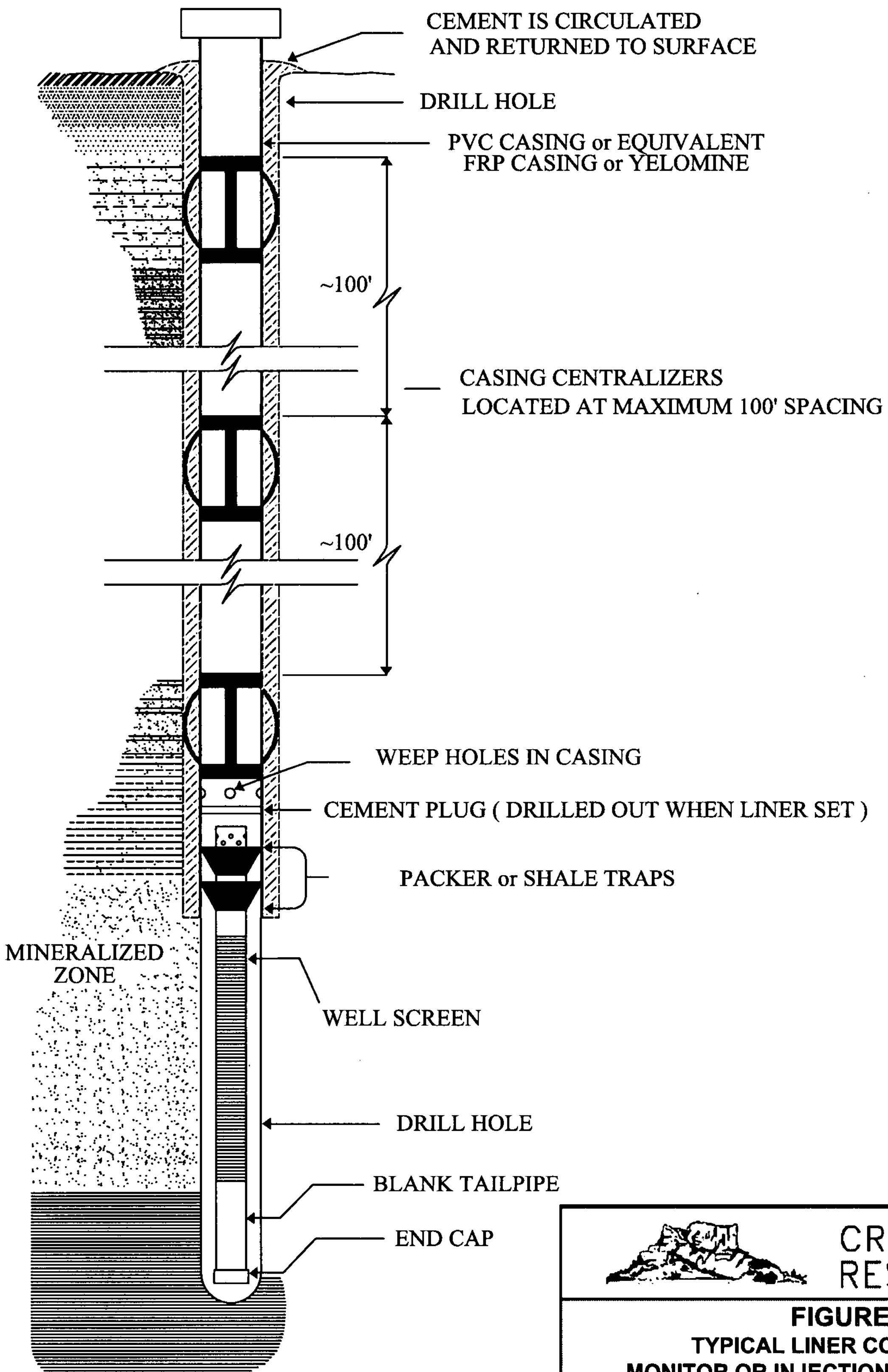

CROW BUTTE RESOURCES, INC.

FIGURE N.1-2
TYPICAL LINER COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS
METHOD NO.2

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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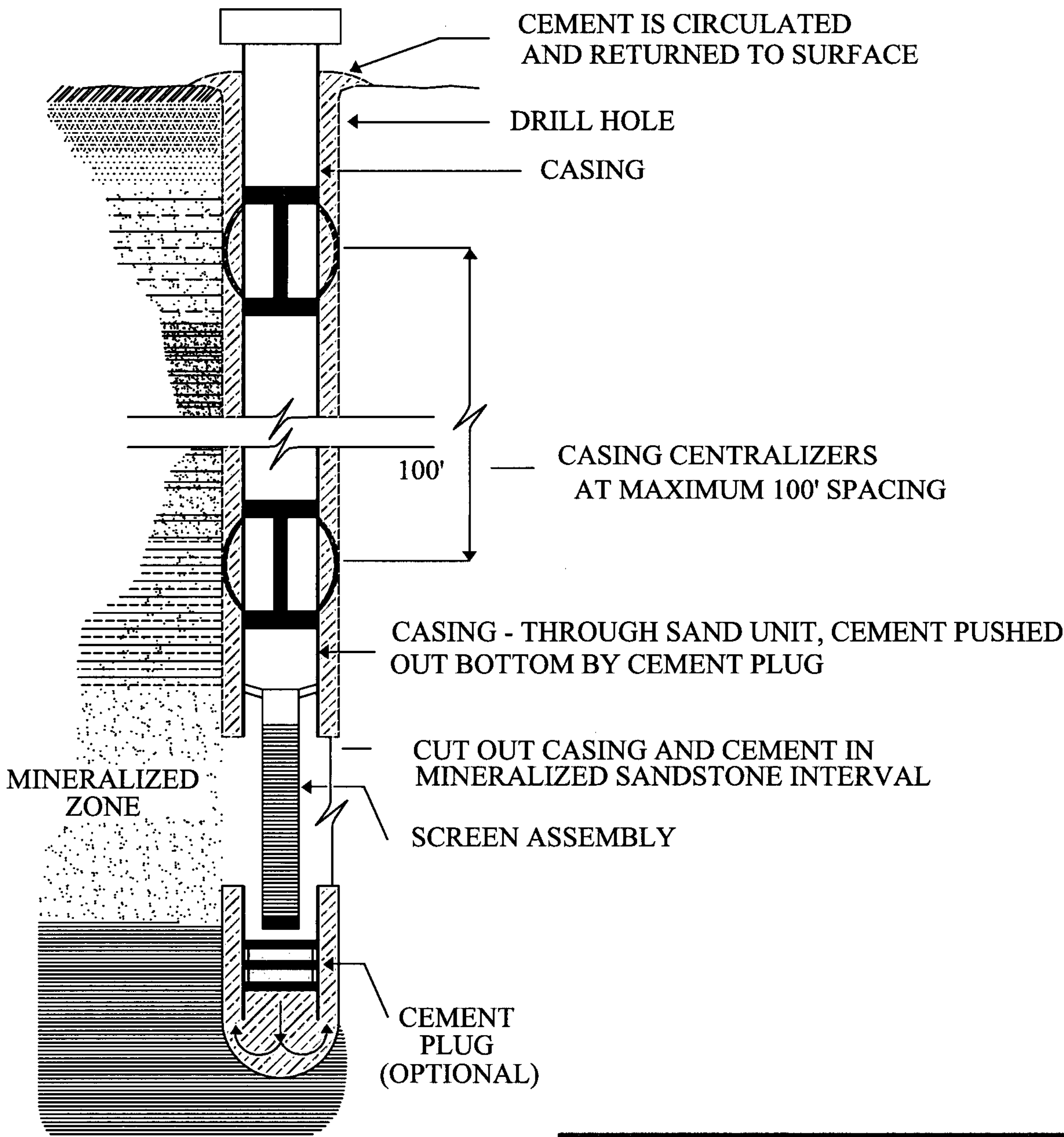

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FIGURE N.1-3

TYPICAL MINERALIZED ZONE COMPLETION FOR INJECTION/PRODUCTION WELLS

METHOD NO.3

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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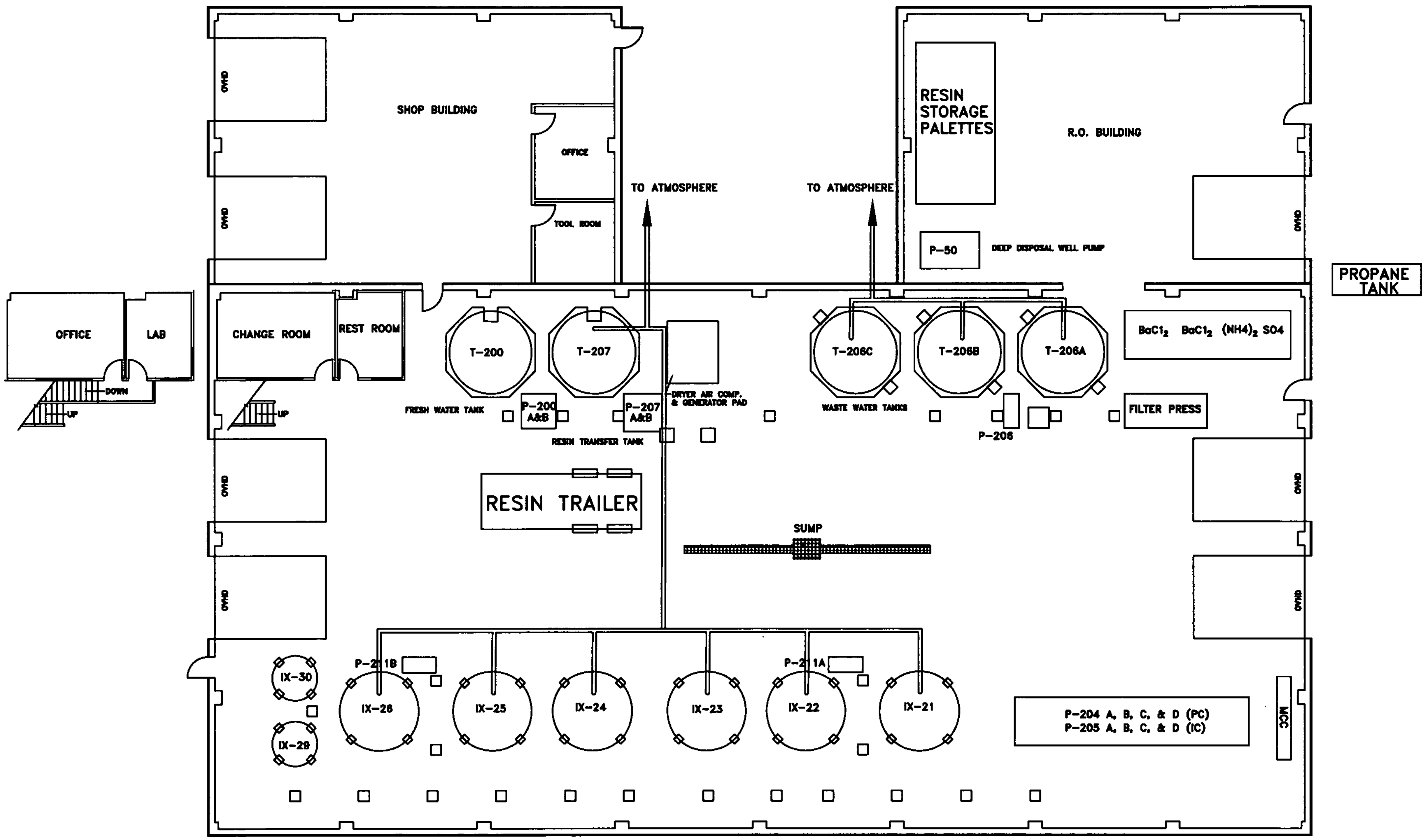

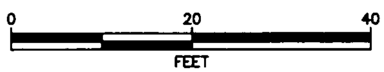

CROW BUTTE RESOURCES, INC.

FIGURE N.2-1
NORTH TREND
SATELLITE LAYOUT

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

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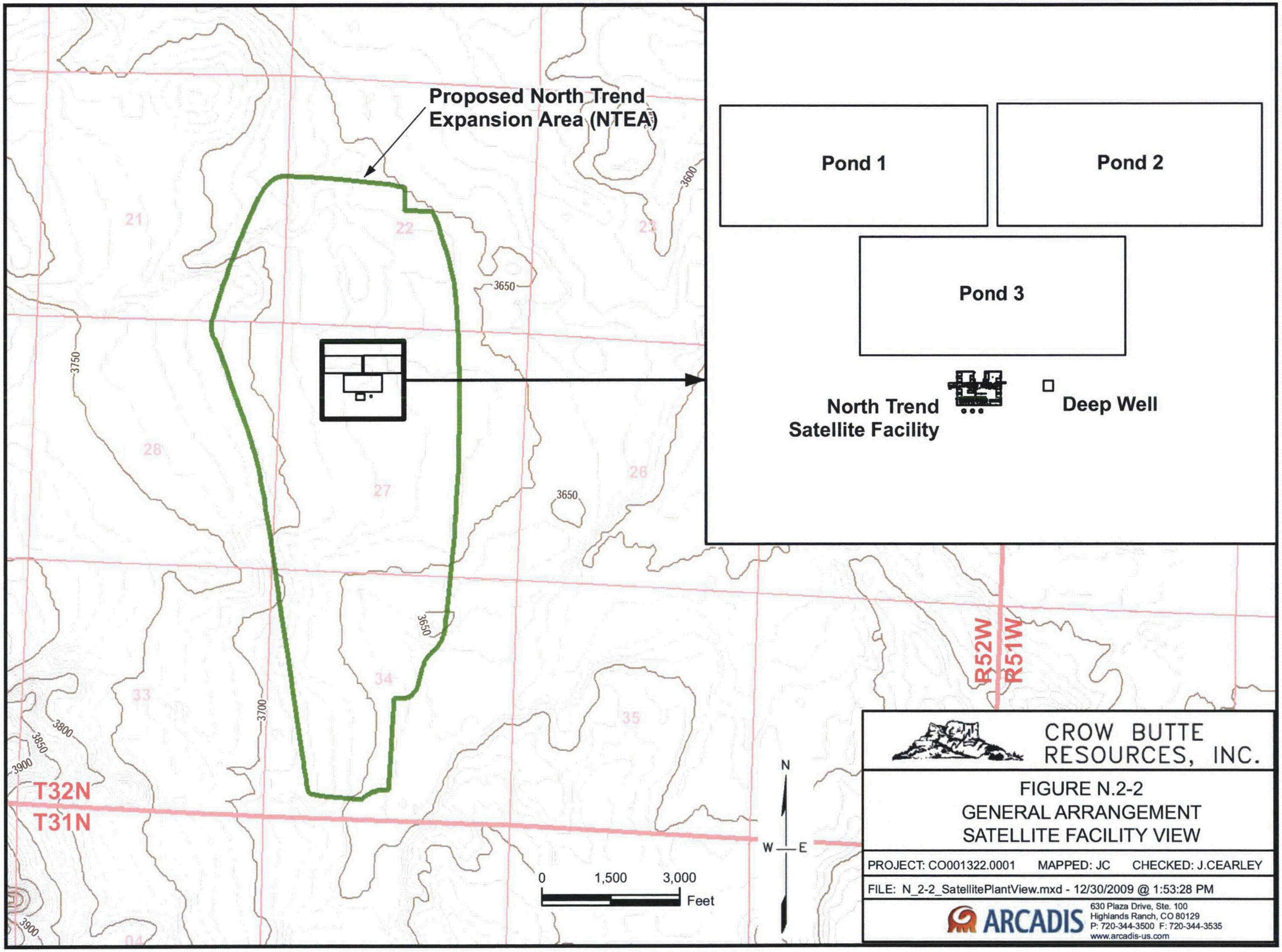

CROW BUTTE RESOURCES, INC.

FIGURE N.2-2
GENERAL ARRANGEMENT
SATELLITE FACILITY VIEW

PROJECT: CO001322.0001 MAPPED: JC CHECKED: J.CEARLEY

FILE: N_2-2_SatellitePlantView.mxd - 12/30/2009 @ 1:53:28 PM

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CHAPTER O. CONTINGENCY PLANS FOR WELL SHUT-INS AND FAILURES

A contingency plan to cope with well shut-ins or failures so as to prevent migration of injection fluids into any underground source of drinking water.

O.1 Contingency Plans

The Nebraska Department of Environmental Quality (NDEQ) has authority for groundwater protection including the proper plugging and abandonment of wells. Improperly plugged and abandoned wells can allow contamination of groundwater resources through the influence of surface contamination or mixing between formations with different groundwater quality. Proper plugging and abandonment of mining and monitor wells located at the North Trend Expansion Area (NTEA) will be regulated under NDEQ Rules and Regulations, Title 122, *Rules and Regulations for Underground Injection and Mineral Production Wells* and the Class III Underground Injection Control (UIC) Permit.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, and improperly abandoned exploration wells. Crow Butte Resources, Inc. (CBR) controls such potential vertical excursions through rigorous well construction, abandonment, and testing requirements. Construction and integrity testing methods are discussed in detail in Section N – Well Construction & Associated Facilities. Wells are abandoned in accordance with methods approved and monitored by the NDEQ and discussed in detail in Section T.1 – *Well Plugging and Abandonment*. Procedures for wellfield reclamation are also contained in CBR's Environmental Health and Safety Management System (EHSMS) Program Volume VI, Section 12 – *Crow Butte Wellfield Reclamation* (CBR 2008). Applicable actions addressed in these documents pertaining to shut-ins and well failures are addressed in this section.

Several controls are in place to prevent the migration of fluids to overlying aquifers. CBR will plug all exploration holes to prevent commingling of the Brule and Chadron aquifers and to isolate the mineralized zone. In addition, prior to placing a well in service, a well mechanical integrity test (MIT) will be performed. This requirement of the NDEQ UIC Program ensures that all wells are constructed properly and capable of maintaining pressure without leakage. Finally, monitor wells completed in the overlying aquifer will be sampled regularly for the presence of leach solution.

Should upward fluid migration be detected, injection will be shut in until proper plugging can be accomplished. The NDEQ will be notified as required in Title 122, Chapter 21 – *Reporting Requirements*. Should any problems be detected in the casing of an injection well, the well will be repaired and must pass an MIT before it can be placed in service.

Typically, the reasons for shutting in and abandoning a well fall into the following categories:

- The well is damaged or well performance cannot be restored.

Fracturing of a well casing and casing damage due to maintenance operations (e.g., workover with a drill rig or servicing with equipment) are two potential examples of situations requiring well replacement.

The second category of well failures may be typified by a well which, due to formation damage or other reasons, will not respond to treatment allowing adequate injections or production.

Should a well failure be detected, the well will be integrity tested per Section Q.4 – *Well Integrity Testing*, to try and determine the nature of the failure. If repair is feasible, the well will be repaired and integrity tested again. If the well passes the integrity testing, it will be put back into service and monitored closely. Should the well fail integrity testing, or should it be beyond repair, it will be plugged and abandoned in accordance with Section T –*Plugging and Abandonment Plan.*

- Newly constructed wells may occasionally be unusable for two reasons:
  - The well will not pass an integrity test and cannot be successfully repaired; or
  - The casing string is too crooked to allow drilling out the cement grout or under-reaming of the casing at the proper depth.

If the well to be plugged does not pass an integrity test, it will be plugged using the following procedure:

- A mechanical plug may be placed above the screened interval at the discretion of the Site Geologist or his designee.
- Thirty to 50 feet of coarse bentonite chips will be added to provide a grout seal.
- An approved bentonite-based hole-plugging product or cement grout will be placed by tremie pipe from the chips to the top of the casing. The weight of the gel or grout plus the weight of the bentonite chips will be enough to exceed the local Chadron Formation pressure plus the maximum injection pressure allowed (100 pounds per square inch [psi]).
- The tremie pipe will be removed (when possible), and the casing will be filled to the surface.
- The well casing will be capped but will not be cut off below ground level at this time in order to monitor the casing for any problems which may arise.
- If the well to be plugged is too crooked to be completed, it is still effectively sealed to prevent groundwater migration. Therefore, cement grout or bentonite plugging product will be placed with a tremie pipe as deep as possible into the open portion of the well casing and filled to the surface. These wells will not be cut off below the ground level for monitoring purposes.

The type of plugging fluid, volume, and density shall be measured and recorded for all plugged and abandoned wells. Per the requirements of Title 122, Chapter 35, CBR will submit a notarized affidavit to the NDEQ detailing the significant data and the procedure used in connection with each well plugged. The affidavit will be signed by a qualified witness to the plugging procedure. For an individual well, the affidavit will be submitted within 15 days after the plugging is complete.

The Nebraska Department of Natural Resources (DNR) also requires filing of a well abandonment notice for registered wells. The DNR report is to be filed within 60 days of the decommissioning of the well.

O.2 References

Crow Butte Resources, Inc. (CBR). 2008. *Environmental Health and Safety Management System, Volume VI, Environmental Manual.*

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CHAPTER P. INJECTION OPERATING PRESSURES

Proposal for maximum injection pressure at the wellhead and injection zone.

P.1 Regulatory Requirements

Nebraska Department of Environmental Quality (NDEQ) Title 122, Chapter 19, Section 002.02 requires that the injection pressure at the wellhead of Class III underground injection control (UIC) injection wells shall not exceed a maximum, which shall be calculated to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause migration of injection or formulation fluids into an underground source of drinking water. Injection pressures will also be limited to the pressure at which the well was integrity tested. U.S. Environmental Protection Agency (USEPA) Regions 3, 4, 6, 8, 9, and 10 allow for use of a default value of 0.733 pounds per square inch per foot (psi/ft) for formation gradient pressure in a number of states, whereas USEPA Region 5 allows use of a default value of 0.80 psi/ft (**Table P.1-1**). The NDEQ has previously approved a fracture pressure gradient of 0.63 psi/ft at depth for the nearby operating Crow Butte facility.

P.2 North Trend Injection Pressure Requirements

The maximum injection pressure to be used for the North Trend Expansion Area (NTEA) wellfield operations will be limited to 100 psi at the wellhead, with an average of 96.4 psi. These pressures are required in order to keep the oxidant (oxygen) in solution. This maximum value has historically and successfully been applied to the nearby Crow Butte Resources, Inc. (CBR) operations, which is below the pressures passing the mechanical integrity testing for injection wells. Based on these wellhead injection pressures, the maximum injection pressure shall not exceed 0.62 psi/ft of well depth or the maximum operating pressure of the injection piping. Operating with an average injection pressure of 100 psi at the wellhead, and the maximum 0.62 psi/ft of well depth, provides a factor of safety to avoid fracturing the formation at the depths and piezometric surfaces encountered in the vicinity of the wellfield or cause migration of injection or formation fluids into another underground source of drinking water (requirements of NDEQ Title 122, Chapter 19, Section 002.02). This maximum wellhead injection pressure and resulting pressure at well depth will be significantly lower than pressures allowed by the USEPA that are based on default formation gradient pressure values (**Table P.1-1**).

The injection pressure monitoring system will have a high-pressure alarm and, if the pressure exceeds the set point, corrective action will be taken. This corrective action may include shutting down the injection pump.

In summary, operating at a maximum wellhead injection pressure of 100 psi, with a maximum formation gradient of 0.62 psi/ft at depth, will result in the North Trend operations meeting the requirements of NDEQ Title 122, Chapter 19, Section 002.02. In addition, the calculated fracture pressure gradient is well below default levels allowed by the USEPA for a number of other states. The nearby CBR facility is a similar operating facility that has operated successfully using similar pressures within a comparable geologic setting since 1991.

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Table P.1-1 Maximum Injection Pressure and Formation Gradient Comparisons

Regulatory Agency	Allowable Maximum Injection Pressure at Wellhead (psi)	Formation Gradient Pressure (psi/ft)	Formation Depth (Feet) [top of production zone]
USEPA[a]	160	0.733 [419 psi at 572 feet]	
USEPA[b]	196	0.80 [458 psi at 572 feet]	572[d]
CBR[c]	**100**	**0.62** **[355 psi at 572 feet]**	

[a] USEPA formula used to calculate maximum injection pressure using fracture gradient formation default value of 0.733 psi/ft [40 CFR 147 (the same formula is used for a number of states, including Colorado, Montana, Oklahoma, California, Nevada, Oregon, Pennsylvania, Kentucky, and Florida)].

Pm = (0.733-0.433Sg)d

Where :

Pm = injection pressure at the well head

0.733 = default value for the fracture gradient in units of pounds per square inch (psi) per foot (ft)

0.433 = normal hydrostatic pressure gradient of a column of fresh formation water of depth.

Sg = specific gravity of the injection fluid (i.e., lixiviant); CBR value is 1.005

d = injection well depth in feet (average depth of 572 feet bgs for top of production zone in the NTEA)

[b] Using USEPA Region 5's fracture pressure gradient formation default value of 0.80 psi/ft in the above-referenced USEPA formula. States allowed to use this default value include Michigan, Indiana, and Ohio.

[c] The NDEQ has previously approved a maximum wellhead injection pressure of 100 psi and a resulting 0.63 psi/ft formation pressure gradient for the current nearby CBR facility. These pressures have proven to be compatible for a geologic setting similar to the NTEA.

[d] Refers to an average depth of 572 feet bgs for screened interval at top of production zone in the NTEA; based on seven wells currently completed in or nearby the NTEA: COW-1, COW-2, COW-3, COW-4, COW-5, COW-6 and CPW-2). Note: COW-1 is located approximately 1,125 feet outside the permit boundary (Figure H.2-1).

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CHAPTER Q. MONITORING PROGRAM

Discussion of equipment and procedures to meet the following monitoring requirements:

Q1. Analysis of the physical and chemical characteristics of the injected fluid with sufficient frequency to yield representative data on its characteristics.

Q2. Devices to continually monitor the injection pressure, flow rate and volume of injection fluids.

Q3. Devices to continually monitor the pressure on the annulus between the tubing and the long string of casing.

Q4. Mechanical integrity testing of injection well according to Title 122, Chapter 18.

Q5. Number and location of monitor wells used to monitor any migration of injection fluids into or pressure changes in the underground source of drinking water. Number of designated restoration monitor wells following cessation of mining.

Q6. Evaporation Pond Monitoring Requirements.

Q7. Standard Monitoring Conditions

Q.1 Characteristics of the Injected Fluid

For the injection of sodium carbonate/bicarbonate and an oxidant, or a restoration reductant to the wells designated as injection wells, CBR proposes to utilize the injection well limitations shown in **Tables Q.1-1** and **Q.1-2**.

Sample(s) taken in compliance with the injection requirements specified in **Tables Q.1-1** and **Q.1-2** would be collected at the following locations:

a. Injection pressure from a gauge on the manifold.
b. Injection totalizer from flow meter downstream of any filters after chemicals are added but before oxidant addition.
c. Injection fluid (physical and chemical characteristics) downstream from filter after chemicals are added but before oxidant addition.

The injection filters may be located in the main Satellite Facility, downstream of the injection pumps. Samples of lixiviant would be collected from the injection pipeline downstream of the injection filters, immediately before the pipeline leaves the main Satellite Facility building. Samples collected here would be analyzed daily for chloride, sulfate, sodium, total alkalinity and pH.

Injection fluid properties are discussed in Chapter J, and injection operating pressures are discussed in Chapter P.

Q.2 Monitoring Devices

Q.2.1 Instrumentation and Control

The wellfield houses will be located remotely from the Satellite Facility building. A distribution system will be used to control the flow to and from each well in the wellfield. Wellfield instrumentation will be provided to measure total production and injection flow and to indicate the pressure that is being applied to the injection trunklines. Wellfield houses will be equipped with wet alarms to monitor the presence of liquids in the wellfield house sumps.

Instrumentation will be provided to monitor the total flow into the Satellite Facility, the total injection flow leaving the plant, and the total waste flow leaving the plant. Instrumentation will be provided on the plant injection manifold to record an alarm in the event of any pressure loss that might indicate a leak or rupture in the injection system. The instruments used for flow measurement will include, but are not limited to, turbine meters, ultrasonic meters, variable area meters, electromagnetic flow meters, differential pressure meters, positive displacement meters, piezoelectric and vortex flow meters. The injection pumps will be sized or equipped so that they are incapable of producing pressures high enough to exceed design pressure of the injection lines or the maximum pressure to be applied to the injection wells. Pressure gauges, pressure shutdown switches and pressure transducers will be used to monitor and control the trunkline pressures.

The basic control system at the Crow Butte site will be built around a Sequential Control and Data Acquisition (SCDA) network. At the heart of this network is a series of programmable logic controllers. This system allows for extensive monitoring and control of all waste flows, wellfield flows, and recovery plant operations.

The SCDA system will be interconnected throughout the facility via a Local Area Network (LAN) to many computer display screens. The software used to display plant processes and collect data incorporates a series of menus which allows the plant operators to monitor and control a variety of systems and parameters. Critical processes, pressures, and wellfield flows will have alarmed set-points that alert operators when any parameters are out of tolerance. In addition, each wellfield house will contain its own processor, which will allow it to operate independent of the main computer. Pressure switches will be fitted to each injection manifold in the Header House to alert the plant and wellfield operators of increasing manifold pressures. All critical equipment will be equipped with uninterruptible power supply (UPS) systems in the event of a power failure.

Through this system, not only will the plant operators be able to monitor and control every aspect of the operation on a real-time basis, but management will be able to review historical data to develop trend analysis for production operations. This will not only ensure an efficient operation, but will allow Crow Butte personnel to anticipate problem areas and to remain in compliance with appropriate regulatory requirements.

In the process areas, tank levels may be measured in chemical storage tanks as well as process tanks.

Detailed information on the instrumentation and controls will be developed as part of the final design activities prior to construction. This information will be made available to the NDEQ for review prior to any construction activities.

Q.3 Annulus Pressure Monitoring

Due to the construction and testing methods required for Class III wells and described in Chapter N, the annular space around the well casing is filled with cement during construction. Therefore, there will be no need to continually monitor the pressure on the annulus between the tubing and the long string of casing.

Q.4 Well Integrity Testing

Field-testing of all injection, production, and monitor wells will be performed to demonstrate the mechanical integrity of the well casing. This mechanical integrity test (MITs) will be performed using pressure-packer tests. Every well will be tested after well construction is completed and before it can be placed in service, after any workover with a drill rig or servicing with equipment or procedures that could damage the well casing, at least once every 5 years, and whenever there is any question of casing integrity. To assure the accuracy of the integrity tests, the field pressure gages and a calibrated test gage will be periodically compared. The MIT procedures have been approved by the Nebraska Department of Environmental Quality (NDEQ) for the current Crow Butte Resources, Inc. (CBR) operations and are currently contained in CBR's Environmental Health and Safety Management System (EHSMS) Program Volume III, *Operating Manual* (CBR 2003a). These same procedures will be used at the North Trend Expansion Area (NTEA).

The following general MIT procedure is used:

- The well is tested after the cement plug at the bottom of the casing has been drilled out. The test consists of placement of one or two packers within the casing. The bottom packer is set just above the well screen, and the upper packer is set at the wellhead. The packers are inflated with nitrogen, and the casing is pressurized with water to 125 percent of the maximum operating pressure (125 psi).
- The well is then "closed in", and the pressure is monitored for a minimum of 20 minutes.
- If more than 10 percent of the pressure is lost during this period, the well has failed the integrity test. When possible, a well that fails the integrity testing will be repaired and the testing repeated. If the casing leakage cannot be repaired or corrected, the well is plugged and reclaimed as described in Chapter T. CBR submits all integrity testing records to the NDEQ for review after the initial construction of a mine unit or wellfield. Test results are also maintained on site for regulatory review.

Q.5 Monitor Wells

Q.5.1 Monitoring Program Description

The environmental water monitoring program includes the routine monitoring and analysis of water samples within the permitted areas and surrounding environs to ensure compliance with federal and state rules and regulations and company policies. The water monitoring programs are designed to provide maximum surveillance for environmental control and are based on many years of monitoring experience in conjunction with guidance and suggested practices from numerous regulatory agencies.

During operations at the North Trend Satellite Facility, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. CBR's operational water monitoring program includes the evaluation of groundwater within the permit area.

Q.5.1.1 Groundwater Monitoring for Operations

The groundwater excursion monitoring program will be designed to detect excursions of lixiviant into the ore zone aquifer outside of the wellfield being leached into the overlying water bearing strata. The Pierre Shale below the ore zone is more than 1,200 feet thick and contains no water-bearing strata. Therefore, it is not necessary to monitor any water-bearing strata below the ore zone

Q.5.1.1.1 Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells will be installed no farther than 300 feet from the wellfield boundary and no farther than 400 feet apart. After completion, wells will be washed out and developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears stable and consistent with the anticipated quality of the area. After development, wells will be sampled to obtain baseline water quality. For baseline sampling, wells will be purged before sample collection to ensure that representative water is obtained. All monitor wells, including ore zone and overlying monitor wells, will be sampled three times at least 14 days apart. Samples will be analyzed for chloride, conductivity, and total alkalinity as specified in **Table Q.5-1**. Results from the samples will be averaged arithmetically to obtain a baseline value as well as a maximum value for determination of upper control limits (UCLs) for excursion detection. Well development and sampling will be performed in accordance with the instructions contained in CBR's EHSMS Program Volume VI, *Environmental Manual* (CBR 2003b).

A typical wellfield layout is shown in **Figure M.1-1** of Chapter M. The cell dimensions will vary depending on the formation and the characteristics of the ore body. The typical locations of monitor wells for the proposed NTEA are shown in **Figure M.1-2** of Chapter M. As the NTEA is further developed, the mine unit map (i.e, wellfield and monitor well layout) will be developed in detail and submitted to the NDEQ for approval.

- Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, UCLs will be set for chemical constituents that would indicate a migration of lixiviant from the wellfield. The constituents chosen as indicators of lixiviant migration and for which UCLs are set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a highly mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion, as bicarbonate is the major constituent added to the lixiviant during mining. Water levels will be obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits are set at 20 percent above the maximum baseline concentration for the excursion indicator. For excursion indicators with a baseline average below 50 mg/L, the UCL may be determined by adding 5 standard deviations or 15 mg/L to the baseline average for the indicator.

Operational monitoring would consist of sampling the monitor wells on a biweekly basis and analyzing the samples for the excursion indicators (**Table Q.5-1**). In addition, all shallow monitor wells designed to monitor water quality in the Brule Aquifer will, as a minimum, be analyzed annually for uranium and radium-226 to the lowest detection limit available.

- Excursion Verification and Corrective Action

If a single parameter UCL is exceeded or if two or more multiple parameter UCLs are exceeded for a particular well, a verification sample will be collected within 24 hours from the time the first analysis is available. If the second sample does not indicate exceeded UCLs, a third sample shall be taken within 48 hours of the time the first sample was taken.

If the second or third samples indicate an exceeded UCL, the well in question shall be placed on excursion status and monitored on a weekly basis. The NDEQ will be notified by telephone within 24 hours from the time the confirmation sample was taken. The laboratory data from all the samples and a plan of corrective action will be mailed to the Department. These data will be postmarked within 5 days from the time the confirmation sample was taken. In the event neither the second nor third samples indicate exceeded UCLs, then the well shall be returned to its regular sampling frequency.

When three consecutive 1-week sample results are below the exceeded UCL, the excursion status shall be removed from the well. Weekly sampling shall continue for an additional 3 weeks. If the UCL is not exceeded, then biweekly sampling shall resume. Should an excursion occur, a formal report shall be submitted with the quarterly report containing all lab data and the results of the corrective actions performed. If corrective actions have not been effective within 90 days of the excursion confirmation, the injection of fluid shall be terminated in the affected area. Resumption of the injection shall not occur until receipt of approval from the NDEQ Director. All wells on excursion status will continue to be sampled weekly until the excursion is concluded. The wells are sampled weekly until three consecutive 1-week samples are below the exceeded UCL(s). Weekly sampling then continues for an additional three weeks. If no UCL's are exceeded during this sampling period then the biweekly sampling resumes.

Upon receipt of pertinent monitoring data and prior to operation, the UCLs for the monitor wells shall be calculated using the following methods:

i. Determine the maximum recorded value from preoperational sampling and multiply the value by 1.20 to calculate the multiple parameter value.
ii. For those monitor wells where the baseline average of the indicator parameter is 50 mg/L or less, the multiple parameter UCL shall be calculated as equal to 20 percent above the maximum concentration measured for the parameter, baseline average for the parameter plus 5 standard deviations, or baseline average plus 15 mg/L.
iii. Multiply the multiple parameter value by 1.20 to calculate the single parameter value.

These values will be rounded off to the nearest unit.

The samples taken in compliance with the monitoring requirements specified above shall be collected at the well head or at a location approved by the Director. Pumping or air lifting shall be used to evacuate at least one casing volume, and the pH and conductivity shall be allowed to stabilize prior to sampling. Sample filtering, preservation, and hold times shall be in accordance with the latest edition of the U.S. Environmental Protection Agency's (USEPA's) Approved Methods for Sampling and Sample Preservation of Water and Wastewater (APHA 2005, USEPA 1983).

If an excursion is verified, the following methods of corrective action are instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation is completed to determine the probable cause.
- Production and/or injection rates in the vicinity of the monitor well are adjusted as necessary to increase the net over recovery, thus forming a hydraulic gradient toward the production zone.
- Individual wells are pumped to enhance recovery of mining solutions.

Injection into the wellfield area adjacent to the monitor well may be suspended. Recovery operations continue, thus increasing the overall bleed rate and the recovery of wellfield solutions.

Q.5.1.2 Groundwater Monitoring during Restoration

Upon the construction of a new mine unit, one baseline restoration well per 4 acres within the mine unit will be sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. All of the premining sampling of the baseline restoration wells will be at least 300 feet from any active mine unit. The samples shall be collected at least 14 days apart and would be analyzed for the parameters listed in **Table Q.5-2.**

Once mining has ceased in each mine unit, the NDEQ shall be notified in writing and shall proceed to establish the post-mining water quality for all of the parameters listed in the **Table Q. 5-2** for the designated restoration wells, subject to change per NDEQ requirements. This task shall be accomplished by collecting a sample of the lixiviant injected into the mine unit to be representative of the post-mining water quality.

A written restoration plan shall be submitted, including a stabilization period of least 6 months for that mine unit, and after NDEQ approval, restoration will begin. The NDEQ may require additional wells be installed for evaluating the success of restoration efforts. When restoration is deemed to have been completed, sampling and analysis of all designated restoration wells for all of the parameters listed in the approved restoration table shall be completed. See Section T.2 for more detailed discussions of the proposed restoration program including groundwater restoration methods, stabilization phase, and basis of restoration goals.

There shall be a minimum of one injection or production well per acre in each mine unit designated as a restoration well. There shall be a minimum of 10 restoration wells per mine unit. The production well of each standard injection well pattern shall be designated as the restoration well. If there is more than one standard injection well pattern per acre, the production or injection well which is centrally located will be designated as the restoration well. Any monitor well which has an excursion will automatically become an additional restoration well. The designation of the baseline restoration wells will be included in the Notice of Intent to Operate for the mine unit. The designation of the remaining restoration wells will be included in the restoration plan submitted for that mine unit.

Q.5.1.3 Private Well Monitoring

All private wells within 0.6 mile (1 kilometer) of the currently permitted CBR wellfield area boundary are sampled quarterly with the landowner's consent. CBR will perform similar private well monitoring around the NTEA. Groundwater samples are taken in accordance with the instructions contained in EHSMS Program Volume VI, Environmental Manual. Samples are analyzed for natural uranium and radium-226.

Historical and recent groundwater monitoring of private wells in the NTEA and associated Area of Review (AOR) are discussed in Section K.3 of Chapter K.

CBR conducted a water user survey in 1996 to identify and locate all private water supply wells within a 2-mile radius of the proposed NTEA. The water user survey determined the location, depth, casing size, depth to water, and flow rate of all wells within the area that were (or could be) used for domestic, agricultural, or livestock uses. CBR updated the well survey in 2004 (2.0-mile radius) and 2008 (2.25-mile radius).

Q.6 Evaporation Pond

Once the evaporation pond is placed into operation, the evaporation leak detection systems and the evaporation pond freeboards shall be monitored as specified in **Table Q.6-1**.

The measurements taken in compliance with the monitoring requirements specified in **Table Q.6-1** shall be taken from the detection system and at the pond. With the exception of specific monitoring requirements identified in this application, all monitoring of the ponds and the detection systems shall be in accordance with the Nuclear Regulatory Commission (NRC) License SUA-1534.

Upon initial pond operation and until approval by the Director to cease such monitoring, the evaporation pond monitor well(s) shall be monitored as specified in **Table Q.6-2**.

A minimum of 5 feet of freeboard shall be maintained in the commercial evaporation ponds during normal operations. The Director shall be notified immediately when the freeboard decreases to less than the specifications.

Should the water depth change abruptly or a leak be detected in the evaporation pond liner, the Department will be immediately notified. The pond fluids will be evacuated as soon as practicable to another location approved by the Director and the pond seal repaired. The extent of any subsurface contamination shall be determined, and a report submitted to the Director within 30 days after the leak is detected. The plan shall also include a plan for corrective action.

All other reporting requirements shall be in accordance with Title 122, Chapter 21.

Q.7 Standard Monitoring Conditions

All monitoring requirements will be in accordance with Title 122, Chapter 20.

Q.7.1 Representative Sampling

Samples and measurements required for the Class III UIC Permit shall be representative of all the volume and nature of the monitored discharge or injection. Monitoring points will not be changed without notification to and the approval of the Department.

Q.7.2 Mechanical Integrity

Mechanical integrity shall be demonstrated at least once every 5 years during the life of the well(s) as required in Title 122, Chapters 18 and 20.

Q.7.3 Test Procedures

Test procedures for the analyses of pollutants required for the Class III UIC permit, unless otherwise specified by the Director, shall conform to the latest edition of the following references:

- *Standard methods for the Examination of Water and Wastewaters*, 21st edition, 2005, American Public Health Association. New York, NY 10019.
- *ASTM. Standards, Part 11*, American Society for Testing and Materials, Philadelphia, PA 19103.

- *Methods for Chemical Analysis of Water and Wastes*, March 1983, Environmental Protection Agency Water Quality Office, Analytical Quality Control Laboratory NERC, Cincinnati, Ohio 45268.

Q.7.4 Additional Monitoring

If sampling occurs for any parameter more frequently than required using approved testing procedures or procedures specified in the permit, the results of the monitoring shall be included in the calculation and reporting of the data submitted in the Mining Monitoring Report.

Q.7.5 Averaging of Measurements

Calculations for all limitations which require averaging shall utilize an arithmetic mean unless otherwise specified by the Director.

Q.8 References

American Public Health Association (APHA). 2005. *Standard methods for the Examination of Water and Wastewaters*, 21st edition. New York, NY 10019

American Society for Testing and Materials (ASTM). 1998. *ASTM Standards, Part 1.* 1998 (updated). Philadelphia, PA 19103.

Crow Butte Resources (CBR). 2003a. *Environmental, Health, and Safety Management System, Volume III, Operating Manual.*

Crow Butte Resources (CBR). 2003b. *Environmental, Health, and Safety Management System, Volume VI, Environmental Manual.*

United States Environmental Protection Agency Water Quality Office. (USEPA). 1983. *Methods for Chemical Analysis of Water and Wastes.* Analytical Quality Control Laboratory NERC, Cincinnati, Ohio 45268. March.

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Table Q.1-1 Injection Well Requirements

Characteristics	Limitations	Monitoring Requirements	
	Maximum Limits	Measurement Frequency	Sample Type
Well Head pressure	100 psi[a]	Once/day	Manifold Gauge
Flow Rate	See Table Q.1-2	Once/day	24 Hr. Average
Injection Fluid[b]			
Chloride	≤5000 mg/L	Once/day	24 Hr. Composite
Sulfate	≤5000 mg/L	Once/day	24 Hr. Composite
Sodium	≤6000 mg/L	Once/day	24 Hr. Composite
Alkalinity	≤4100 mg/L	Once/day	24 Hr. Composite
pH	6.0 to 10.5 S.U.	Once/day	Grab
Bleed Rate	None		Totalized Meter

a Formation injection pressures will be limited to 0.62 psi/ft of well depth.
b Injection fluid shall be sampled downstream from filter after chemicals are added but before oxidant addition.

Table Q.1-2 Mining Requirements

Total Mine Injection Rates (Cumulative For All Mine Units)		
Production Flow (Maximum)	**Restoration Flow**	**Total Flow (maximum)**
4,500 gpm	Total Flow – Production Flow	4,500 gpm[a] (6,480,000 gpd)

a The total injection rate at the facility shall be calculated using a 24-hr average daily collected from flow meters for each well.

Table Q.5-1 Monitor Well Requirements

Monitoring Requirements Upper Control Limit				
Monitor Characteristics	**Sampling Frequency**	**Single Parameter**	**Multiple Parameter**	**Sample Type**
Chloride	Biweekly	mg/L	mg/L	Grab
Conductivity	Biweekly	umhos/cm	umhos/cm	Grab
Alkalinity (as $CaCO^3$)	Biweekly	mg/l	mg/l	Grab
Water Level	Biweekly	Reported to the nearest 0.1 foot from land surface.		
Barometric Pressure	Biweekly			

Table Q.5-2 Restoration Parameters

Current Title 118 Numerical Standards		Parameters Set on Wellfield Averages	Other Parameters	
Parameter	Standard	Parameter	Parameter	Value
Arsenic (As)	0.05 mg/L	Calcium (Ca)**	Ammonia (NH^4 as N)	10.0 mg/L
Barium (Ba)	2.0 mg/L	Total Carbonate*	Molybdenum (Mo)	1.0 mg/L
Cadmium (Ca)	0.005 mg/L	Potassium (K)**	Nickel (Ni)	0.15 mg/L
Chloride (Cl)	250 mg/L	Magnesium (Mg)**	Vanadium (V)	0.2 mg/L
Copper (Cu)	1.3 mg/L	Sodium (Na)*		
Fluoride (F)	4.0 mg/L	Total Dissolved Solids (TDS)***		
Iron (Fe)	0.3 mg/L			
Mercury (Hg)	0.002 mg/L			
Manganese (Mn)	0.05 mg/L			
Nitrate as N (NO^3)	10.0 mg/L			
Lead (Pb)	0.015 mg/L			
Radium (Ra)	5.0 pCi/L			
Selenium (Se)	0.05 mg/L			
Uranium (U)	0.03 mg/L			
Sulfate (SO^4)	250 mg/L			
Zinc (Zn)	5.0 mg/L			
pH	6.5-8.5 S.U.			

* Total carbonate shall not exceed 50 percent of the total dissolved solids value.

** One order of magnitude above baseline mean shall be used as a restoration value for some parameters due to the ability of some major ions to vary one order of magnitude depending on pH.

*** The restoration value for total dissolved solids shall be the baseline mean plus one standard deviation.

All parameters listed as parameters with numerical groundwater standards (Title 118 or other sources) are subject to change based on NDEQ procedures.

Note: These restoration parameters are currently used for the existing CBR operating facility (NDEQ Class III UIC Permit No. NE0126611)

Table Q.6-1 Evaporation Pond Monitoring Requirements – Water Level

Monitoring Characteristics	Sampling Frequency
Fluid Level	Weekly*
Freeboard	Weekly

* In the event elevated fluid levels or other conditions of a leak are detected in the underdrain system, the Department shall be notified immediately and monitoring shall be conducted in accordance with the NRC License SUA-1534 until occurrences causing the leak(s) into the underdrain have been corrected, and the results from required monitoring of sample analysis substantiate the corrective actions. Such information shall be reported to the Department. If corrective actions require the pumping of the contents of one evaporation pond into another, the minimum freeboard levels may be temporarily exceeded until such time as the corrective actions have succeeded, and the evaporation pond can be placed back into service.

Table Q.6-2 Evaporation Pond Monitor Well Requirements[a]

Monitoring Characteristics		Sampling Frequency	Sample Type[b]
Conductivity	umhos/cm	Quarterly	Grab
Chloride	mg/L	Quarterly	Grab
Alkalinity (as CaCO3)	mg/L	Quarterly	Grab
Sodium	mg/L	Quarterly	Grab
Sulfate	mg/L	Quarterly	Grab

[a] Sample(s) taken in compliance with the designated monitoring requirements shall be collected at the well head.

[b] Pumping, air lifting, or bailing shall be used to evacuate at least one casing volume, and the pH and conductivity shall be allowed to stabilize prior to sampling. Sample filtering, preservation, and hold times shall be in accordance with the latest edition of USEPA's *Methods for Sampling and Sample Preservation of Water and Wastewater.*

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CHAPTER R. FORMATION PRESSURES, FLUID DISPLACEMENT, AND INJECTION FLUID MOVEMENT

A narrative detailing the following:

R1. Expected changes in formation pressures.

R2. Expected formation (native) fluid displacement.

R3. Direction of injection fluid movement.

R.1 Expected Changes In Pressure

Groundwater pressure differential is used to control the movement of lixiviant within the mining area. Except during well stimulation, injection pressures will not be allowed to exceed a magnitude which could initiate fractures or propagate existing fractures in the injection zone. A maximum operating wellhead pressure of 100 pounds per square inch (psi) will be used for the North Trend Expansion Area (NTEA) injection rates. At this injection rate, a maximum allowable formation gradient of 0.62 psi per foot of well depth will not be exceeded. With a maximum injection pressure of 100 psi at the injection wellhead, and the fluid pressure increasing at a rate of 0.62 psi/ft with depth, the pressure at 572 feet bgs (average upper screening interval depth at top of production zone) will be 355 psi. At the top and bottom of the formation (approximately 350 and 700 feet) the formation pressures would be approximately 217 and 434 psi, respectively. Injection rates will be adjusted to maintain wellhead injection and formation gradient pressures below the maximum allowable levels. Injection operating pressure calculations are discussed in more detail in Chapter P.

Regional information, previous Crow Butte Resources, Inc. (CBR) permit submittals, and historical operational practices indicate that the minimum pressure that could initiate hydraulic fracture is greater than 0.63 psi/ft of well depth (CBR 2007). This value has historically and successfully been applied to current CBR operations. As such, the injection pressure proposed for the NTEA is limited to a similar value of less than 0.62 psi/ft of well depth. Injection pressures also will be limited to the pressure at which the well was integrity tested. The calculated formation gradient of 0.62 psi/ft for the NTEA differs slightly from the 0.63 psi/ft used for the current CBR production area due to use of a U.S. Environmental Protection Agency (USEPA) formula for the latter and differences in production zone depth. Injection pressure calculations are discussed in Chapter P.

In order to prevent fracturing, CBR will monitor injection volumes, rates, and pressures (detailed discussions in Chapter Q). Annulus pressure monitoring is not needed because the annular spacing around the well casing is filled with cement during construction.

Wellhead pressure will be monitored at all injection manifolds. Pressure gauges will be installed at each injection manifold, and pressure will be monitored and recorded at least daily.

Each new production well (extraction and injection) will be pressure-tested to confirm the integrity of the casing prior to being used for mining operations. Wells that fail pressure testing will be repaired, if possible, or abandoned and plugged according to accepted procedure.

R.2 Expected Formation (Native) Fluid Displacement

During operations, leaching solution enters the formations through the injection wells and flows to the recovery wells. Within each mine unit, more water is produced than injected to create an overall hydraulic cone of depression in the production zone, resulting in a "negative pressure gradient" or "pressure sink" within the production zone. Under this negative pressure gradient, the natural groundwater movement from the surrounding area is toward the wellfield, providing additional control of the leaching solution movement. To simplify, the fluid flow in the wellfield is controlled by pumping the production well at a greater rate than the injection wells, which are injecting the fluid. This creates a flow towards the production well because it is being pumped at a greater rate than the fluid being pumped into the nearby injection wells. This negative pressure gradient (i.e., cone of depression) also minimizes the dilution of the lixiviant by uncontrolled fluid movement.

The difference between the amount of water produced and the amount injected is the wellfield "bleed". The minimum over-production or bleed rates will be a nominal 0.5 percent of the total wellfield production rate, and the maximum bleed rate typically approaches 1.5 percent. Over-production is adjusted as necessary to ensure that the perimeter ore zone monitor wells are influenced by the cone of depression resulting from the wellfield production bleed. Maintenance of the bleed will cause an inflow of groundwater into the production area and prevent loss of leach solution. Based on the proposed bleed rate of 0.5 to 1.5 percent of the total mining flow (4,500 gallons per minute [gpm]), groundwater consumption from the North Trend operation is expected to be minimal. These bleed rates have successfully been applied in the current permitted area. Additional volume will be consumed during aquifer restoration, especially the groundwater sweep phase. However, it is expected that the average net consumptive use for the entire operation will be on the order of 50 to 100 gpm for the life of the mine (estimated at 20 years). In this regard, the vast majority (on the order of 99 percent) of groundwater used in the mining process will be treated and reinjected (**Figure M.1-3**). Therefore, potential impacts on groundwater quality due to consumptive use outside the license area are expected to be negligible.

The maintenance of a hydrologic bleed and the close proximity of the perimeter monitor wells around the wellfield, no greater than 300 feet from the mining patterns, will ensure there is negligible migration of mining fluid. The ongoing adjustment of this "over-production" will help to ensure that the perimeter ore zone monitor wells are influenced by the cone of depression resulting from the wellfield production bleed. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. The ubiquitous clays present in the Middle Chadron Formation (Peanut Peak Member), which cap the Basal Chadron Formation, exhibit vertical hydraulic conductivities on the order of 10^{-11} cm/sec. Likewise, the underlying Pierre Shale is more than 1,200 feet thick and acts as a significant aquitard. The vastly different piezometric heads between the

Basal and Middle Chadron, as well as the results of pumping test #6, support the conclusion that the Basal Chadron is vertically isolated.

The wellfield injection/production pattern to be employed at the NTEA is based on a hexagonal seven-spot pattern, which may be modified to fit the characteristics of the ore body. A typical wellfield layout for these spot patterns is shown in **Figure M.1-1** of Chapter M. Figure R.1-1 shows a typical uranium in-situ wellfield production and injection schematic, with only one of six injection wells of a seven-spot pattern shown (WNA 2008 Modified). The purpose of this figure is to demonstrate the typical "controlled" flow patterns associated with such an injection/recovery pattern when there is an equal flow rate of injection wells. This pattern is a beneficial recovery method due to the low flow rates of the injection wells that create a high total productivity for the system, and they also provide a nearly uniform solution distribution throughout the ore body (IAEA 2001).

Monitoring of production (extraction) and injection rates and volumes will enable an accurate assessment of water balance for the wellfields (**Figure M.1-3** of Chapter M). Monitor wells completed in the aquifers directly overlying the production zone (Basal Chadron) detect any migration of injection fluids from the production zone. Water levels will be routinely measured in the production zone and overlying aquifer. Sudden changes in water levels within the production zone may indicate that the wellfield flow system is out of balance. Flow rates would be adjusted to correct this situation. Increases in water levels in the overlying aquifer may indicate fluid migration from the production zone. Adjustments to well flow rates or complete shutdown of individual wells may be required to correct this situation. Increases in water levels in the overlying aquifer may also indicate casing failure in a production, injection, or monitor well. Isolation and shutdown of individual wells can be used to determine the well causing the water level increases.

During production, injection of the lixiviant into the wellfield will result in a temporary degradation of water quality in the exempted aquifer compared to pre-mining conditions. Typical lixiviant concentrations of various constituents are presented in **Table J.1-1**. The concentrations (low and high range) in this table could be found in barren lixiviant (injected solution) or pregnant lixiviant (flow from recovery wells to satellite processing facility). Groundwater restoration at the end of wellfield production will restore the groundwater in the production zone to levels at or below those approved by the Nebraska Department of Environmental Quality (NDEQ) and the Nuclear Regulatory Commission (NRC) (see Section T.2 Groundwater Restoration for detailed discussions).

Analysis of pumping test data in 2006 (**Appendix 5**) for the production zone in the NTEA indicated an average transmissivity of 60 ft^2/day, an average hydraulic conductivity of 2.3 ft/day and an average permeability (assuming a water viscosity of 1.35 cp and density of 1.0) of 1,110 millidarcies (md) (Petrotek 2006). The average storativity was 5.3 x 10^{-5}. The testing indicated that the transmivissity of the Basal Chadron Sandstone in the NTEA is relatively consistent, but the thickness and hydraulic conductivity vary with direction and location. Based on the data evaluated during this study, the variance may impact mining operations planning (e.g., well spacing, completion interval, and injection/production rates) but is not anticipated to impact regulatory issues (Petrotek 2006).

The results of pumping test #6 indicate that the Basal Chadron Sandstone is relatively homogenous and isotropic (i.e., the hydraulic conductivity [permeability] is consistent with respect to direction and location) within the current CBR commercial area. This is consistent with regional geologic information and suggests that the individual nature and characteristics of the Brule Formation, Chadron Formation, and the Pierre Shale are laterally consistent with the Crawford Basin.

Groundwater impacts and consumption related to the North Trend operation will be fully assessed in an Industrial Groundwater Permit application that is required by NDNR Information from the existing Groundwater Permit for the current license area indicates that the drawdown from mining operations in the Basal Chadron Sandstone is minimal (e.g., less than 10 percent of the available head). Based on drawdown data from years of operation in the current license area and on the formation characteristics from the North Trend Pumping Test (**Appendix 5**), the drawdown effect on the Basal Chadron Sandstone aquifer as a result of operations has been and is expected to remain minimal.

R.3 Direction of Injection Fluid Movement

As stated above, the negative pressure gradient (i.e., cone of depression) created by the layout of the injection wells and associated recovery wells controls the flow direction and minimizes the dilution of the lixiviant by uncontrolled fluid movement. As shown in **Figure M.1-3** of Chapter M, with a total mine flow of 4,500 gpm from production wells and a bleed rate of 1.5 percent, approximately 4,432 gpm of refortified lixiviant would be returned to the wellfield via the nearby injection wells. This net flow pattern due to the bleed minimizes the potential for leaching fluid moving away from the wellfield, holding or containing the lixiviant within the desired ore bearing region, and prevents the unwanted excursion of lixiviant away from the ore body. Excursions represent a potential effect on the adjacent groundwater as a result of operations. Monitor wells around the wellfield are used to detect any excursions, as discussed in Chapter Q. However, in the event an excursion is detected, immediate actions are taken to determine and remedy the cause, as applicable (see Chapter Q for detailed discussions of proposed excursion monitoring programs and Section I.5.2.5 for groundwater impacts for the NTEA).

The groundwater flow in the Basal Chadron Sandstone (production zone) is predominantly to the southeast in the NTEA with an average hydraulic gradient of approximately 0.0018 ft/ft (9.5 ft/mile) (see discussions in Section G.2.1 of Chapter G). As discussed above, the effect of mining operations (e.g., negative pressure gradient associated with injection of barren lixiviant and recovery pregnant lixiviant) within the wellfields will have a localized impact on the groundwater flow, but will not have a significant impact on the region.

R.4 References

Crow Butte Resources, Inc. (CBR). 2007. Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report – Volume I. Submitted to NRC on May 30, 2007.

International Atomic Energy Agency (IAEA). 2001. *Manual of acid in-situ leach uranium mining technology*. IAEA-TECDOC-1239. August.

Petrotek Engineering Corporation (Petrotek). 2006. *North Trend Hydrologic Testing Report – Test #6*. December.

World Nuclear Association. (WNA). 2008. In-situ Leach (ISL) Mining of Uranium. [Webpage]. Located at: http://www.world-nuclear.org/info/inf27.html. March 2008.

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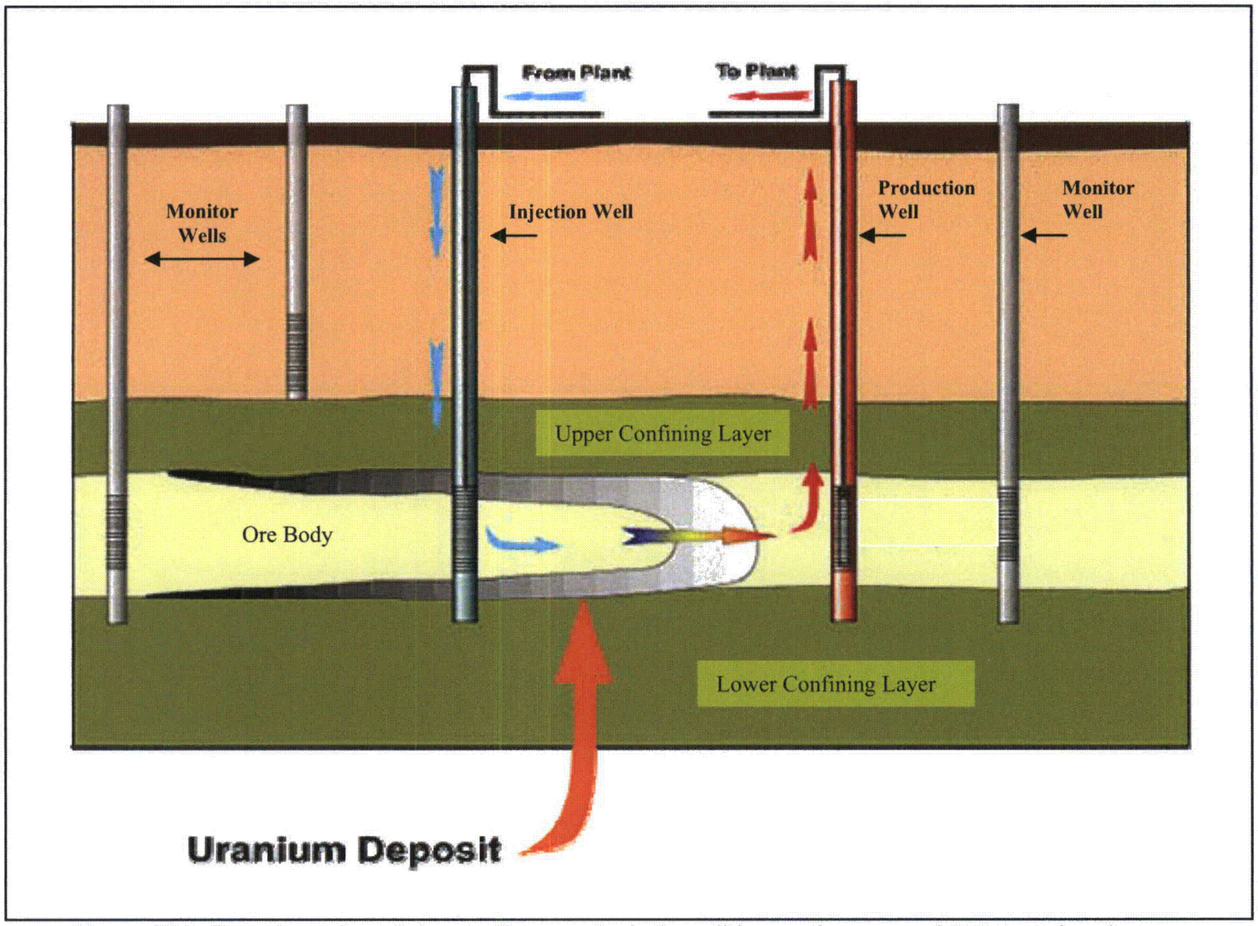
Figure R.1-1 Typical Uranium In Situ Wellfield Production and Injection Schematic



Notes: This figure is not intended to duplicate geological conditions at the proposed NTEA. It is only to demonstrate a typical uranium in situ wellfield production and injection schematic.
Modified from WNA 2008.

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CHAPTER S. CORRECTIVE ACTION PLAN

A corrective action plan for improperly completed wells found within the area of review that are constructed into or through the proposed injection zone (Title 122, Chapter 11, Section 006.24).

Title 122, Chapter 34, requires that CBR, in applying for a Class III injection well permit, to identify the location of all wells which penetrate the injection and/or production zone within the facility's area of review (AOR). These wells are discussed and listed in **Chapter D**. For any such identified wells that are improperly sealed, completed or abandoned, the applicant shall submit a plan identifying steps or modifications that are necessary to prevent movement of fluid into underground sources of drinking water (corrective action).

S.1 Oil and Gas Test Holes

Based on review of public plugging records, all the referenced oil and gas test holes in the North Trend Expansion Area AOR with drilling depths ranging from 2006 to 5123 feet have been properly plugged in accordance with the Nebraska Oil and Gas Conservation Commission regulations (NOGCC 2008). Historical information on these test holes is shown in **Table D.1-1** and their locations in **Figure D.1-1** of **Chapter D**. These test holes date back to 1928, 1945, 1969, 1972, 1976 and 1977. Only one test hole (Soester-Wulf Oil) was drilled within the NTEA (**Figure D.1-1** of **Chapter D**). Based on a review of the above referenced NOGCC database, there are currently no known oil and gas test holes within the AOR that are suspected of being improperly abandoned and requiring corrective action.

S.2 Private Water Wells and CBR Monitor Wells

A water well survey of the North Trend Expansion Area and the AOR was conducted by CBR in 1996 and updated in 2004 (2.0-mile radius) and 2007 and 2008 (2.25-mile radius). The update tasks consisted of focused-interviews and a review of the Nebraska Department of Natural Resources state water well database (NDNR 2008). The results of the survey and updates indicate that all of the groundwater pumped from active wells surveyed within a 2.25-mile radius of the proposed North Trend License Area boundary is used primarily for agriculture (e.g., livestock watering), followed by limited "other uses" (e.g., lawn and garden watering) or for limited domestic purposes. **Figure H.2-2** of **Chapter H** shows the location of all active and abandoned water wells in the North Trend License Area and the 2.25-mile review area. *Table G.2-1* of *Chapter G* lists the active and abandoned groundwater wells in the expansion area and the 2.25-mile review area, with more detailed information on the water well user survey in **Appendix 6**.

Private water supply wells and CBR monitor wells that penetrate the injection zone within the AOR are discussed in **Chapter D** and listed in **Tables D.2-1** and **D.2-2. Table D.2-3** of **Chapter D** lists 4 private water wells (52, 65, 81 and 114), 1 City of Crawford water well (425), and 2 CBR project wells (RC-3, CPW-1) that were plugged and abandoned from 2004 to 2008.

Copies of the affidavits of abandonment for abandoned wells listed in **Table D.2-3** of **Chapter D** are presented in **Appendix 2**. Although no completion problems were identified with these wells, they were no longer used and abandonment reduces any future risks associated with the wells.

S.3 Corrective Action Plans for Improperly Completed Wells

In the event that CBR identifies any wells completed into the injection zone (Basal Chadron sandstone) within the AOR that are inadequately completed or abandoned, efforts will be made to immediately properly plug the wells. Wells owned or under the control of CBR will be properly plugged, as discussed below. For such wells owned by a private party, efforts will be made to obtain permission to properly plug such wells.

For wells which are not adequately sealed, completed or abandoned, CBR will use a drill rig to reopen the hole and then perform the plugging and abandonment procedures specified in **Chapter T** – Plugging and Abandonment Plan.

In order to minimize the potential for impacts on any private water supply wells within the AOR, CBR will have specific safeguards in place to prevent movement of lixiviant into any such well completed in the injection zone:

- During operations, leaching solution enters the formations through injection wells and flows to recovery wells. Within each wellfield, more water is produced than injected to create an overall hydraulic cone of depression in the production zone. Under the pressure gradient, the natural groundwater movement from the surrounding area is toward the wellfield, providing additional control of the leaching solution movement (over-recovery of lixiviant from a wellfield). During normal operations, CBR will recover 0.5% to 1.5% more solution than is injected. This will result in a hydrologic depression in the vicinity of the wellfield and the groundwater flow will tend to be into the wellfield, preventing migration of the lixiviant from the wellfield.
- In the event that the over-recovery is not effective or controlled properly, CBR will have a series of monitor wells located around the perimeter of the wellfield. These wells will be sampled at a frequency specified by the NDEQ. CBR is committed, and required by its UIC permit, to taking corrective action if any indicator species exceeds the upper control limit specified in the UIC permit.
- CBR will operate with injection pressures that shall not exceed a maximum, which will ensure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause migration of injection or formulation fluids into underground sources of drinking water. The maximum injection pressure to be used for the NTEA wellfield operations will be limited to 100 pounds per square inch (psi) at the wellhead. Historically, this maximum injection pressure has been successfully applied to the nearby CBR operations and is well below the pressures used for the mechanical integrity testing of injection wells. The injection pressure

monitoring system will have a high-pressure alarm and, if the pressure exceeds the set point, corrective action will be taken.

Corrective action taken may include:

- Increasing the over-recovery rate of the wellfield water balance.
- Reordering the wellfield in order to control fluid movement.
- Cease injection of lixiviant (e.g., shutting down injection pump) or whatever action is necessary to recall the lixiviant.

Injection procedures to be used by CBR for the NTEA operations to ensure that the leach solutions are contained within the designated area of the aquifer being mined are discussed in **Chapter M – Injection Procedures.**

S.4 References

Grantham, R. 2008. Personal communication between Rhonda Grantham of Crow Butte Resources, Inc. and Leonard Chubb, Chubb Water Wells, Crawford, NE. June 06, 2008.

Nebraska Department of Natural Resources (NDNR) 2008. Department of Natural Resources Stream Gauging. Data for 2001 – 2006. [Web page]. Located at: http://www.dnr.state.ne.us/docs/hydrologic.html. Accessed on May 20, 2008.

Nebraska Oil and Gas Conservation Commission (NOGCC). 2008. [Webpage]. Located at: http://www.nogcc.ne.gov/ (Well data and publications). Accessed on April 1, 2008.

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CHAPTER T. PLUGGING AND ABANDONMENT PLAN

A plugging and abandonment plan demonstrating resources necessary to close, plug or abandon the injection well and to conduct restoration of the affected aquifer and the affected surface resources. (Refer to Title 122, Chapter 35).

T.1 Well Plugging and Abandonment

T.1.1 Plugging and Abandonment of Cased Holes

All wells that are no longer useful to the continued mining or restoration operations will be abandoned. These include all injection and production wells, monitor wells, and any other wells within the production unit used for the collection of hydrologic or water quality data or incidental monitoring purposes. The only known exception at this time may be a shallow monitor well that could be transferred to the landowner for domestic or livestock use.

The objective of the Crow Butte well abandonment program is to seal and abandon all wells in such a manner that the groundwater supply is protected and to eliminate any potential physical hazard.

The plugging method (Balance Method), used at the current permit area is approved by the Nebraska Department of Environmental Quality (NDEQ) (as per Title 122, Chapter 35, Section 007.02B), will be used at the North Trend Expansion Area (NTEA). The method is generally as follows:

- A mechanical plug may be placed above the screened interval.
- Thirty to 50 feet of coarse bentonite chips will be added to provide a grout seal.
- An approved bentonite-based hole plugging product or cement grout will be placed by tremie pipe from the chips to the top of the casing. The weight of the gel or grout plus the weight of the bentonite chips will be enough to exceed the local Chadron formation pressure plus the maximum injection pressure allowed (100 pounds per square inch [psi]).
- The tremie pipe will be removed (when possible) and the casing will be filled to the surface.
- An approved hole plug will be installed.
- The well casing will be cut off below ground level, capped with cement, and the surface disturbance will be smoothed and contoured.
- The hole will be backfilled and the area revegetated.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning. The Nebraska Department of Natural Resources (DNR) also requires filing a well abandonment notice for all registered wells.

T.1.1.1 Plugging and Abandonment Plan

Prior to plugging, abandonment, or restoration activities for the Class III UIC injection wells, Crow Butte Resources, Inc. (CBR) shall submit a written abandonment plan to the NDEQ Director for approval. No plugging, abandonment, or restoration activities, shall take place until the plan has been approved by the Director. CBR will notify the Director 7 days before commencing plugging and abandonment.

Plugging and abandonment plan shall include the plugging, abandonment, and restoration procedures as follows (Title 122, Chapter 35, 007):

- Method and materials used to stabilize the well.
- Plugging information that includes, but is not limited to:
  - Type and number of plugs to be used;
  - Method for placement of the plugs (Balance Method);
  - Placement of each plug including the elevation of the top and bottom; and
  - Type, grade, and quantity of plugging material to be used.
- Abandonment information shall include, but not be limited to, the following:
  - Type, grade, and quantity of the abandonment fluid to be used;
  - Method for placement of the abandonment fluid; and
  - Method and type of surface completion.
- Restoration information shall include, but not be limited to:
  - Surface area to be restored and
  - Process for restoration.

All cement will be American Society for Testing Materials (ASTM) Type I, II or American Petroleum Institute (API) Class B or G. All bentonite products will have specifications outlined in the approved plugging and abandonment plan.

Prior to abandonment, all wells shall be plugged with cement or other approved plugging material in a manner which will prohibit the movement of fluids out of the injection zone into or between underground sources of drinking water.

Records of abandoned wells will be tabulated and reported to the appropriate agencies after decommissioning. The DNR also requires filing a well abandonment notice for all registered wells.

T.1.1.2 Plugging and Abandonment Affidavit

Following completion of the plugging, abandonment, or restoration activities, an affidavit setting forth the significant data in connection with the well (including well details) and the procedure used in plugging, abandonment, or restoration shall be filed with the NDEQ within 90 days after plugging, abandonment, or restoration has been completed.

The affidavit will be signed by a qualified witness to the plugging, abandonment, or restoration procedures and duly notarized.

T.1.2 Development Drilling and Abandonment of Uncased Holes

Development drilling will occur within the permit area for the purpose of determining new mine unit locations. CBR shall notify the NDEQ at least 10 days prior to any development drilling within the permit area.

T.1.2.1 Abandonment Mud

Upon completion of a development hole, the hole shall be plugged with an approved abandonment mud in a manner which will prohibit the movement of fluids out of the injection zone or between underground sources of drinking water. The product sheet will state that the product is an abandonment mud (mud). The mud shall be mixed through a hopper and meet the following criteria:

- A viscosity of at least 20 seconds/qt. above the Total Depth (TD) viscosity to exceed 60 seconds/qt. (Using a Marsh funnel) and
- A mud density of a least 8.7 lbs/gal.

The mud shall be circulated through the hole until it returns to the surface. If the formation pressure is such that the density of the mud is not sufficient to hold the plug in place, a weighting agent shall be added to the Plug Gel or a Portland cement slurry shall be used.

T.1.2.2 Hole Plug

An approved hole plug shall be placed 6 feet below the land surface followed by cement which has been mixed with water to within 2 feet of the land surface. The top 2 feet of the hole shall be filled with dirt into which a hole marker, showing section, township, and range, shall be placed.

T.1.2.3 Surface Reclamation

The topsoil will be removed and stockpiled separately from the rest of the pit material. Upon completion of the hole, the pit will be filled and the dirt mounded to allow for subsidence. The pit will then be leveled, topsoil replaced, and the entire site reseeded with an approved seed mixture.

T.1.2.4 Hole Abandonment Report

A hole abandonment report shall be included with the quarterly report. It shall include the TD, viscosity (seconds/qt.), the abandonment viscosity (second/qt.), the mud density (lbs/gal.), and the amount and type of approved abandonment product used to plug each hole.

T.2 Groundwater Restoration

T.2.1 Groundwater Restoration Methods

T.2.1.1 Introduction

Restoration activities in the current permit area have proven that the groundwater can be restored to the appropriate standards following commercial mining activities. As shown in **Table A.2-1**, Mine Units 2 through 5 are currently undergoing restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the Nuclear Regulatory Commission (NRC) and surface reclamation activities are underway. On February 12, 2003, the NRC issued the final approval of groundwater restoration in Mine Unit 1 at Crow Butte. This approval was the accumulation of 3 years of agency reviews including a license amendment to accept the NDEQ restoration standards as the approved secondary goals. Mine Unit 1 consisted of 40 patterns installed in 9.3 acres immediately adjacent to the Central Plant. Included within the boundaries of Mine Unit 1 were five wells that were originally mined beginning in 1986 as part of the research and development pilot plant operation. Commercial mining activities began in 1991 and were completed in 1994. Mine Unit 1 was successfully restored to the approved primary or secondary restoration standards for all parameters.

CBR's approved restoration plan consists of four steps:

- Groundwater transfer,
- Groundwater sweep,
- Groundwater treatment, and
- Wellfield recirculation

A reductant may be added at anytime during the restoration stage to lower the oxidation potential of the mining zone. A sulfide or sulfite compound will be added to the injection stream in concentrations sufficient to reduce the mobilized species.

The stabilization stage consists of monitoring the restoration wells for at least 6 months following successful completion of the restoration stage. Stabilization begins once restoration activities have returned the average concentration of restoration parameters to acceptable levels. Following the stabilization phase, CBR provides a restoration report to the appropriate regulatory agencies.

During mining, and until restoration is complete, a hydrologic bleed will be maintained in each Mine Unit to prevent lateral migration of mining lixiviant. If a proper hydrologic bleed is not maintained, it is possible for affected water to begin migrating toward the monitor well ring. The mobile ions, such as chloride and carbonate, would be detected at the monitor well ring and adjustments would be made to reverse the trend. The maintenance of a hydrologic bleed and the close proximity of the monitor well ring, no greater than 300 feet from the mining patterns, will ensure that there is negligible migration of mining fluid. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. The ubiquitous Chadron Formation clays, which cap the Lower Chadron Formation ore body, have vertical hydraulic conductivities on the order of 10 to 11 cm/sec. Likewise, the underlying Pierre Shale is more than 1,200 feet thick and acts as a significant aquitard. The vastly different pieziometric heads between the Lower and Middle Chadron, as well as the results of the pumping test support the conclusion that the Lower Chadron, is vertically isolated.

T.2.1.2 Restoration Process

Restoration activities include four steps that are designed to optimize restoration equipment used in treating groundwater and to minimize the number of pore volumes circulated during the restoration stage. CBR will monitor the quality of selected wells during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary.

T.2.1.2.1 Groundwater Transfer

During the groundwater transfer step, water may be transferred between the mine unit commencing restoration and a mine unit commencing mining operations. Baseline quality water from the mine unit starting mining may be pumped and injected into the mine unit in restoration. The higher total dissolved solids (TDS) water from the mine unit in restoration is recovered and injected into the mine unit commencing mining. The direct transfer of water will act to lower the TDS in the mine unit being restored by displacing water affected by the mining with baseline quality water.

The goal of the groundwater transfer step is to blend the water in the two mine units until they become similar in conductivity. The recovered water may be passed through ion exchange columns and filtration during this step if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer step to occur, a newly constructed mine unit must be ready to commence mining. If a mine unit is not available to accept transferred water, groundwater sweep or other activity will be utilized as the first step of restoration. The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the wastewater disposal system during restoration.

T.2.1.2.2 Groundwater Sweep

During groundwater sweep, water is pumped without injection from the wellfield, causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline quality water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The affected water near the edge patterns of the wellfield is also drawn into the boundaries of the mine unit. The number of pore volumes transferred during groundwater sweep, if any, depends on the presence of other active mine units along the mine unit boundary, the capacity of the wastewater disposal system, and the success of the groundwater transfer step in lowering TDS.

T.2.1.2.3 Groundwater Treatment

Following the groundwater sweep step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. Ion exchange (IX), reverse osmosis (RO), and/or Electro Dialysis Reversal (EDR) treatment equipment is generally used during this stage as shown on the generalized restoration flow sheet on **Figure T.2-1**.

Water recovered from restoration that contains a significant amount of uranium is passed through the IX system. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Once the solubilized uranium is removed, a small amount of reductant may be metered into the restoration wellfield injection to reduce any pre-oxidized minerals. The concentration of reductant injected into the formation is determined by the concentration and type of trace elements encountered. The goal of reductant addition is to reduce those minerals that are solubilized by carbonate complexes to prevent the buildup of dissolved solids, which would increase the time for restoration to be completed.

Another method for reducing the wellfield is through bioremediation. Bioremediation entails adding a nutrient source to the aquifer to stimulate native bacteria. As the bacteria feed on the nutrient source, they generate a reducing environment which in turn causes most metals in solution to precipitate back to their pre-mining state. The concentration of native bacteria colonies returns to normal levels once the organic media are consumed.

A portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids in the contaminated groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration.

Before the water can be processed by the RO, soluble uranium can be removed by the IX system. The RO unit contains membranes that pass about 60 to 75 percent of the water through, leaving 60 to 90 percent of the dissolved salts in the water that will not pass the membranes. **Table T.2-1** shows typical RO manufacturers' specification data for removal of ion constituents. The clean water, called "permeate", will be re-injected, sent to storage for use in the mining process, or to the wastewater disposal system. The 25 to 40 percent of water that is rejected, called "brine", contains the majority of dissolved salts that contaminate the groundwater and is sent for disposal in the waste system. Make-up water (permeate) may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas. The typical composition of the permeate solution is shown in **Table T.2-2**.

The reductant (either biological or chemical) added to the injection stream during the groundwater treatment stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding a reductant, the Eh of the aquifer is lowered, thereby decreasing the solubility of these elements. Hydrogen sulfide (H_2S), sodium sulfide (Na_2S), or a similar compound will be added as a reductant. CBR typically uses sodium sulfide due to the chemical safety issues associated with proper handling of H_2S. A comprehensive safety plan regarding reductant use is implemented.

The number of pore volumes treated and re-injected during the groundwater treatment stage will depend on two things: the efficiency of the RO in removing TDS and the success of the reductant in lowering the uranium and trace element concentrations. See Section T.2.1.3 for estimated pore volumes for the NTEA.

T.2.1.2.4 Wellfield Recirculation

At the completion of the groundwater treatment stage, wellfield recirculation may be initiated. In order to homogenize the aquifer, the production wells may be pumped and recovered solution may be re-injected into injection wells to recirculate the solutions.

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

Once the restoration activities are completed, CBR will sample the restoration wells and determine if the mining unit has achieved the restoration values on a mine unit average basis. If so, CBR will notify the NDEQ that it is initiating the Stabilization Stage and will submit supporting documentation that the restoration parameters are at or below the restoration standards. If, at the end of restoration activities, the parameters are not at or below the approved values, CBR will either re-initiate certain steps of the restoration plan or submit documentation to the agencies that the best practical technology has been used in restoration. The documentation will include a justification for alternate parameter value(s) including available water quality data and a narrative of the restoration techniques used.

T.2.1.2.5 Pore Volume Calculations

CBR has developed new estimates for pore volumes required for restoration of the NTEA. The number of pore volumes that are displaced during groundwater restoration is as follows: three pore volumes through the ion exchange (IX) columns; six pore volumes through the Reverse Osmosis (RO) unit; and two pore volumes of recirculation. There were nine pore volumes used for Mine Unit 1 at the current CBR operations. For the remainder of the mine units (Mine Units 2 through 11), 11 pore volumes will be used.

The pore volume calculations for the individual five mine units are shown in **Table T.2-3**. The calculated pore volume for the entire North Trend Wellfield will be 526,990,278 gallons per pore volume. This is based on a calculated square footage of the potential wellfield area (16,195,066 ft^2), an average under-ream interval of 15 feet and a 29% open pore space value.

T.2.2 Stabilization Phase

Upon completion of restoration, a groundwater stabilization monitoring program will begin in which the restoration wells and any monitor wells on excursion status during mining operations will be sampled and analyzed for the restoration parameters listed in **Table T.2-4**. The sampling frequency will be one sample per month for a period of 6 months, and if the six samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, restoration shall be deemed complete.

T.2.3 Reporting

During the restoration process CBR will perform daily, weekly, and monthly analyses as needed to track restoration progress. These analyses will be summarized and discussed in the Monthly Restoration Report submitted to NDEQ. This information will also be included in the final report on restoration.

Upon completion of restoration activities and before stabilization, all designated restoration wells in the mine unit will be sampled for the constituents listed in **Table T.2-4**. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NDEQ, CBR will proceed with the stabilization phase of restoration.

During stabilization, all designated restoration wells will be sampled monthly for the constituents listed in **Table T.2-4**. At the end of a 6-month stabilization period, CBR will compile all water quality data obtained during restoration and stabilization and submit a final report to the regulatory agencies. If the analytical results continue to meet the appropriate standards for the mine unit and do not exhibit significant increasing trends, CBR would request that the mine unit be declared restored. Following agency approval, the wellfield will be reclaimed and wells will be plugged and abandoned as described in Section T.1.

T.2.4 Basis of Restoration Goals

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to pre-injection baseline values on a mine unit average as determined by the baseline water quality sampling program. This sampling program is performed for each mine unit before mining operations commence. Should restoration efforts be unable to achieve baseline conditions after diligent application of the best practicable technology (BPT) available, CBR commits, in accordance with the Nebraska Environmental Quality Act and NDEQ regulations, to return the groundwater to the restoration values set by the NDEQ in the Class III UIC Permit. These secondary restoration values ensure that the groundwater is returned to a quality consistent with the use, or uses, for which the water was suitable prior to in-situ leach (ISL) mining. These secondary restoration values are approved by the NDEQ in the individual Notice of Intent (NOI) for each mine unit based on the permit requirements and the results of the baseline monitoring program.

T.2.4.1 Restoration Determination

Before mining in each mine unit, the baseline groundwater quality is determined. The data are established in each mine unit by assigning and evaluating groundwater quality in the "baseline restoration wells". A minimum of one baseline restoration well for each 4 acres is sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. All of the premining sampling of the baseline restoration wells must be at least 300 feet from any active mine unit. The samples are collected at least 14 days apart. The samples are analyzed for the parameters list in **Table T.2-2**.

T.2.4.1.1 Designation of Restoration Wells

Within each mine unit, a minimum of one injection or production well per acre shall be designated as a restoration well. There shall be a minimum of ten restoration wells per mine unit. The production well of each standard injection well pattern shall be designated as the restoration well. If there is more than one standard injection well pattern per acre, the production or injection well that is centrally located shall be designated as the restoration well. Any monitor well that has an excursion will automatically become an additional restoration well. The designation of the baseline restoration wells will be included within the NOI for the mine unit. The designation of the remaining restoration wells shall be included in the restoration plan submitted for that mine unit.

T.2.4.2 Establishment of Restoration Parameters

The baseline data are used to establish the restoration standards for each mine unit. As previously noted, the primary goal of restoration is to return the mine unit to preoperational water quality condition on a mine unit average. Because ISL operations alter the groundwater geochemistry, it is unlikely that restoration efforts will return the groundwater to the precise water quality that existed before operations.

Secondary restoration goals are established by NDEQ to ensure that, if baseline water quality is not achievable after diligent application of BPT, the groundwater is suitable for any use for which it was suitable before mining. NRC considers these NDEQ restoration goals as the secondary standards. The NDEQ restoration values are established for each mine unit and are approved with the NOI submittals according to the following analysis:

- For parameters that have numerical groundwater standards established in NDEQ Title 118, the restoration goal is based on the Title 118 maximum contaminant level (MCL).
- If the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.
- If there is no MCL for an element (e.g., vanadium), the restoration value is based on BPT.
- The restoration value for the major cations (Ca, Mg, K, Na) allows the concentrations of these cations to vary by as much as one order of magnitude as long as the TDS restoration value is met. The total carbonate restoration criterion allows for the total carbonate to be less than 50 percent of the TDS. The TDS restoration value is set at the baseline mine unit average plus one standard deviation.

The current NDEQ restoration standards are listed in **Table T.2-4**.

It is anticipated that the Class III UIC Permit issued for the NTEA will have similar requirements. Under the provisions of Title 122, the NDEQ reviews and approves the establishment of the restoration standards. The restoration value for each mine unit is based on the current Title 118 standard at the time the NOI is approved by the NDEQ.

Appendix 9 contains the restoration tables for Mine Units 1 through 10 in the current commercial license area. These tables provide the baseline average for all restoration parameters as well as the NDEQ restoration standard approved for that mine unit in the NOI. These parameters must be restored to the standard value unless the standard is exceeded by a mean of the preoperational sampling values (baseline mean). The restoration value for parameters whose baseline mean exceeds the standard shall be equal to the mine unit plus two standard deviations (see **Table T.2-4**).

Mine Unit restoration values are contained in **Appendix 9** as follows:

- The mine unit average and NDEQ restoration values for Mine Unit 1 are given in **Appendix 9-1 of Appendix 9** The approval of the NOI which accepted these restoration values was issued on March 6, 1991.
- The mine unit average and NDEQ restoration values for Mine Unit 2 are given in **Appendix 9-2 of Appendix 9.** The approval of the NOI which accepted these restoration values was issued on March 25, 1992.
- The mine unit average and NDEQ restoration values for Mine Unit 3 are given in **Appendix 9-3 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on January 8, 1993.
- The mine unit average and NDEQ restoration values for Mine Unit 4 are given in **Appendix 9-4 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on March 11, 1994.
- The mine unit average and NDEQ restoration values for Mine Unit 5 are given in **Appendix 9-5 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on October 24, 1995.
- The mine unit average and NDEQ restoration values for Mine Unit 6 are given in **Appendix 9-6 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on March 3, 1998.
- The mine unit average and NDEQ restoration values for Mine Unit 7 are given in **Appendix 9-7 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on July 9, 1999.
- The mine unit average and NDEQ restoration values for Mine Unit 8 are given in **Appendix 9-8 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on July 5, 2002.

- The mine unit average and NDEQ restoration values for Mine Unit 9 are given **Appendix 9-9 of Appendix 9.** The approval of the NOI which accepted these restoration values was issued on October 21, 2003.
- The mine unit average and NDEQ restoration values for Mine Unit 10 are given **Appendix 9-10 of Appendix 9**. The approval of the NOI which accepted these restoration values was issued on January 23, 2007.

CBR Mine Unit 1 groundwater restoration has been approved by the NDEQ and NRC, with NRC approval being given in 2003. **Appendix 9-1** shows the Mine Unit No. 1 water quality parameter values for pre-mining, post-mining, post-restoration, and during the stabilization period (USNRC 2007, CBR 2000).

T.2.4.3 Restoration Procedure

At the cessation of mining in each mine unit, NDEQ shall be notified in writing, and shall proceed to establish the post-mining water quality for all parameters listed on the restoration table (**Table T.2-4**) of the designated restoration wells. This may be accomplished by collecting a sample of the lixiviant injected into the mine unit to be representative of the post-mining water quality. These samples may be split between a lab of CBR's choice and a lab of NDEQ's choice.

A written restoration plan shall be submitted, including a stabilization period of at least 6 months for that mine unit, and after NDEQ approval, shall commence restoration. Prior to approval of the restoration plan, additional wells may be installed to evaluate the success of the restoration efforts, if so directed by NDEQ. When it is determined that restoration is complete, sampling and analysis of all designated restoration wells for all of the parameters listed in the restoration table shall be completed. These samples will be split between a lab of CBR's choice and a lab of NDEQ's choice. The results of these samples shall be submitted to NDEQ.

T.2.4.4 Restoration Determination and Stabilization

- Restoration Parameters Achieved

Once the restoration procedure has returned the wellfield average of the restoration parameters to concentrations at or below the parameters approved by NDEQ, the NDEQ shall be notified that stabilization is being initiated. The notification shall include data supporting the fact that restoration parameters have been achieved. During stabilization, all designated restoration wells shall be monitored monthly for all of the parameters listed on the restoration table. At the end of the stabilization period, the data shall be submitted to NDEQ with a request that the wellfield be considered restored if the restoration parameters have been achieved and there is an absence of significant increasing trends for any of the restoration parameters. NDEQ will, in writing, extend the stabilization, require further restoration, or accept the restoration of the mine unit.

- Restoration Parameters Not Achieved

If the restoration parameters established in the NOI have not been met, or if there are significant increasing trends for any of the restoration parameters after application of best available technology, a written justification for alternate values shall be submitted to NDEQ for approval.

If the subsequent restoration is deemed successfully completed by NDEQ, sampling and analysis will be completed of all designated restoration wells for all parameters listed in the restoration table. These samples will be split between a lab of CBR's choice and a lab of NDEQ's choice. The sampling results shall be submitted to NDEQ. Restoration determination shall begin again as outlined in T.2.4.1

If NDEQ determines, with cause, that the alternate values are not justified, then a second restoration plan will be submitted detailing further restoration and, after approval, restoration shall be commenced.

T.3 Surface Reclamation

The following section addresses the final decommissioning methods of disturbed lands including wellfields, plant areas, evaporation ponds, and diversion ditches that will be used on the Crow Butte project sites. The section discusses general procedures to be used during final decommissioning as well as the decommissioning of a particular phase or production unit area.

Decommissioning of wellfields and process facilities, once their usefulness has been completed in an area, will be scheduled after agency approval of groundwater restoration and stability. Decommissioning will be accomplished in accordance with an approved decommissioning plan and the most current applicable NDEQ and NRC rules and regulations, permit and license stipulations, and amendments in effect at the time of the decommissioning activity.

The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section T.3.4.
- Determine appropriate cleanup criteria for structures and soils.
- Perform radiological surveys and sampling of all facilities, process-related equipment, and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Remove from the site all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocate to an operational portion of the mining operation.
- Decontaminate items to be released for unrestricted use to levels consistent with the requirements of NRC.
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.

- Perform final site soil radiation surveys consistent with the requirements of NRC.
- Backfill and recontour all disturbed areas.
- Establish permanent revegetation on all disturbed areas.

The following sections describe, in general terms, the planned decommissioning activities and procedures for the Crow Butte facilities. These activities and procedures will apply to the NTEA facilities as well as the current facilities. CBR will, prior to final decommissioning of an area, submit to the NRC and NDEQ a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning.

T.3.1 General Surface Reclamation Procedures

The primary surface disturbances associated with the NTEA-associated facilities will be the Satellite Facilities (uranium recovery building, fuel and chemical storage, shop, office, rest rooms and laboratory), evaporation ponds, and wellfield production areas. Surface disturbances also occur during the well drilling program, pipeline installation, and road construction. These more superficial disturbances, however, involve relatively small areas or have very short-term impacts.

The principal objective of the surface reclamation plan is to return disturbed lands to production compatible with the post-mining land use of equal or better quality than the pre-mining condition. For the NTEA, the reclaimed lands should be capable of supporting livestock grazing and providing stable habitat for native wildlife species. Soils, vegetation, wildlife, and radiological baseline data will be used as guidelines for the design, completion, and evaluation of surface reclamation. Final surface reclamation will blend affected areas with adjacent undisturbed lands to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind and water and sedimentation, and re-establish natural trough drainage patterns.

The following sections provide procedural techniques for surface reclamation of all disturbances addressed in the CBR mine plan. Reclamation procedures are provided for the facility sites, wellfield production units, evaporation ponds, and access and haul roads. Reclamation techniques and procedures for the North Trend Satellite Facility, ponds, and wellfields will follow these same concepts. Reclamation schedules for wellfield production units will be discussed separately because they depend on the progress of mining and the successful completion of groundwater restoration. Cost estimates for bonding calculations are discussed in **Chapter U** and include all activities that are anticipated to complete groundwater restoration, decontamination, decommissioning, and surface reclamation of wellfield and satellite plant facilities installed. These cost estimates are updated annually to cover work projected for the next year of mining activity.

T.3.1.1 Topsoil Handling and Replacement

In accordance with NDEQ requirements, topsoil is salvaged from building sites (including Satellite buildings) and pond areas. Conventional rubber-tired, scraper-type earth-moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which are determined during final wellfield construction activities.

As described in Section E.5.5, topsoil thickness varies within the NTEA. Topsoil is usually thickest in and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil-stripping depths may vary, depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, the field mapping and Soil Conservation Service Soil Surveys will be utilized to determine approximate topsoil depths.

Salvaged topsoil is stored in designated stockpiles. These stockpiles are generally located on the leeward side of hills to minimize wind erosion. Stockpiles are not located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles are seeded as soon as possible after construction with the permanent seed mix.

During mud pit excavation associated with well construction, exploration drilling, and delineation drilling activities, topsoil is separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil is replaced and topsoil is applied. Mud pits generally remain open for a short time. The success of revegetation efforts at the current site show that these procedures adequately protect topsoil and result in vigorous vegetation growth.

T.3.1.2 Contouring of Affected Areas

Due to the relatively minor nature of disturbances created by ISL mining, there are only a few areas disturbed to the extent to which subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. Generally speaking, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials, which requires replacement and contour blending during reclamation. The existing contours will only be interrupted in small, localized areas. Because approximate original contours will be achieved during final surface reclamation, no post-mining contour maps have been included in this application.

Changes in the surface configuration caused by construction and installation of operating facilities will be only temporary during the operating period. These changes will be caused by topsoil removal and storage along with the relocation of subsoil materials used for construction purposes. Restoration of the original land surface, which is consistent with the pre- and post-mining land use, the blending of affected areas with adjacent topography to approximate original contours, and the re-establishment of drainage patterns will be accomplished by returning the earthen materials moved during construction to their approximate original locations.

Drainage channels that have been modified by the mine plan for operational purposes such as road crossings will be re-established by removing fill materials, culverts, and reshaping to as close to pre-operational conditions as practical. Surface drainage of disturbed areas that have been located on terrain with varying degrees of slope will be accomplished by final grading and contouring appropriate to each location so as to allow for controlled surface runoff and eliminate depressions where water could accumulate.

T.3.1.3 Revegetation Practices

Revegetation is conducted in accordance with NDEQ requirements. During mining operations, the topsoil stockpiles and as much as practical of the disturbed wellfield and pond areas will be seeded with vegetation to minimize wind and water erosion. After placement of topsoil and contouring for final reclamation, an area will normally be seeded with a seed mixture developed in consultation with the Natural Resources Conservation Service (NRCS) as required by the NDEQ.

T.3.2 Process Facility Site Reclamation

Following removal of structures, subsoil and stockpiled topsoil will be replaced on the disturbances from which they were removed during construction, within practical limits. Areas to be backfilled will be scarified or ripped prior to backfilling to create an uneven surface for application of backfill. This will provide a more cohesive surface to eliminate slipping and slumping. The less suitable subsoil and unsuitable topsoil, if any, will be backfilled first so as to place them in the deepest part of the excavation to be covered with more suitable reclamation materials. Subsoils will be replaced using paddle wheel scrapers, bulldozers, or other appropriate equipment to transfer the earth from stockpile locations or areas of use and to spread it evenly on the ripped disturbances. Grader blades may be used to even the spread of backfill materials. Topsoil replacement will commence as soon as practical after a given disturbed surface has been prepared. Topsoil will be picked up from storage locations by paddle wheel scrapers or other appropriate equipment and distributed evenly over the disturbed areas. The final grading of topsoil materials will be done so as to establish adequate drainage, and the final prepared surface will be left in a roughened condition.

The NRCS shall be consulted for technical assistance in reclaiming the land surface, including appropriate seed mixtures. Topsoil from the ponds and building areas shall be removed, stockpiled, and seeded during operation and reapplied to the contoured surface. Reclamation plans (including the proposed seed mixture) will be submitted to the NDEQ for approval at least 60 days prior to commencement of reclamation. Pond reclamation and decommissioning shall be in accordance with NRC License SUA-1534.

T.3.3 Evaporation Pond Decommissioning

T.3.3.1 Disposal of Pond Water

The volume of water remaining in the lined evaporation ponds after restoration, as well as its chemical and radiological characteristics, will be considered to determine the most practical disposal program. Disposal options for the pond liquid include evaporation, treatment and disposal, or transportation to another licensed facility or disposal site. The pond water from the later stages of groundwater restoration may be treatable to within discharge limits. If this can be accomplished, the water will be treated and discharged under an appropriate National Pollutant Discharge Elimination System (NPDES) permit. Evaporation of the remaining water may be enhanced by use of sprinkler systems, etc.

T.3.3.2 Pond Sludge and Sediments

Pond sludges and sediments will contain mining process chemicals and radionuclides. Wind-blown sand grains and dust blown into the ponds during their active life also add to the bulk of sludges. This material will be contained within the pond bottom and kept in a dampened condition at all times, especially during handling and removal operation, to prevent the spread of airborne contamination and potential worker exposure through inhalation. Dust abatement techniques will be used as necessary. The sludge will be removed from the ponds and loaded into roll-off containers, dump trucks, or drums and transported to an NRC-licensed disposal facility.

T.3.3.3 Disposal of Pond Liners and Leak Detection Systems

Pond liners will be kept washed down and intact as much as practical during sludge removal so as to confine sludges and sediments to the pond bottom. Pond liners will be cut into strips and transported to an NRC-licensed disposal facility or will be decontaminated for release to an unrestricted area. After removal of the pond liners, the pond leak detection system piping will be removed. Materials involved in the leak detection system will be surveyed and released for unrestricted use if not contaminated or transported to an NRC-licensed facility for disposal. The earthen material in the pond bottom and leak detection system trenches will be surveyed for soil contamination. Any contaminated soil in excess of the cleanup criteria in **Table T.3-1** will be removed and disposed at an NRC-licensed disposal facility.

Following the removal of all pond materials and the disposal of any contaminated soils, surface preparation will take place prior to reclamation.

T.3.4 Wellfield Decommissioning

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

Wellfield decommissioning will consist of the following steps:

- The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters, or control fixtures may be salvaged.
- Buried wellfield piping will be removed.
- Wells will be plugged and abandoned according to the procedures described in Section T.1.
- The wellfield area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.
- Final revegetation of the wellfield areas will be conducted according to the revegetation plan.
- All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.

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

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

T.3.4.1 Buried Trunklines, Pipes, and Equipment

Buried process-related piping, such as injection and production lines, will be removed from the mine unit undergoing decommissioning. Salvageable lines will be held for use in ongoing mining operations. Lines that are not reusable may either be assumed to be contaminated and disposed of at a licensed disposal site or may be surveyed and, if suitable for release to an unrestricted area, may be sent to a sanitary landfill.

T.4 References

Crow Butte Resources, Inc. (CBR). 2000. *Mine Unit 1Restoration Report, Crow Butte Uranium Project*, Source Materials License Application SUA-1534, Crow Butte Resources, Inc., Crawdford, Nebraska. ADAMS ML003677938.

U. S. Nuclear Regulatory Commission (USNRC). 2007. Prepared by J.A. Davis and G.P. Curtis. *Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities*. NUREG/CR-6870. January 2007.

Table T.2-1 Typical Reverse Osmosis Membrane Rejection

Name	Symbol	Percent Rejection
Cations		
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Cadmium	Cd^{+2}	96-98
Calcium	Ca^{+2}	96-98
Copper	Cu^{+2}	98-99
Hardness	Ca and Mg	96-98
Iron	Fe^{+2}	98-99
Magnesium	Mg^{+2}	96-98
Manganese	Mn^{+2}	98-99
Mercury	Hg^{+2}	96-98
Nickel	Ni^{+2}	98-99
Potassium	K^{+1}	94-96
Silver	Ag^{+1}	94-96
Sodium	Na^{+}	94-96
Strontium	Sr^{+2}	96-99
Zinc	Zn^{+2}	98-99
Anions		
Bicarbonate	HCO_3^{-1}	95-96
Borate	$B_4O_7^{-2}$	35-70
Bromide	Br^{-1}	94-96
Chloride	Cl^{-1}	94-95
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Ferrocyanide	$Fe(CN)_6^{-3}$	99+
Fluoride	F^{-1}	94-96
Nitrate	NO_3^{-1}	95
Phosphate	PO_4^{-3}	99+
Silicate	SiO_2^{-1}	80-95
Sulfate	SO_4^{-2}	99+
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+

Source: Osmonics, Inc.

Table T.2-2 Analytical Results for Permeate

Major Ions	Units	Reporting Limit	Results
Calcium	mg/L	1.0	<1.0
Magnesium	mg/L	1.0	<1.0
Sodium	mg/L	1.0	15.2
Potassium	mg/L	1.0	1.1
Carbonate	mg/L	1.0	<0.1
Bicarbonate	mg/L	1.0	15.0
Sulfate	mg/L	1.0	5.4
Chloride	mg/L	1.0	14.8
Ammonia as N	mg/L	0.05	<0.05
Nitrite as N	mg/L	0.10	<0.10
Nitrate + Nitrite as N	mg/L	0.10	<0.10
Fluoride	mg/L	0.10	<0.10
Silica	mg/L	1.0	<1.0
Non-Metals			
Total Dissolved Solids	mg/L	10.0	10.0
Conductivity	umho/cm	1.0	47.0
Alkalinity	mg/L	1.0	12.0
pH	std. units	0.10	6.30
Trace Metals			
Aluminum	mg/L	0.10	<0.10
Arsenic	mg/L	0.001	0.001
Barium	mg/L	0.10	<0.10
Boron	mg/L	0.10	0.29
Cadmium	mg/L	0.005	<0.005
Chromium	mg/L	0.05	<0.05
Copper	mg/L	0.01	<0.01
Iron	mg/L	0.05	<0.05
Lead	mg/L	0.001	<0.001
Manganese	mg/L	0.01	<0.01
Mercury	mg/L	0.001	<0.001
Nickel	mg/L	0.05	<0.05
Selenium	mg/L	0.001	<0.001
Vanadium	mg/L	0.10	<0.10
Zinc	mg/L	0.01	0.02
Radiometrics			
Uranium	mg/L	0.0003	0.0082
Radium-226	pCi/L	0.2	3.1
Radium Error Estimate ±	--	--	0.3

Sample Date: 02/22/2001 Report Date: 03/16/2001
pCi/gm – picocuries per gram
mg/L – milligrams per liter
umho/cm – microomhs per centimeter

Table T.2-3 Pore Volume Calculations for North Trend Wellfield Mine Units

Mine Unit (MU)	MU Area (ft^2)		Average Under-Ream Interval (ft)		Open Pore Space Value (%)		Gallons/ ft^3		Gallons Per Pore Volume
1	3,451,070	x	15	x	.29	x	7.4805	=	112,298,421
2	3,440,718	x	15	x	.29	x	7.4805	=	111,961,565
3	3,464,312	x	15	x	.29	x	7.4805	=	112,729,318
4	3,467,111	x	15	x	.29	x	7.4805	=	112,820,398
5	2,371,855	x	15		.29		7.4805	=	77,180,576
TOTAL	**16,195,066**	--	**15**	x	**.29**	x	**7.4805**		**526,990,278**

Table T.2-4 NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]
Ammonium (mg/L)	Not Listed	10.0
Arsenic (mg/L)	0.010	0.010
Barium (mg/L)	2.0	2.0
Cadmium (mg/L)	0.005	0.005
Chloride (mg/L)	250	250
Copper (mg/L)	1.3	1.3
Fluoride (mg/L)	4.0	4.0
Iron (mg/L)	0.3	0.3
Mercury (mg/L)	0.002	0.002
Manganese (mg/L)	0.05	0.05
Molybdenum (mg/L)	(Reserved)	1.0
Nickel (mg/L)	(Reserved)	0.15
Nitrate (mg/L)	10.0	10.0
Lead (mg/L)	0.015	0.015
Radium (pCi/L)	5.0	5.0
Selenium (mg/L)	0.05	0.05
Sodium (mg/L)	N/A	Note 2
Sulfate (mg/L)	250	250
Uranium (mg/L)	0.030	0.030
Vanadium (mg/L)	(Reserved)	0.2
Zinc (mg/L)	5.0	5.0
pH (Std. Units)	6.5 - 8.5	6.5 – 8.5
Calcium (mg/L)	N/A	Note 2
Total Carbonate (mg/L)	N/A	Note 3
Potassium (mg/L)	N/A	Note 2
Magnesium (mg/L)	N/A	Note 2

Table T.2-4 NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]
TDS (mg/L)	N/A	Note 4

1 NDEQ Restoration Standard based on groundwater standard (MCL) from Title 118. For parameters where the baseline concentration exceeds the applicable MCL, the standard is set as the mine unit baseline average plus two standard deviations.

2 One order of magnitude above baseline is used as the restoration value for some parameters due to the ability of some major ions to vary one order of magnitude depending on pH.

3 Total carbonate shall not exceed 50% of the TDS value.

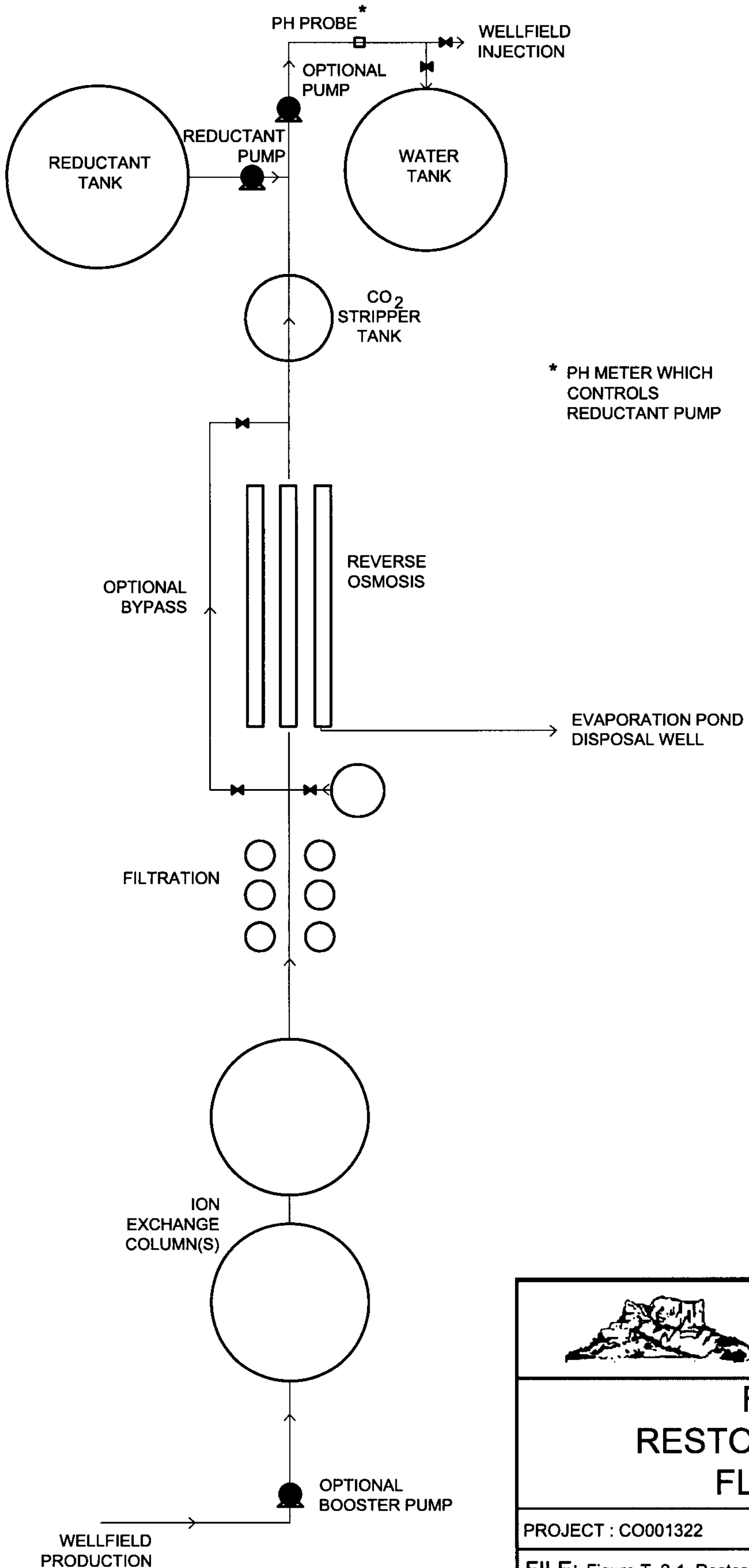
4 The restoration value for TDS shall be the baseline mean plus one standard deviation.

Source: NDEQ Class III UIC Permit Number NE0122611

Table T.3-1 Soil Cleanup Criteria and Goals

Layer Depth	Radium-226 (pCi/gm)		Natural Uranium (pCi/gm)	
	Limit	Goal	Limit	Goal
Surface (0 15 cm)	5	5	230	150
Subsurface (15 cm layers)	15	10	230	230

pCi/gm – picocuries per gram



CROW BUTTE RESOURCES, INC.

FIGURE T.2-1 RESTORATION PROCESS FLOW DIAGRAM

PROJECT : CO001322 MAPPED: JC CHECKED: J. CEARLEY

FILE: Figure T_2-1_RestorationProcessRevised.dwg @ 5/19/2009 9:54 AM

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CHAPTER U. COST ESTIMATE FOR ENVIRONMENTAL PROTECTION

An estimate of the costs to undertake environmental protection measures necessary to prevent contamination of the USDW during and after the cessation of operations. These measures shall include, but are not limited to (Refer to Title 122, Chapter 13):

- *The proper closing, plugging, and abandonment of a well(s).*
- *The proper disassembly, decontamination, and restoration of the aquifer site.*
- *The probable difficulty of completing the requirements above), due to such factors as topography, geology of the site, and hydrology.*
- *Any post-operational monitoring as may be required by the Environmental Protection Act, the regulations of Title 122, and/or the permit.*
- *Additional estimated costs to the State which may arise from applicable public contracting requirements or the need to bring personnel and equipment to the permit area to complete the restoration after its abandonment by the permittee.*

U.1 Decontamination, Decommissioning and Reclamation Cost Estimates

As required by Title 122, Chapter 13, Section 001.01, this section presents a written estimate of the costs for "environmental protection" deemed to be necessary during and after the cessation of operations. These cost estimates focus on costs associated with the restoration and reclamation (decommissioning) of the North Trend Expansion Area in order to ensure adequate funds are available for permanent closure of the project. The cost estimates address the above-referenced "measures" of concern. The estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

Once the estimated costs are approved by the NDEQ, CBR will provide proof of financial surety arrangements prior to commencement of operations, as per Title 122 Chapter 13. The NRC also requires a financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover costs of reclamation activities. Evidence of financial responsibility in the form of a letter of credit or other form satisfactory to the NDEQ in accordance with Title 122, Chapter 13, shall be provided to the NDEQ in an amount which is equal to or greater than the total costs indicated in the Surety Cost Estimate as required, along with an audit statement from an independent professional auditing firm. CBR will review the cost estimate on an annual basis and update in order to ensure adequacy of the dollar amount. The purpose is to ensure that there are sufficient funds available for decontamination, decommissioning and reclamation of the facility in the event CBR is incapable of performing the tasks.

Groundwater and surface reclamation and restoration methods to be used for the North Trend Expansion Area are discussed in Chapter T, as well as in CBR's Application for Amendment of USNRC Source Materials License North Trend Expansion Area Technical Report (CBR 2007). A decommissioning plan shall be based on factors such as the mine plan, baseline environmental information, and any other factors that will assure the long-term physical, geotechnical and geochemical stability of the site. Restoration of a specific mining unit can be started as soon as mining is completed, hence the importance of integrating the mine plan and the decommissioning plan. Restoration of a specific mine unit can occur while uranium recovery operations continue at other mining units. Once groundwater restoration has been completed in the final mining unit and approved by the NDEQ, decommissioning of the satellite processing plant, remaining evaporation ponds and other structures can be initiated.

The cost estimates presented in this section are based on the cost per year to restore one mine unit and reclaim one mine unit (surface and subsurface features). The CBR mine plan calls for sequential restoration and reclamation, and CBR will have approximately two to three mine units in restoration, mining, or reclamation at any one time. The surety cost estimates will be adjusted as necessary when additional mine units are to be brought on line and the proposed operations are better defined. A current and updated surety is required at least 90 days prior to commencement of construction of a new mine unit or significant expansion.

Cost information is presented in the following tables:

Table U.1-2	North Trend Total Restoration and Reclamation – 2010 Surety Estimate
Table U.1-3	North Trend Groundwater Restoration – 2010 Surety Estimate
Table U.1-4	North Trend Wellfield Reclamation – 2010 Surety Estimate
Table U.1-5	North Trend Well Abandonment Unit – 2010 Surety Estimate
Table U.1-6	North Trend Satellite Facility Equipment Decommissioning – 2010 Surety Estimate
Table U.1-7	North Trend Building Demolition Cost – 2010 Surety Estimate
Table U.1-8	North Trend Evaporation Pond Reclamation – 2010 Surety Estimate
Table U.1-9	North Trend Miscellaneous Site Reclamation – 2010 Surety Estimate
Table U.1-10	North Trend Deep Disposal Well Reclamation – 2010 Surety Estimate
Table U.1-11	North Trend Groundwater Sweep (GWS) [Unit Cost] – 2010 Surety Estimate
Table U.1-12	North trend Groundwater Reverse Osmosis (RO) Treatment [Unit Cost] – 2010 Surety Estimate
Table U.1-13	North Trend Groundwater Recirculation [Unit Cost] – 2010 Surety Estimate
Table U.1-14	North Trend Well Abandonment [Unit Cost] – 2010 Surety Estimate
Table U.1-15	North Trend Master Cost Basis – 2010 Surety Estimate

Table U.1-2 provides a summary of the total estimated costs for projected restoration and reclamation activities ($2,197,234), which includes a contract administration and contingency fees of 10 and 15 percent, respectively. The remaining tables provide a further refinement of the cost estimates and the basis for the tasks and cost estimates.

The deep disposal well will operate under a separate UIC permit, but the reclamation cost estimates for this well have been provided as part of the total surety estimate for the North Trend Expansion Area.

Some of the main assumptions that serve as the basis for the estimated surety costs are shown in **Table U.1-1**.

U.2 Restoration and Reclamation Issues Associated with Topography, Geology and Hydrology

There are no major difficulties anticipated with the restoration and reclamation of the groundwater of the North Trend Expansion Area, including plugging and abandonment of wells and disassembly, decontamination, and restoration of the aquifer site. However, restoration of the affected aquifer to "precise pre-existing levels" may not be feasible (see discussions below). CBR has successfully plugged and abandoned numerous wells, and restored the groundwater of Mine Unit 1, in the current permitted area. Similar geological and hydrological conditions at the North Trend Expansion Area would indicate the same results can occur at this proposed mining area. There are no topography issues within the North Trend Expansion Area that would pose as a problem with decontamination and reclamation of surface or subsurface features.

The primary goal of the groundwater restoration program is to return groundwater affected by mining operations to conditions suitable for the uses for which they were suitable before mining. Preference would be to attain pre-injection baseline values on a mine unit average as determined by the baseline water quality sampling program. However, since ISL operations alter the groundwater geochemistry, it is unlikely that restoration efforts will return the groundwater to the "precise" water quality that existed before operations. Should restoration efforts be unable to achieve baseline conditions after diligent application of the best practicable technology (BPT) available, CRB will, in accordance with the Nebraska Environment Quality Act and NDEQ regulations, return the groundwater to the restoration values set by the NDEQ in the Class III UIC permit. A reverse osmosis treatment unit will be used to enhance the treatment of groundwater in an attempt to return the groundwater to as near baseline as possible. Cost estimates presented in the attached tables assume groundwater can be restored to levels acceptable the NDEQ. This is believed to be achievable based on successful restoration of Mine Unit 1 in the current permitted area. Cost estimates are considered to be adequate in addressing other perceived "issues" associated with decommissioning.

Geological, surface water and groundwater environmental impacts associated with operations are discussed in detail in sections I.5.2.3, I.5.2.5 and I.5.2.6 of Chapter I. Restoration determination and establishment of restoration parameters are discussed in Section T.2.4 of Chapter T.

U.3 Post-Operational Monitoring as May be Required by the Environmental Protection Act, the Regulations Of Title 122, and/or the Permit.

The primary post-operational monitoring task will be associated with restoration and stabilization of the groundwater in the affected aquifer. Monitoring of designated monitor wells used during operations will continue through restoration and stabilization of a mine unit, and new wells may be added as needed. It is assumed that the plugging of wells and surface reclamation of the mining units and support facilities will take place once the NDEQ has deemed restoration complete and in compliance with applicable regulations.

Restoration and stabilization monitoring procedures are discussed in Section T.2. Cost estimates for the projected monitoring activities are presented in the attached Tables.

U.4 Additional Estimated Costs to Complete Restoration if Abandoned by Permittee

In the event that CBR abandoned the project, and the State was required to complete decommissioning of the site, sufficient funds have been provided in the estimated costs to address such an unlikely event. In addition the estimated costs for actual decommissioning activities and required equipment, cost estimates for supervisors and other required staffing, have been provided for in the estimated costs. There is also a contract administration cost estimate of $175,779 (10% of total estimated costs) and a contingency of $263,668 (15% of total estimated costs). This position of adequately estimated funds is based on restoration of one mine unit and reclamation of one mine unit, which is reflective of the initial operation. As new mine units are added, the surety will be updated to reflect associated increased decommissioning costs. Therefore, sufficient funds will always be available in the event the State is forced to take the project over and complete decommissioning.

Table U.1-1 Primary Assumptions Serving as the Basis for Surety Cost Estimates Associated with Restoration and Reclamation of One (1) Mine Unit

Assumptions	Quantity
Total number of production wells	30
Total number of injection wells	50
Total number of shallow monitor wells	16
Total number of perimeter wells	25
Total number of restoration wells	16
Wellfield Area (ft^2)	600,000
Wellfield Area (acres)	25.00
Affected Ore Zone Area (ft^2)	600,000
Average completed thickness (ft)	20.0
Porosity	0.29
Affected Volume (ft^3)	12,000,000
K gallons per Pore Volume	26,030
Estimated Number of Pore Volumes for Restoration	11
Number of Wells per Wellfield	121
Total Number of Wells	121
Average Well Depth (ft) – Deep Wells	550
Average Well Depth (ft) – Shallow Depth	200

Estimated costs are shown in Table U.1-2 and U.1-3.

Table U.1-2 North Trend Total Restoration and Reclamation Cost Estimate – 2010 Surety Estimate

Task		Cost $
I.	Groundwater Restoration (Table U.1-3)	616,769
II.	Wellfield Reclamation (Tables U.1-4 and U.1-5)	127,233
III.	North Trend Satellite Facility Reclamation/Decommissioning (Tables U.1-6 and U.1-7)	697,911
IV.	Evaporation Pond Reclamation (Table U.1-8)	172,822
V.	Miscellaneous Site Reclamation (Table U.1-9)	80,872
VI.	Deep Disposal Well Reclamation (Table U.1-10)	62,180
Subtotal Reclamation and Restoration Cost Estimate		1,757,787
	Contract Administration (10%)	175,779
	Contingency (15%)	263,668
	TOTAL	**$2,197,234**

Table U.1-3 North Trend Groundwater Restoration – 2010 Surety Estimate

Task	MU1	MU2	MU3	MU4	MU5	--	--	--	--	--	--	Total
I. Groundwater IX Treatment Costs												
PVs Required		3	3	3	3							
Total Kgals for IXTreatment	3	0	0	0	0							0
Groundwater Sweep Unit Cost ($ Kgal)	78090	$0.70	$0.70	$0.70	$0.70							
(Table U.1-11)	$0.70	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$0.00**
Subtotal Groundwater IX Treatment Costs	**$54,663.0**	**$0.00**										
per Wellfield	**0**											
Total Groundwater Sweep Costs	**$54,663.0**											
	0	**6**	**6**	**6**	**6**							
II. Reverse Osmosis Costs		0	0	0	0							0
PVs Required		$1.93	$1.93	$1.93	$1.93							$1.93
Total Kgals for Treatment	6	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$0.00**
Reverse Osmosis Unit Cost ($/Kgal (Table	156,180	**$0.00**										**$0.00**
U.1-12)	$1.93											
Subtotal Reverse Osmosis Costs per Wellfield	**$301,427.**											
Total Reverse Osmosis Costs	**40**	2	2	2	2							
	$301,427.	0	0	0	0							0
III. Recirculation Costs	**40**	$0.40	$0.40	$0.40	$0.40							$0.40
PVs Required		**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$0.00**
Total Kgals for Treatment		**$0.00**										
Recirculation Unit Cost ($/KgaL) (Table U.1-	2											
13)	52060											
Subtotal Recirculation Costs per Wellfield	$0.46											
Total Recirculation Costs	**$23,947.6**	$0.00	$0.00	$0.00	$0.00							$0.00
	0	$0.00	$0.00	$0.00	$0.00							$0.00
IV. Consumables	**$23,947.6**											
Spare parts, filters and consumables -	**0**				$0.00							$0.00
$20,188.55/year		$0.00	$0.00	$0.00	$0.00							$0.00
		$0.00	$0.00	$0.00								
Active restoration period (months)												
Consumable usage (months restoration x	8.52											
annual rate estimate)	**$14,333.7**											
	3				0							0
Subtotal Consumables per Mine Unit		0	0	0	0							0

Total Consumables Costs		0	0	0		
	$14,333.7				0.00	0.00
V. Monitoring and Sampling Costs	**3**	0.00	0.00	0.00	0.00	0.00
Guideline 8 analysis - $200.00 analysis	**$14,333.7**	0.00	0.00	0.00	0.00	0.00
6 parameter in-house analysis - $50.24 analysis	**3**	0.00	0.00	0.00	0.00	0.00
Total restoration wells		0.00	0.00	0.00		
Total monitor wells						
Groundwater sweep duration (months)	16					
Reverse Osmosis duration (months)	41					
Recirculation duration (months)						
Stabilization duration (months)	1.55					
	5.94					
	1.03					
	6					

MU = Mine Unit   PV = Pore Volumes   RO = Reverse Osmosis   HP = Health Physicists
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Table U.1-3 North Trend Groundwater Restoration – 2010Surety Estimate *(continued)*

Task	MU1	MU2	MU3	MU4	MU5	--	--	--	--	--	--	Total
A. Restoration Well Sampling												
1. Well sampling prior to restoration start												
# of wells	16	0	0	0	0							0
$/sample	$200.00	$200.00	$200.00	$200.00	$200.00							
2. Groundwater IX Treatment Sampling												
# of wells	16	0	0	0	0							
Total # samples	32	0	0	0	0							0
$/sample	$50.04	$50.04	$50.04	$50.04	$50.04							
3. Reverse Osmosis Sampling												
# of wells	16	0	0	0	0							
Total # samples	96	0	0	0	0							0
$/sample	$550.04	$50.04	$50.04	$50.04	$50.04							
4. Recirculation Sampling												
# of wells	16	0	0	0	0							
Total # samples	32	0	0	0	0							0
$/sample	$200.00	$200.00	$20..00	$200.00	$200.00							$200.00
5. Stabilization Sampling (Guideline 8))												
# of wells	16	0	0	0	0							
Total # samples	48	0$200.00	0	0	0							0$200.00
$/sample	$200.00		$200.00	$200.00	$200.00							
6. Stabilization Sampling (6 parameter in-house)		0										
# of wells	16	0	0	0	0							0
Total # samples	96	$50.04	0	0	0							
$/sample	$50.04		$50.04	$50.04	$50.04							
7. Monitor Well Sampling		0										
# of wells	41	$50.04	0	0	0							
$/sample	$50.04	0	$50.04	$50.04	$50.04							0
Total # samples (2.2/mo. For entire period)	1039		0	0	0							
8. Other Laboratory Costs												
Radon, urinalysis, etc. = $912.05/month		$0.00										$0.00
Total for other laboratory costs	$7,770.67		$0.00	$0.00	$0.00							
Subtotal Monitoring and Sampling Costs per Mine Unit		**$0.00**										**$0.00**
Total Monitoring and Sampling Costs	**$103,732.03**		**$0.00**	**$0.00**	**$0.00**							
		$0.00										
	$103,732.03											

MU = Mine Unit PV = Pore Volumes RO = Reverse Osmosis HP = Health Physicists
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Table U.1-3 North Trend Groundwater Restoration – 2010 Surety Estimate *(continued)*

Task	MU1	MU2	MU3	MU4	MU5	--	--	--	--	--	--	Total
VI. Supervisory Labor Cost												
Engineering Support = $9,250.31 month												
HP Technician Support = $4,677.49 month												
Active restoration period (months)	8.52	0.00	0.00	0.00	0.00							
Stabilization period (months)	6	0	0	0	0							
1. Engineer support during active restoration	$78,812.64	$0.00	$0.00	$0.00	$0.00							$0.00
2. HP Technician support during active restoration	$39,852.21	$0.00	$0.00	$0.00	$0.00							$0.00
3. Engineer support during final stabilization												
4. HP Technician support during final stabilization												**$0.00**
Subtotal Supervisory Labor per Mine Unit	**$118,664.85**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							
Total Supervisory Labor Costs	**$118,664.85**	**$0.00**										
Total Restoration Cost per Wellfield	$616,768.61	**$0.00**	**$0.00**	**$0.00**	**$0.00**					**$0.00**	**$0.00**	**$0.00**
TOTAL GROUNDWATER RESTORATION COSTS			**$616,768.61**									

MU = Mine Unit PV = Pore Volumes RO = Reverse Osmosis HP = Health Physicists

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Table U.1-4 North Trend Wellfield Reclamation - 2010Surety Estimate

	MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--	Totals
Wellfield Piping												
Assumptions:												
Number of Wellhouses	1	0	0	0	0							1
Total Mine Unit surface area (acres)	25.00	0.00	0.00	0.00	0.00							25.00
Total length of small diameter production and injection lines (laterals) (ft)	27000	0	0	0	0							27000
Total length of 3/8-inch hose (ft)	0	0	0	0	0							0
Total length 1-1/4-inch stinger pipe (ft)	5000	0	0	0	0							5000
Total length of 2-inch downhole production pipe (ft)	16500	0	0	0	0							16500
Total Length of Trunkline (6-inch) (ft)	0	0	0	0	0							0
Total Length of Trunkline (8-inch) (ft)	1500	0	0	0	0							1500
Total Length of Trunkline (10-inch) (ft)	0	0	0	0	0							0
Total Length of Trunkline (12-inch) (ft)	0	0	0	0	0							0
Total Length of All Trunkline (ft)	1500	0	0	0	0							1500
Total number of production wells	30	0	0	0	0							30
Total number of injection wells	50	0	0	0	0							50
Total number of shallow monitor wells	16	0	0	0	0							16
Total number of perimeter monitor wells	25	0	0	0	0							25
I. Production and Injection Piping												
A. Removal and Loading												
Production and Injection Piping Removal Unit Cost ($/ft of pipe)	$0.67	$0.67	$0.67	$0.67	$0.67							
Subtotal Production and Injection Piping Removal and Loading Costs	*$18,090.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$18.090.00*
B. Pipe Shredding												
Production and Injection Piping Shredding Unit Cost ($/ft of pipe)	$0.08	$0.08	$0.08	$0.08	$0.08							
Subtotal Production and Injection Piping Removal and Loading Costs	*$2,160.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$2,160.00*
C. Equipment Costs												
Cat 924G Loader Unit Costs for removal (450'/day)	$26,529.60	$0.00	$0.00	$0.00	$0.00							
Shredder Unit Costs for shredding (450'/day)	$5,760.00	$0.00	$0.00	$0.00	$0.00							
Subtotal Equipment Costs	*$32,289.60*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$32,289.60*

Table U.1-4 North Trend Wellfield Reclamation - 2010Surety Estimate

	MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	–	--	--	Totals
D. Transport and Disposal Costs (NRC-Licensed Facility)												
Chipped Volume Reduction (ft^3/ft)	0.0069	0.0069	0.0069	0.0069	0.0069							
Chipped Volume per Wellfield (yd^3)	6.9	0.0	0.0	0.0	0.0							
Volume for Disposal Assuming 25% Void Space (yd^3)	8.6	0.0	0.0	0.0	0.0							8.6
Transportation and Disposal Unit Cost ($/$yd^3$) Unpackaged Bulk	$357.12	$357.12	$357.12	$357.12	$357.12							
Subtotal Production and Injection Piping Transport and Disposal Costs	*$3,071.23*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$3,071.23*
Total Production and Injection Piping Costs	**$55,610.83**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$55,610.83**
II. Trunklines												
A. Removal and Loading												
Trunkline Removal Unit Cost ($/ft of pipe)	$1.51	$1.51	$1.51	$1.51	!.51							
Subtotal Trunkline Removal and Loading Costs	*$2,190.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$2,265.00*
B. Pipe Shredding												
Trunkline Shredding Unit Cost ($/ft of pipe)	$1.51	$.151	$1.51	$1.51	$1.51							
Subtotal Trunkline Shredding Costs	*$2,265.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$2,265.00*
C. Equipment Costs												
Cat 924G Loader Unit Costs for removal (200'/day)	$3,316.20	$0.00	$0.00	$0.00	$0.00							
Shredder Unit Costs for shredding (200'/day)	$720.00	$0.00	$0.00	$0.00	$0.00							
Subtotal Equipment Costs	*$4,036.20*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$4,036.20*
D. Transport and Disposal Costs (NRC-Licensed Facility)												
Chipped Volume Reduction (6-inch) (ft^3/ft)	0.0651	0.0651	0.0651	0.0651	0.0651							
Chipped Volume Reduction (8-inch) (ft^3/ft)	0.1103	0.1103	0.1103	0.1103	0.1103							
Chipped Volume Reduction (10-inch) (ft^3/ft)	0.1712	0.1712	0.1712	0.1712	0.1712							
Chipped Volume Reduction (12-inch) (ft^3/ft)	0.2408	0.2408	0.2408	0.2408	0.2408							
Chipped Volume per Wellfield (yd^3)	6.1	0.0	0.0	0.0	0.0							
Volume for Disposal Assuming 25% Void Space (ft^3)	7.6	0.0	0.0	0.0	0.0							7.6
Transportation and Disposal Unit Cost ($/$ft^3$)	$357.12	$357.12	$357.12	$357.12	$357.12							
Subtotal Transport and Disposal Costs	*$2,714.11*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$2,714.11*
Total Trunkline Costs	**$11,280.31**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$11,280.31**
III. Downhole Pipe												
A. Removal and Loading												

Table U.1-4 North Trend Wellfield Reclamation - 2010Surety Estimate

	MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--	Totals
Downhole Piping Removal Unit Cost ($/ft of pipe)	$0.080	$0.080	$0.080	$0.080	$0.080							
Downhole Hosing Removal Unit Cost ($/ft of pipe)	$0.150	$0.150	$0.150	$0.150	$0.150							
Removal of 1-1/4-inch stinger pipe	$400.00	$0.00	$0.00	$0.00	$0.00							
Removal of downhole production pipe	$1,320.00	$0.00	$0.00	$0.00	$0.00							
Removal of downhole hose	$0.00	$0.00	$0.00	$0.00	$0.00							
Subtotal Downhole Piping Removal and Loading Costs	*$1,720.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$1,720.00*
B. Pipe Shredding												
Downhole Piping Shredding Unit Cost ($/ft of pipe)	$0.070	$0.070	$0.070	$0.070	$0.070							
Subtotal Downhole Piping Shredding Costs	*$1,505.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$1,505.00*
C. Equipment Costs												
Smeal Unit Costs for removal	$1,075.00	$0.00	$0.00	$0.00	$0.00							
Shredder Unit Costs for shredding	$458.67	$0.00	$0.00	$0.00	$0.00							
Subtotal Equipment Costs	*$1,533.67*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$1,533.67*
D. Transport and Disposal Costs (NRC-Licensed Facility)												
Chipped Volume Reduction - 1-1/4-inch stinger (ft^3/ft)	0.0044	0.0044	0.0044	0.0044	0.0044							
Chipped Volume Reduction - 2-inch downhole production (ft^3/ft)	0.0074	0.0074	0.0074	0.0074	0.0074							
Volume Reduction - 3/8-inch hose (ft3/ft)	0.0313	0.0313	0.0313	0.0313	0.0313							
Chipped Volume - 1-1/4-inch stinger (ft^3)	22	0	0	0	0							
Chipped Volume - 2-inch downhole production (ft^3)	122	0	0	0	0							
Volume 3/8-inch hose (ft3)	0	0	0	0	0							
Volume for Disposal Assuming 25% Void Space (yd^3)	6.7	0.0	0.0	0.0	0.0							6.7
Transportation and Disposal Unit Cost ($\$/yd^3$) (Unpackaged Bulk)	$357.12	4357.12	$357.12	$357.12	$357.12							
Subtotal Downhole Piping Transport and Disposal Costs	*$2,392.70*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$2,392.70*
Total Downhole Piping Costs	**$7,151.37**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$7.151.37**
IV. Surface Reclamation												
A. Removal and disposal of contaminated soil around wells												
Volume of contaminated soil (0.37 yd3 per injection and production well)	29.6	0	0	0	0							29.60
Disposal of contaminated soil ($150.27 per yd3)	$4,447.99	$0.00	$0.00	$0.00	$0.00							$4,447.00
Equipment (Cat 924G loader at 2 yd3/hr)	$818.00	$0.00	$0.00	$0.00	$0.00							

Table U.1-4 North Trend Wellfield Reclamation - 2010Surety Estimate

	MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--	Totals
Labor (1 man-hour per 2 Yd3)	$279.31	$0.00	$0.00	$0.00	$0.00							
Subtotal removal and disposal of contaminated soil	*$5,545.30*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$5.545.30*
B. Recontour and seeding												
Recontour and seeding (est. $300/acre)	$7,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Subtotal Recontour and Seeding	*$7,500.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$7,500.00*
Total Surface Reclamation	**$13,045.30**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$13.045.30**
IV. Well Houses												
Total Quantity	1	0	0	0	0	0	0	0	0	0	0	
Average Well House Weight (Lbs.)	6000	6000	6000	6000	6000							
A. Removal												
Dismantlement at 2-man-days per wellhouse (man-days)	2	0	0	0	0							
Dismantlement Labor Costs	$301.96	$0.00	$0.00	$0.00	$0.00							$301.96
Equipment (Cat 924G at 2 hours per wellhouse) (hrs)	2	0	0	0	0							
Equipment Costs	$110.54	$0.00	$0.00	$0.00	$0.00							$110.54
Subtotal Well House Dismantlement Costs	*$412.50*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$412.50*
B. Disposal												
Total Disposal Weight (6000 lbs per wellhouse) (Lbs)	6000	0	0	0	0							
Subtotal Disposal Costs	*$115.02*	*$0.00*	*$0.00*	*$0.00*	*$0.00*							*$115.02*
Total Well House Removal and Disposal Costs	**$527.52**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$527.52**
TOTAL REMOVAL AND DISPOSAL COSTS PER WELLFIELD	**$87,615.33**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$86,615.33**
TOTAL WELLFIELD BUILDINGS AND EQUIPMENT REMOVAL AND DISPOSAL COSTS					**$87,615.33**							

MU = Mine Unit

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Table U.1-5 North Trend Well Abandonment - 2010Surety Estimate

		MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--	Total
I. Well Abandonment (Wellfields)													
# of Production Wells		30	0	0	0	0							
# of Injection Wells		50	0	0	0	0							
# of Perimeter Monitor Wells		25	0	0	0	0							
# of Shallow Monitor Wells		16	0	0	0	0							
Total Number of Deep Wells		105	0	0	0	0							105
Total Number of Shallow Wells		16	0	0	0	0							16
Average Diameter of Casing (inches)		5	5	5	5	5							
Production, Injection and Perimeter Well Average Depth (ft)		550	0	0	0	0							
Shallow Well Average Depth (ft)		200	0	0	0	0							
Total Mine Unit Well Depth (ft)		60950	0	0	0	0							
Well Abandonment Unit Cost ($/ft. of well)		$0.65	$0.65	$0.65	$0.65	$0.65							
Subtotal Abandonment Cost per Wellfield		**$39,617.50**	**$0.00**	**$0.00**	**$0.00**	**$0.00**							**$39,617.50**
II. Downhole Pump Disposal													
Number of Downhole Pumps	0												
Pump Disposal Volume(ft3)	0.5												
Total Pump Disposal Volume(yd3)	0.0												0.0
Downhole Pump Disposal Rate ($/yd3)	$357.12												357.12
Subtotal Downhole Pump Disposal		**$0.00**											**$0.00**
Total Wellfield Abandonment Costs		**$39,617.50**											

MU = Mine Unit
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Table U.1-6 North Trend Satellite Facility Equipment Decommissioning - 2010 Surety Estimate

I.	**Removal and Loading Costs**	
	Tankage	
	Number of Contaminated Tanks	10
	Volume of Contaminated Tank Construction Material (ft^3)	397
	Number of Chemical Tanks	0
	Disposal Void Factor	1.25
A.	Labor to Remove and Load Tankage	
	Number of Persons	2
	Tanks/Day	1
	Number of Days	10
	$/Day/Person	$150.98
	Subtotal Removal Labor Costs	*$3,019.60*
B.	Labor to Clean Chemical Tankage	
	Number of Persons	1
	Tanks/Day	1
	Number of Days	0
	$/Day/Person	$150.98
	Subtotal Cleaning Labor Costs	*$0.00*
C.	Equipment	
	Saws, scaffolding, etc.	$6,000
	Subtotal Equipment Costs	*$6,000*
Total Equipment Removal and Loading Costs		**$9,019.60**
II.	**Transportation and Disposal Costs (NRC-Licensed Facility)**	
A.	Tankage	
	Volume of Tank Construction Material (ft^3)	397
	Volume for Disposal Assuming Void Space (yd^3)	18.4
	Transportation and Disposal Unit Cost ($/$yd^3$) (Unpackaged Bulk)	$357.12
	Subtotal Tankage Transportation and Disposal Costs	*$6,571.01*
B.	Contaminated PVC Pipe	
	Volume of Shredded PVC Pipe (ft^3)	153.6
	Volume for Disposal Assuming Void Space (yd^3)	7.1
	Transportation and Disposal Unit Cost ($/$yd^3$) (Unpackaged Bulk)	$357.12
	Subtotal Contaminated PVC Pipe Transportation and Disposal Costs	*$2,535.55*
C.	Pumps	
	Volume of Process Pumps (yd^3) (no void factor used)	2.4
	Transportation and Disposal Unit Cost ($/$yd^3$) (Unpackaged Bulk)	$357.12
	Subtotal Pump Transportation and Disposal Costs	*$857.09*
D.	Filters (injection, backwash and yellowcake filters)	
	Volume of Filters (yd^3) (no void factor used)	0.0
	Transportation and Disposal Unit Cost ($/$yd^3$) (Unpackaged Bulk)	$357.12
	Subtotal Filter Transportation and Disposal Costs	*$0.00*
E.	Dryer	
	Dryer Volume (yd^3) (no void factor used)	0.0
	Transportation and Disposal Unit Cost ($/$yd^3$) (Unpackaged Bulk)	$357.12
	Total Dryer Transportation and Disposal Costs	*$0.00*
	Total Contaminated Equipment Transportation and Disposal Costs	**$9,963.65**

Table U.1-6 North Trend Satellite Facility Equipment Decommissioning - 2010 Surety Estimate

III. Transportation and Disposal (Solid Waste for Landfill Disposal)	
A. Cleaned Tankage	
Volume of Tank Construction Material (ft^3)	0
Number of Landfill Trips	1
Transportation and Disposal Unit Cost ($/Load)	$212.00
Subtotal Tankage Transportation and Disposal Costs	*$212.00*
B. Uncontaminated PVC Pipe	
Volume of Shredded PVC Pipe (ft^3)	0
Number of Landfill Trips	1
Transportation and Disposal Unit Cost ($/Load)	$212.00
Subtotal PVC Pipe Transportation and Disposal Costs	*$212.00*
Total Uncontaminated Equipment Transportation and Disposal Costs	**$424.00**
IV. Supervisory Labor Costs During Plant Decommissioning	
Estimated Duration (months)	6
Engineer	$55,501.86
Radiation Technician	$28,064.94
Total Supervisory Labor Costs	**$83,566.80**
SUBTOTAL EQUIPMENT REMOVAL AND DISPOSAL COSTS PER FACILITY	$102,974.05
Building Area (ft^2)	34,000
Building Equipment Removal and Disposal Cost per Square Foot	$3.03
TOTAL EQUIPMENT REMOVAL AND DISPOSAL COSTS	**$102,974.05**

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Table U.1-7 North Trend Building Demolition - 2010 Surety Estimate

I. Decontamination Costs	
A. Wall Decontamination	
Area to be Decontaminated (ft^2)	0
HCl Application Rate (Gallons/ft^2)	1
HCl Acid Cost	$1.65
Subtotal Wall Decontamination Materials Costs	$0.00
B. Concrete Floor Decontamination	
Area to be Decontaminated (ft^2)	9000
HCl Application Rate (Gallons/ft^2)	2
HCl Acid Cost	$1.65
Subtotal Floor Decontamination Materials Costs	$29,700.00
C. Decontamination Labor	
Labor (man-days)	2
Subtotal Decontamination Labor Cost	$301.96
D. Decontamination Equipment Costs	
Sprayer pump	$500
Recycle pump	$500
Sprayer with hose	$1,000
Subtotal Decontamination Equipment Costs	$2,000
E. Decontamination Waste Disposal (to Ponds)	
Total gallons HCl waste	18,000
Pumping costs (5 HP/30 gpm)	$178.73
Subtotal Decontamination Costs	$32,180.69
Total Decontamination Costs	**$32,180.69**
II. Demolition Costs	
Assumptions (based on 2007 costs):	
Dismantling interior steel, tanks, pumps, etc.	$159,450.00
Dismantling plant building	$79,725.00
A. Building Dismantling	
Dismantle interior components (2007 $'s escalated by CPI)	$157,217.70
Plant building dismantling (2007 $'s escalated by CPI)	$78,608.85
Subtotal Building Dismantling	*$235,826.55*
B. Concrete Floor Removal	
Area of direct-dispose concrete floors (ft2)	13,400
Removal Rate ($/ft2)	$14.04
Subtotal Concrete Floor Removal	*$188,136.00*
Total Demolition Costs	**$423,962.55**
III. Disposal Costs	
A. Concrete Floor	
Area of Direct-Dispose Concrete Floor (ft^2)	13,400
Average Thickness of Concrete Floor (ft)	0.75
Volume of Concrete Floor (ft^3)	10,050
Volume of Concrete Floor (Yd3)	372
Transportation and Disposal Unit Cost ($/$Yd^3$) (Unpackaged Bulk)	$357.12
Subtotal Concrete Floor Disposal Costs	*$132,848.64*
Total Disposal Costs	**$132,848.64**

Table U.1-7 North Trend Building Demolition - 2010 Surety Estimate

IV Plant Site Reclamation	
A. Plant Site Earthwork	
Material to be Moved (yd^3)	20,000
D8N Bulldozer Earthwork Rate (yd^3/hr)	700
D8N Hourly Rate	$166.06
Subtotal Plant Site Earthwork	*$4,744.57*
B. Revegetation	
Area requiring Revegetation (Ac)	4
Revegetation Unit Cost ($/Ac)	$300
Subtotal Plant Site Revegetation	*$1,200.00*
Total Plant Site Reclamation Costs	**$5,944.57**
SUBTOTAL BUILDING DEMOLITION AND DISPOSAL COSTS	$594,936.45
Building Area (ft^2)	34,000
Building Demolition Cost per Square Foot	$17.50
TOTAL BUILDING DEMOLITION AND DISPOSAL COSTS	**$594,936.45**

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Table U.1-8 North Trend Evaporation Pond Reclamation - 2010 Surety Estimate

	Assumptions/Data:		
		Number of Ponds	2
		Area of Ponds (ft^2)	250,000
		Thickness of Liner Material (ft)	0.00833
		Leak detection piping size (in)	4
		Leak detection piping length (ft/pond)	2,100
		Earthwork Requirements (yd^3/pond)	60,000
		Surface Restoration/Revegetation (Acres)	20
		Sludge Production Rate (yd^3 sludge/gal)	0.000000102
		(1 yd^3 sludge/9,772,000 gal R&D Phase)	
		Estimated 2011 to 2012 Total Production (gallons)	3,942,000
		Liner Removal Rate (ft^2/man-day)	10,000
		Sludge Removal Rate (yd^3/man-day)	8.33
I.	**Pond Liner and Piping Removal**		
	A.	Pond Liner and Piping Removal Labor	
		Area of Ponds	500,000
		Liner Removal Rate (ft^2/Man-Day)	10,000
		Total Man-Days	50
		Labor Rate ($/man-day)	$150.98
		Subtotal Liner and Piping Removal Labor Costs	*$7,549.00*
	B.	Pond Liner and Piping Removal Equipment	
		Total Man-Days Removal Effort	50
		Size of Crew	4
		Total Days Removal Effort	12.5
		Cat 924G Loader Hourly Rate ($/hr)	$55.27
		Subtotal Liner and Piping Removal Equipment Costs	*$5,527.00*
	Total Pond Liner and Piping Removal Costs		**$13,076.00**
II.	**Pond Sludge Removal**		
		Pond Sludge Estimate	
		Estimated Production Flow since 1991 (gal)	3,942,000
		Historical Sludge Production Rate	0.000000102
		Estimated Pond Sludge Volume (yd^3)	0
	A.	Pond Sludge Removal Labor	
		Pond Sludge Volume (yd^3)	0
		Sludge Removal Rate (yd^3/man-day)	8.33
		Total Man-Days	0
		Labor Rate ($/man-day)	$150.98
		Subtotal Pond Sludge Removal Labor Costs	*$0.00*
	B.	Pond Sludge Removal Equipment	
		Total Man-Days Removal Effort	0
		Size of Crew	3
		Total Days Removal Effort	0
		Cat 924G Loader Hourly Rate ($/hr)	$55.27
		Subtotal Pond Sludge Removal Equipment Costs	*$0.00*
	Total Pond Sludge Removal Costs		**$0.00**

Table U.1-8 North Trend Evaporation Pond Reclamation - 2010 Surety Estimate

III.	**Pond Byproduct Material Disposal**		
	A.	Pond Liner Disposal	
		Area of Pond Liner (ft^2)	500,000
		Thickness of Pond Liner (ft)	0.00833
		Volume of Pond Liner (ft^3)	4,165
		Void Space Factor	1.25
		Total Disposed Volume (yd^3)	193
		Disposal Unit Costs ($/$yd^3$) (Unpackaged Bulk)	$357.12
		Subtotal Pond Liner Disposal Costs	*$68,924.16*
	B.	Pond Piping Disposal	
		Total Length of Piping	4,200
		Piping Volume Factor (ft^3/ft)	0.0103
		Total Volume Pond Piping (ft^3)	43
		Void Space Factor	1.25
		Total Disposed Volume (yd^3)	2.0
		Disposal Unit Costs ($/$yd^3$) (Unpackaged Bulk)	$357.12
		Subtotal Pond Piping Disposal Costs	*$714.24*
	C.	Pond Sludge Disposal	
		Total Volume Pond Sludge (yd^3)	0
		Disposal Unit Costs ($/$yd^3$) (Soil rate)	$150.27
		Subtotal Pond Sludge Disposal Costs	*$0.00*
	Total Byproduct Material Disposal Costs		**$69,638.40**
IV	**Pond Site Reclamation**		
	A.	Pond Earthwork Requirements	
		Earthwork Requirements yd^3)	120,000
		D8N Bulldozer Earthwork Rate (yd^3/hr)	700
		Total D8N Hours	171
		D8N Hourly Rate	$166.06
		Subtotal Pond Earthwork	*$28,396.26*
	B.	Revegetation	
		Area requiring Revegetation (Ac)	20
		Revegetation Unit Cost ($/Ac)	$300.00
		Subtotal Plant Site Revegetation	*$6,000.00*
	Total Pond Site Reclamation Costs		**$34,396.26**
V.	**Supervisory Labor Costs During Pond Reclamation**		
		Estimated Duration (months)	4
		Engineer Rate ($/month)	$9,250.31
		Total Engineer Labor	$37,001.24
		Radiation Technician Rate ($/month)	$4,677.49
		Total Radiation Technician Labor	$18,709.96
	Total Supervisory Labor Costs		**$55,711.20**
TOTAL EVAPORATION POND RECLAMATION PER POND			**$172,821.86**
TOTAL EVAPORATION POND RECLAMATION COSTS			**$172,821.86**

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Table U.1-9 North Trend Miscellaneous Site Reclamation - 2010Surety Estimate

I. Access Road Reclamation	
Assumptions	
Road Reclamation production rate (yd^3/hr)	200
Length of Main Access Roads (ft)	500
Average Main Access Road width (ft)	25
Depth of Main Access Road Gravel Surface (ft)	1
Surface Area of Main Access Road (Ac)	0.3
Length of Wellfield Access Roads (ft)	500
Average Wellfield Access Road width (ft)	12
Depth of Wellfield Access Road Gravel Surface (ft)	0.5
Surface Area of Wellfield Road (Ac)	0.1
A. Main Access Road Dirtwork	
Main Access Road Gravel Volume (yd^3)	463
Total reclamation time (hrs)	2
D8N Unit Operating Cost ($/hr)	$166.06
Subtotal Main Access Road Gravel Roadbase Removal Costs	*$332.12*
B. Wellfield Road Dirtwork	
Wellfield Road Gravel Volume (yd^3)	111
Total reclamation time (hrs)	1
D8N Unit Operating Cost ($/hr)	$166.06
Subtotal Wellfield Road Gravel Roadbase Removal Costs	*$66.06*
E. Discing/Seeding	
Assumptions	
Surface Area (acres)	0.4
Discing/Seeding Unit Cost ($/acre)	$300.00
Subtotal Discing/Seeding Costs	*$120.00*
Total Access Road Reclamation Costs	**$618.18**
II. Wastewater Pipeline Reclamation	
Assumptions	
Pipeline Removal Rate (ft./man-day)	67
Pipeline Shredding Rate (ft./man-day)	1,500
Number of Pond Pipelines	2
Length of Pond Pipelines (ft)	2,000
Average Pipe Size (Sch 40)	4
A. Pipeline Removal Costs	
Length of Pipelines (ft)	4,000
Removal Rate (ft/man-day)	67
Removal Labor Rate ($/man-day)	$150.98
Cat 924G Loader Use (days)	60
Cat 924G Loader Cost	$26,529.60
Subtotal Pipeline Removal Costs	*$35,588.40*
B. Pipeline Shredding Costs	
Length of Pipelines (ft)	4,000
Shredding Rate (ft/man-day)	1,500
Shredding Labor Rate ($/man-day)	$150.98

Table U.1-9 North Trend Miscellaneous Site Reclamation - 2010Surety Estimate

Shredder Use (days)	3
Shredder Cost	$288.00
Subtotal Pipeline Shredding Costs	*$740.94*
C. Pipeline Transportation and Disposal (NRC-Licensed Facility)	
Pipe Diameter (inches)	4
Chipped Volume Reduction (ft^3/ft)	0.0103
Subtotal Volume of Shredded PVC Pipe (yd^3)	1.5
Disposal Void Factor	1.25
Final Disposal Volume (yd^3)	1.9
Transportation and Disposal Unit Cost ($\$/yd^3$) (Unpackaged Bulk)	$357.12
Subtotal Pipeline Disposal Costs	*$671.39*
Total Wastewater Pipeline Reclamation Costs	**$37,000.73**
III. Electrical Distribution System Removal	
Assumptions	
Length of High Voltage Lines	500
High Voltage Line Removal Rate ($/ft.)	$0.59
High Voltage Line Removal Cost ($/ft.)	$295.00
Substation Removal	$1,175.00
Subtotal Electrical Distribution System Removal Costs	**$1,470.00**
IV. Supervisory Labor Costs During Miscellaneous Reclamation	
Estimated Duration (months)	3
Engineer Rate ($/month)	$9,250.31
Total Engineer Labor	$27,750.93
Radiation Technician Rate ($/month)	$4,677.49
Total Radiation Technician Labor	$14,032.47
Total Supervisory Labor Costs	**$41,783.40**
TOTAL MISCELLANEOUS RECLAMATION COSTS	**$80,783.40**

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Table U.1-10 North Trend Deep Disposal Well Reclamation – 10Surety Estimate

Task	Cost $$
I. Cost Basis	
A. Plugging and Abandonment	
Cost Estimate from March 2004 Permit Re-application for plugging and abandonment	$59,026.00
March 2004 CPI	213.20
June 2007 CPI	215.70
Subtotal Escalated 2003 Plugging and Abandonment Costs	***$59,718.14***
B. Site Reclamation	
Cost Estimate from March 2004 Permit Re-application for site reclamation	$2,433.00
March 2004 CPI	213.12
June 2007 CPI	215.70
Subtotal Escalated 2003 Reclamation Costs	***$2,461.53***
TOTAL DEEP DISPOSAL WELL RECLAMATION COSTS	**$62,179.67**

CPI: Consumer Price Index
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Table U.1-11 North Trend Groundwater IX Treatment (GIX) Restoration [Unit Costs] - 2010 Surety Estimate

Assumptions:

1.	All pumps are 5 hp pumping at 32 gpm		
2.	Cost of electricity =	$0.0797	Kw hr
3.	Horsepower to kilowatt conversion =	0.746	Kw/HP
4.	Operator labor costs =	$150.98	man-day
5	Labor costs are based on 36 pumps at 1,150 gpm		

Wellfield Pumping Electrical Costs per 1000 Gallons

1000	gal	X	5 / 32	hp / gpm	X	1 / 60	hr / min	X	0.746 / hp	kwh	X	$ 0.0797 / kwh		= $	0.155

Wellfield Pumping Labor Costs per 1000 Gallons

1000	gal	X	1 / 1150	min / gal	X	1 / 480	man-day / min	X	$150.98 / man-day		X	2	operators	= $	$0.547

Groundwater Sweep Production Rate

1150	gal / min	X	60	min / hr	X	24	hr / day	X	365	day / year	X	1 / 12	year / month	=	*50,370,000*	*gallons / month*

TOTAL GWS COSTS PER 1000 GALLONS = $ 0.70

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Table U.1-12 North Trend Groundwater Reverse Osmosis (RO) Treatment [Unit Costs] - 2010 Surety Estimate

Assumptions:

1. All pumps are 5 hp pumping at 32 gpm
2. Membrane Rreplacement — $0.025 per 100 gal
3. Cost of electricity = $0.0797 Kw hr
4. Horsepower to kilowatt conversion = 0.746 Kw/HP
5. Operator labor costs = $150.98 man-day
6. RO System horsepower requirements for 400 gpm rated flow based upon:

RO Unit Pump	138	hp
Permeate/Injection pump	60	hp
Waste pump	12	hp
TOTAL:	210	hp

7. Chemical costs:

Reductant =	$0.39	lb
Antiscalant =	$15.90	gal

Membrane Replacement Costs per 1000 Gallon

1000 gal x $660 membrane/ cost per month / 26,280,000 gallons per month — 0.025 per Kgal

Wellfield Pumping Electrical Costs per 1000 Gallons

1000 gal X 5 hp / 32 gpm X 1 hr / 60 min X 0.746 kwh / hp X $ 0.0797 / kwh = $ 0.155 per Kgal

Reverse Osmosis Electrical Costs per 1000 Gallons

1000 gal X 210 hp / 600 gpm X 1 hr / 60 min X 0.746 kwh / hp X $ 0.0797 / kwh = $ 0.347 per Kgal

Reverse Osmosis Labor Costs per 1000 Gallons

1000 gal X 1 min / 600 gal X 1 man-day / 480 min X $150.98 / man-day X 2 operators = $ $1.048 per Kgal

Treatment chemical costs per 1000 Gallons

Antiscalant:

1000 gal X 0.000008330 gal antiscalant / 1 gal X $15.90 / gal antiscalant = $ $0.132 per Kgal

Reductant
:

1000 gal X 0.000560 lbs reductant / 1 gal X $0.390 / lb reductant = $ $0.218 per Kgal

Table U.1-12 North Trend Groundwater Reverse Osmosis (RO) Treatment [Unit Costs] - 2010 Surety Estimate

Reverse Osmosis Production Rate														
600	gal min	X	60	min hr	X	24	hr day	X	365	day year	X	1 12	year month	= *26,280,0000 gallons* *month*
TOTAL RO COSTS PER 1000 GALLONS												**= $**	**1.93**	

Table U.1-13 North Trend Groundwater Recirculation [Unit Costs] - 2010 Surety Estimate

Assumptions:

1. All pumps are 5 hp pumping at 32 gpm
2. Cost of electricity = $0.0797 Kw hr
3. Horsepower to kilowatt conversion = 0.746 Kw/HP
4. Operator labor costs = $150.98 man-day
5. System horsepower requirements for 1,150 gpm rated flow based upon:
   injection pump 30 hp
6. Chemical costs:
   Reductant = $0.39 lb

Wellfield Pumping Electrical Costs per 1000 Gallons

1000	gal	X	5	hp	X	1	hr	X	0.746	kwh	X	$ 0.0797		= $	0.155	per Kgal
			32	gpm		60	min		hp			kwh				

Wellfield Injection Electrical Costs per 1000 Gallons

1000	gal	X	30	hp	X	1	hr	X	0.746	kwh	X	$ 0.0797		= $	0.026	per Kgal
			1150	gpm		60	min		hp			kwh				

Recirculation Labor Costs per 1000 Gallons

1000	gal	X	1	min	X	1	man-day	X	$150.98		X	2	operators	= $	0.274	per Kgal
			1150	gal		480	min		man-day							

Treatment chemical costs per 1000 Gallons

Reductant:

1000	gal	X	0.000560	lbs reductant	X	$0.370	lb	= $	$0.207	per Kgal
			1	gal			reductant			

Recirculation Production Rate

1150	gal	X	60	min	X	24	hr	X	365	day	X	1	year	=	*50,370,000*	*gallons*
	min			hr			day			year		12	month			*month*

TOTAL RECIRCULATION COSTS PER 1000 GALLONS		**= $ 0.46**

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Table U.1-14 North Trend Well Abandonment [Unit Costs] - 2010 Surety Estimate

Assumptions:

1 Use backhoe for 0.25 hr/well to dig, cut off, and cap well.
2 Drill rig used 2.5 hrs to plug well.
3 Labor for installing chips, etc. will require 2 workers at 0.5 hrs per well

Well Abandonment Costs									**Cost per ft (based on 700 ft wells)**
Labor Costs	1	Hours	X	$	18.87	per hour	=$	$18.87	$0.02760
Cat 416 Backhoe	0.25	hours	X	$	44.59	per hour	=$	11.40	$0.0163
Drill rig	2.5	hours	X	$	141.00	per hour	=$	352.50	$0.5036
Well Cap	1	each	X	$	8.03	each	=$	8.03	$0.0115
Materials per foot of well (Variable Cost)									
Cement	0.0714	lbs/ft	X	$	0.080	per pound	=$		$0.0057
Bentonite Chips	0.007	tubes/ft	X	$	7.46	per tube	=$		$0.0522
Plug Gel	0.0088	sacks/ft	X	$	3.35	per sack	=$		$0.0295
Total Estimated Cost per Foot:									**$0.65**

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Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate

		MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--
Total number of production wells		30	0	0	0	0						
Total number of injection wells		50	0	0	0	0						
Total number of shallow monitor wells		16	0	0	0	0						
Total number of perimeter monitor wells		18	0	0	0	0						
Total number of restoration wells		9	0	0	0	0						
Wellfield Area (ft2)		600,000	0	0	0	0						
Wellfield Area (acres)		25.00	0.00	0.00	0.00	0.00						
Affected Ore Zone Area (ft2)		600,000	0	0	0	0						
Avg. Completed Thickness		20.0	0	0	0	0						
Porosity		0.29	0	0	0	0						
Affected Volume (ft3)		12,000,000	0	0	0	0						
Kgallons per Pore Volume		26,030	0	0	0	0						
Number of Patterns in Unit(s)												
	Current	0	0	0	0	0						
	Estimated next report	30	0	0	0	0						
	Total Estimated	30	0	0	0	0						
Number of Wells in Unit(s)												
Production Wells												
	Current	0	0	0	0	0						
	Estimated next report	30	0	0	0	0						
	Total Estimated	30	0	0	0	0						
Injection Wells												
	Current	0	0	0	0	0						
	Estimated next report	50	0	0	0	0						
	Total Estimated	50	0	0	0	0						
Shallow Monitor Wells												
	Current	0	0	0	0	0						

Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate

		MU 1	MU 2	MU 3	MU 4	MU 5	--	--	--	--	--	--
	Estimated next report	16	0	0	0	0						
	Total Estimated	16	0	0	0	0						
Perimeter Monitor Wells												
	Current	0	0	0	0	0						
	Estimated next report	25	0	0	0	0						
	Total Estimated	25	0	0	0	0						
Number of Wells per Wellfield		121	0	0	0	0						
Total Number of Wells		121										
Average Well Depth (ft) - Deep Wells		550	0	0	0	0						
Average Well Depth (ft) - Shallow Wells		200	0	0	0	0						

Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate *(continued)*

Electrical Costs			
	2009Rate	2010 Est Rate	
Power cost (adj for current actual cost)	$0.0759	$0.0797	kwHr
Kilowatt to Horsepower	0.746	0.746	Kw/HP
Horsepower per gallon per minute	0.167	0.167	HP/gpm
Labor Rates			
Operator Labor Cost	$153.12	$150.98	day
Engineer Cost	$9,381.65	$9,250.31	month
Radiation Technician Costs	$4,743.90	$4,677.49	month
Chemical Costs			
Antiscalant for RO (adj for current actual cost)	$15.22	$15.90	gal
Reductant (adj for current actual cost)	$0.37	$0.39	lb
Cement (adj for current actual cost)	$0.07	$0.08	pound
Bentonite Tubes (adj for current actual cost)	$7.10	$7.46	tube
Salt (adj for current actual cost)	$127.60	$133.98	ton
Plug Gel (adj for current actual cost)	$3.19	$3.35	sack
Well Cap (adj for current actual cost)	$7.65	$ 8.03	each
Hydrochloric Acid (adj for current actual cost)	$1.24	$1.65	gallon
Analytical Costs			
Guideline 8 (contract lab adjusted for current contract cost)	$200.00	$200.00	analysis
6 parameter (in-house) Est Rate (CPI)	$50.75	$50.04	analysis
Other (radon, bio, etc.) Est Rate (CPI)	$925.00	$912.05	month
Spare Parts			
	2009 Rate	2010 Est Rate (CPI)	
Restoration spare parts estimate	$20,475.00	$20,188.35	year

CPI Escalators (CPI U, U.S. City Average) CPI Escalators (CPI	
1988 CPI (average)	118.3
April 2009CPI (deep well estimate)	213.2
2008 CPI (June 2008 used in last update)	218.8
Current CPI (June 2009)	215.7
2009 Escalation Factor	0.986

Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate (*continued*)

Equipment Costs						
Equipment	**Base Rental Rate ($/hr)**	**Labor Costs ($/hr)**	**Repair Reserve Costs ($/hr)**	**Fuel Costs ($/hr)**	**Mob & Demob ($/hr)**	**Total ($/hr)**
Cat 924G Loader	$26.50	$19.14	$3.00	$6.63	inc.	$55.27
Cat 416 Backhoe	$16.50	$19.14	$3.10	$6.85	inc.	$45.59
Shredder	$12.00			inc	inc	$12.00
Cat D8N Bulldozer	$110.00	$19.14	$11.50	$25.42	inc.	$166.06
Pulling Unit	$37.50	Inc	inc	inc	Inc	$37.50
Mixing Unit	$5.00			inc	inc	$5.00
Drill Rig	$141.00	Inc	inc	inc	inc	$141.00

Basis:
Cat 924G, 416 and D8N rental rates from Nebraska Machinery (Aug '09); others estimated.
Repair Reserve costs based on from Nebraska Machinery (Aug '09).
Current diesel usage from from Nebraska Machinery (Aug '09), with current (Aug '09) costs for off-road fuel: $2.210 gallon

Labor rate based on current operator labor rate

Pipe Volumes			
Nominal Pipe Size	Wall Thickness (inches)	Pipe OD (inches)	Volume per foot (ft3/ft)
3/8-inch O2 hose		0.37500	0.03130
2-inch Sch. 40 downhole	0.15400	2.37500	0.00740
1-1/4-inch Sch. 40 stinger	0.14000	1.66000	0.00440

Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate (*continued*)

2-inch SDR 13.5 inj & prod.	0.14815	2.29630	0.00690
4-inch SDR 35	0.11430	4.22860	0.01030
6-inch Sch. 40 process pipe	0.28000	6.56000	0.03840
6-inch Trunkline	0.49100	6.56600	0.06510
8-inch Trunkline	0.63900	8.54800	0.11030
10-inch Trunkline	0.79600	10.65400	0.17120
12-inch Trunkline	0.94400	12.63700	0.24080

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Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate *(continued)*

Pipe Removal and Shredding Costs

Activity	Removal Rate (ft/man-day)	Shredding Rate (ft/man-day)	Labor Rate (day)	Activity Cost per foot
2-inch SDR 13.5 inj & prod. Removal	225		$150.98	$0.67
2-inch SDR 13.5 inj & prod. Shredding		1920	$150.98	$0.08
Trunkline Removal	100		$150.98	$1.51
Trunkline Shredding		100	$150.98	$1.51
Downhole Pipe Removal	2000		$150.98	$0.08
Downhole Pipe Shredding		2250	$150.98	$0.07
Downhole Hose Removal	1000		$150.98	$0.15
Waste and RO Building Pipeline Removal	67		$150.98	$2.25
Waste and RO Building Pipeline Shredding		1500	$150.98	$0.10

Waste Disposal Costs

Waste Form	Fee		Density Correction Factor (Tons/yd^3)	Fee per Cubic Yard	Transport Cost		Total Transportation and Disposal	
Soil, Bulk Byproduct Material	$195.45	per Ton	0.54	$105.00	$45.27	per yd^3	$150.27	per yd^3
Unpackaged Bulk Byproduct Material (e.g., pipe,equipment)	$742.50	per Ton	0.42	$311.85	$45.27	per yd^3	$357.12	per yd^3
Solid Waste (landfill)	$0.01917	per Lb			Incl.	per Lb	$0.01917	per Lb
Solid Waste (landfill)	$212.00	per Load			Incl.	per Load	$212.00	per Load
Void Factor (for disposal)	1.25							

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Table U.1-15 North Trend Master Cost Basis - 2010 Surety Estimate *(continued)*

Plant Dismantling							
Plant Components:	Number	Units	Estimated Disposal Volume	Units	Activity	Units	2007 Cost
Contaminated Tanks	10	each	39.7	ft^3 each	Dismantle interior steel, tanks, piping and electrical:	$	159450
Uncontaminated Tanks	0	each	39.7	ft^3 each	Dismantle Plant Building	$	79725
Pumps	13	each	5	ft^3 each			
Downhole Pumps	0	each	0.5	ft^3 each	Concrete floor removal rate	Current Cost $/$ft^2$	14.04
Contaminated Piping	4000	feet					
Uncontaminated Piping	0	feet	See estimate by piping size and material				
Filters	0	each	100	ft^3 each			
Dryer	0	each	400	ft^3 each			
Average PVC Pipe Diameter (inches)	3						

Plant Decontamination					
Direct Dispose Plant Floor Area	13400	ft^2	Decon Solution (HCl) Floor Application Rate	2	gal/ft^2
Uncontaminated Plant Floor Area	4400	ft^2			
Decontaminated Plant Floor Area*	9000	ft^2			
Average concrete thickness	0.75	ft			
Plant Wall Area	0	ft^2	Decon Solution (HCl) Wall Application Rate	1	gal/ft^2

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CHAPTER V. CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on inquiry of those individuals immediately responsible for obtaining the information. I believe that the information is true, accurate, and complete. Further, I certify awareness that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

____

Thomas Young
Vice President - Operations
Crow Butte Resources, Inc.

APPENDIX 6
WATER USER SURVEY INFORMATION FOR WATER SUPPLY WELLS IN 2.25-MILE AREA OF REVIEW

Well ID	DNR Regestration No.	Township	Range	Section	Easting	Northing	Water Quality	Owner	Street Address	City	State	Zip Code	Interview Date	Contact Person	Telephone	Interviewer	Supply Source	Screen Interval	Estimated Extraction Rate	Pump test results	Total Depth	Static Level	Drill Date	Casing Depth	Casing Type	Diameter	Pumping Method	Driller	History	Remarks	Remarks 2	Remarks 3
3		31N	52W	15	2650E	4200N	good	Lorentz Raben	Box 463	Crawford	NE	69339	24-Aug-81		665-2673		Well		30 gpm		100	50	01-Jan-70	50	Steel	5.5	Windmill	Haag	stock well, relatively new well, no trouble	windmill 16' 3"		
4		31N	52W	15	5200E	5100N	good	Lorentz Raben	Box 463	Crawford	NE	69339	24-Aug-81		665-2673		Well		30 gpm		100	est 50	01-Jan-70	50	Steel	5.5	submersible	Chubb	also agricultural, est 500 gal/day usage	drill date aprox.	relatively new well	house well with pitless adaptor
20		31N	52W	1	2950E	100N	good	Lester W. Tagart		Crawford	NE	69339	25-Aug-81		665-1792		Well				50	8		50	Plastic	5.5			also agricultural	Tagart unwilling to supply further information	or have well tested	
55		31N	52W	11	100E	4600N		Ricardo Ral	E Highway 20	Crawford	NE	69339	31-Aug-81		665-1618		Well				320	5.5		320	Plastic	4				garden use- used only in summer		
56		31N	52W	2	100E	2850N		Dave Zeillinger	Burlington Railroad - Crawford Depot	Crawford	NE	69339	31-Aug-81		665-1360 (Crawford Depot)		Well		2 gpm estimated		200	112	01-Jan-29	200	Steel	10		Chubb		drill date aprox.	will run dry if run major appliances (washer etc.)	
60		31N	52W	2	1300E	1000N		Francis Anders	Box 455	Crawford	NE	69339	31-Aug-81		665-1920		Well	~150			312		01-Jan-62	312	Steel	5		? Haag	domestic, stock, veterinary clinic	drill date aprox., casing perforated 1/2 way when	drilled, had to be plugged twice by a Hal Burton	firm from Casper, artesian, ran 4' pump, dried up
61		31N	52W	2	1100E	600N		Francis Anders	Box 455	Crawford	NE	69339	31-Aug-81		665-1920		Well				280		01-Jan-60	280		5		Wyo Fuel	domestic, stock, veterinary clinic	drill date aprox.	artesian	
66		31N	52W	12	1900E	5050N		Robt H. McDowell	Box 461	Crawford	NE	69339	03-Sep-81		665-1191		Well				60	20	01-Jan-60	60	Steel			Pelron	stock	drill date aprox. (to 60')	drilled first at 20', then 40', then 60'	need to let pit dry out as water above pump
74		32N	52W	34	3600E	600N		Ronald & Cassandra Olson	#10 W. Bethel Rd / PO Box 505	Crawford	NE	69339	02-Jul-04		665-1599	Miller	Well				60		01-Jan-76	60	Plastic	6		Chubb		drill date aprox.	doesn't like big companies... profit over people	very concerned about impact on water table
75		32N	52W	21	3900E	850N		Dave Dodd		Crawford	NE	69339	05-Nov-81		665-1516		Well				60-70		01-Jan-78	20		6	Windmill	Chubb		drill date aprox.	10' stock tank	
76		32N	52W	21	5050E	4150N		Dave Dodd	451 Dodd Rd.	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well				48	40.5		20		6	Windmill	? Chubb		old well	old hand pump broke, windmill	
77		32N	52W	22	200E	4000N		Dave Dodd	451 Dodd Rd.	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well				61		24-Nov-81	61	cement	36	submersible	Bice of Rapid City		sampled in 1996	submersible with pitless adaptor, 4 8' tanks	
78		32N	52W	27	4900E	3900N		Jerald Wallace	RR 3 Box 2A	Crawford	NE	69339	30-Jul-96		665-1981	Dave Dunn	Well	78-98			98		01-Jan-60	98	Steel Galvanized	6	submersible	Haag		drill date aprox.	electric, house water, sampled in 1996	
79		32N	52W	27	4800E	3900N		Jerald Wallace	RR 3 Box 2A	Crawford	NE	69339	30-Jul-96		665-1981	Dave Dunn	Well	78-98			98				Steel Galvanized		Windmill			old well	windmill broke	
82		32N	52W	22	4600E	300N		Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn	Well	100-120			120		01-Jan-45	120	Steel Galvanized			Haag	windmill	drill date aprox.	not visible	
83		32N	52W	27	2850E	100N		Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn	Well	30-50			50		01-Jan-50	50	Steel Galvanized	6'	submersible			drill date aprox., electric, sampled in 1996	cant measure	
84		32N	52W	34	3200E	5250N		Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn	Well	30-50			50	38	01-Jan-50	50	Steel Galvanized	6	Jet Pump			drill date aprox.	electric	
85		32N	52W	33	4750E	1400N		Sharon Finley	RR 3	Crawford	NE	69339	05-Aug-96		665-1228	Dave Dunn	Well	60-80			80			80	Plastic	5.25	submersible			old well at mothers place	old well	
86		31N	51W	4	2200E	3180S		Fort Robinson		Crawford	NE	69339	18-Nov-81		665-1175		Well	280-300			300	? 180	01-Jan-60	300	Steel	6		Chubb		drill date aprox., technically abd for ~10 yrs.	previously used when Beef Exp. Station was @ fort	but not used since it moved out about 10 yrs ago.
87		32N	52W	29	4650E	3750N		Lloyd Moody	RR	Crawford	NE	69339	18-Nov-81		665-1398		Well				50		01-Jan-30	20	Steel Galvanized	6	Windmill			drill date aprox.	10' stock tank- pump head packed with straw for	winter so couldn't measure
88		32N	52W	35	1300E	5000N		Willoughby (Bob Pickering)	221 Mill Rd	Crawford	NE	69339	07-Jul-04		665-3974	Miller	Well				60	22	01-Jan-58	20	Steel Galvanized	5.25	submersible	Chubb	not in use	drill date aprox.		
89		32N	52W	26	1400E	100N		Willoughby (Bob Pickering)	221 Mill Rd	Crawford	NE	69339	07-Jul-04		665-3974	Clark Miller	Well				35		01-Jan-58	10	Steel Galvanized	5.25	Windmill	Chubb		drill date aprox., 8' stock tank	was packed with manuer for winter so couldn't	measure at the time
90		32N	52W	26	3400E	3850N		Ed Trucks	RR	Crawford	NE	69339	19-Nov-81		665-2808		Well				35	15.5	01-Jan-60	10	Plastic	5.25	Windmill	Chubb		drill date aprox.		
91		32N	52W	26	3400E	300N		Joe Roos	RR	Crawford	NE	69339	29-Jul-96		665-1820	Dave Dunn	Well				est 80		01-Jan-18	20	Steel Galvanized	5.25	submersible		agricultural also	cant measure		
92		32N	52W	26	4400E	2800N		Marvin & Anne Hamar	142 Old Hw 20/PO Box 348	Crawford	NE	69339	06-Jul-04		665-1436	Miller	Well				54	14	01-Jan-72	40	Steel	6	submersible	Chubb		drill date aprox.		
93		32N	52W	26	3900E	2400N		Barton Kreider (Ferguson Place Now)	Box 500	Crawford	NE	69339	19-Nov-81		665-2820 (2607)		Well				85	12+18+22	01-Jan-61	40	Steel Galvanized	5.25	submersible	Chubb		drill date aprox., well in basement 10' below	ground level, runs thru softner to dispel odor	(Hydrogen Sulfide)?
94		32N	52W	26	4800E	1900N		A. A. Ahl	Box 225	Crawford	NE	69339	19-Nov-81				Well	30-50			52		01-Jan-50		Steel Galvanized	6	Jet Pump			drill date early 1900's		
95		32N	52W	35	200E	5100N		Gary Fairbanks		Tecumsa	MI		18-Jul-96		517-451-8632	Dave Dunn	Well	80			100	34.5	01-Jan-72	100	Plastic	5.25	submersible	Chubb		drill date aprox.		
96		32N	52W	35	650E	2600N		Kasey Clark	HC 92	Crawford	NE	69339	16-Aug-96		665-2509	Dave Dunn	Well	46-86			86		01-Jan-30	86	Plastic	5.25	submersible			drill date aprox.		
97		32N	52W	35	1150E	2200N		Kasey Clark	HC 92	Crawford	NE	69339			665-2509		Well		6 gpm		380		01-Jan-75	380	Plastic	2.5		Continental	irrigation- lawn, garden, alphalpha field, etc.	drill date aprox.	artesian well	
98		32N	52W	25	5250E	2900N		Merle Mansfield	PO Box 389	Crawford	NE	69339	19-Nov-81	Merle Mansfield	665-1927	R. Grantham	Well				100	100	01-Jan-70	100	Plastic	5.25		Chubb		Artesian		
99		32N	52W	24	50E	1500N		Ron Raben	RR 3 Box 2B	Crawford	NE	69339	19-Nov-81		665-1763		Well				50	20 est.	01-Jan-68		concrete	36	submersible	Bice Rapid City	agricultural also- supplies pipeline	drill date aprox.	offset old well ~ 12'	
100		32N	52W	35	1700E	3800N		Betty Beaver	229 Annin St.	Crawford	NE	69339	26-Jul-96		665-1453	Dave Dunn	Well	25-35			35	9		35	Steel Galvanized	8	submersible		agricultural also	flooded out		
101		32N	52W	36	300E	900N		Gordon Moore	Box 388	Crawford	NE	69339	19-Nov-81		665-2352		Well	55-75			75		01-Jan-74	75	plastic	5.25	submersible	Chubb		drill date aprox.		
102		32N	52W	35	2500E	200N		Gordon Moore	Box 388	Crawford	NE	69339	19-Nov-81		665-2352		Well	80-100			100		01-Jan-20	100	Steel	5.5	Jet Pump		also agricultural	drill date aprox.	must pull to measure	
103		32N	52W	35	2800E	2260N		Gordon Moore	Box 388	Crawford	NE	69339	19-Nov-81		665-2352		Well	115-125			125		01-Jan-55	125	Steel Galvanized	5.25	Windmill	Jack Carley		drill date aprox.	must pull to measure	
104		32N	52W	35	1600E	3500N		Dannie Barcel	60 Old Hwy 20	Crawford	NE	69339	07-Jul-04		665-1354	Miller	Well				24	10	01-Jan-48	24	Steel	6	Jet Pump	Chubb or Pelrun	also agricultural	drill date aprox.		
105		32N	52W	34	4700E	1800N		Hagemeister	905 3rd	Crawford	NE	69339	22-Jul-96		665-2434	Dave Dunn	Well	50-60			70		01-Jan-61	70	Steel	6	Windmill	Haag		drill date aprox.		
106		31N	52W	3	2000E	4600N		George Moody	21 Mill Road	Crawford	NE	69339	01-Aug-96		665-1404	Dave Dunn	Well	80-100			100		01-Jan-72	100	Steel Galvanized	5.25	submersible	Chubb	also agricultural	drill date aprox.	drilled in 50s and redrilled in 1972	could pump, dry until redrilled
107		32N	52W	34	3200E	2350N		Laura Sinn	91 Mill Road	Crawford	NE	69339	14-Jul-04		665-1665	Clark Miller	Well				45						submersible					sampled 1996
108		32N	52W	34	4850E	650N		Hagemeister	905 3rd	Crawford	NE	69339	22-Jul-96		665-2434	Dave Dunn	Well	55-75			75	43	01-Jan-70	75	Plastic	5.25		Haag		drill date aprox., undeveloped well	not presently in use... planed to build a house	there but never got it built
109		32N	52W	34	3400E	2050N		Theda Clarke		Crawford	NE	69339	08-Aug-96		665-1415	Dave Dunn	Well	33-55			55		01-Jan-75	55	Plastic	5.25	submersible	Chubb	also agricultural	drill date aprox.		
110		32N	52W	33	100E	200N		Alan Holmgren	RR	Crawford	NE	69339	25-Nov-81		665-1430		Well		20 gpm		100		01-Jan-74	20	Plastic	5.25	submersible	Chubb	also agricultural	drill date aprox.		
111		32N	52W	32	250E	1000N		Alan Holmgren	RR	Crawford	NE	69339	25-Nov-81		665-1430		Well		2 gpm		90	est 50	01-Jan-64	20	Steel Galvanized	5.25	submersible	Chubb	also agricultural	drill date aprox.		
112		31N	52W	3	5200E	3200N		Leonard Chubb	11 W Ash Creek Rd	Crawford	NE	69339			665-2587	Dave Dunn	Well				110	57				5.25	submersible			can get info later		
113		31N	52W	3	5050E	2900N		Leonard Chubb	11 W Ash Creek Rd	Crawford	NE	69339			665-2587	Dave Dunn	Well				110	57				5.25	submersible			can get info later		
115		32N	52W	34	4100E	1900N		Varyn Norgard	920 4th	Crawford	NE	69339	14-Jul-04		665-1336	Miller	Well	70-90			90	23	01-Jan-70	90	Plastic	5.25	submersible	Chubb		drill date aprox., flooded out, well pit	covered with a coffee can	
116		32N	52W	34	3200E	2000N		Dale Gittning	71 Mill Rd	Crawford	NE	69339	13-Jul-04		665-2639	Miller	Well				80		01-Jan-81	15	Plastic	5.25		Chubb	also agricultural	drill date aprox., prev owner planed to move	trailer to location but never did.. watered garden	pitless adaptor
117	G-029749	32N	52W	27	1250W	2440N		City of Crawford (Cemetary)	209 Elm	Crawford	NE	69339	15-Jan-81		665-1462		Well				160	60	01-May-61				submersible			lat 42.718711	long 103.408447	
118		32N	52W	27	4750E	2100N		City of Crawford (Cemetary)					15-Jan-82		665-1462		Well				90	67					submersible			rarely used- aux. source	pumps into 3400 gal storage tank	
121		32N	52W	25	800E	4800N		Robert Campbell		Basin	WY		22-Mar-82		307-568-2901		Well				16						Windmill					
122		31N	52W	4	5000E	3950N		Marvin Rising	RR 3	Crawford	NE	69339	05-Aug-96		665-2536	Dave Dunn	Well	40-60			60	17		60		6			water garden	drill date 1940s	electric	
123		32N	52W	35	1000E	1000N		Gordan Moore					25-Jul-96		665-2352	Dave Dunn	Well				280		09-Nov-79	280				Wyoming Fuel		artesian well		
126		31N	52W	8				Fort Robinson		Crawford	NE	69339	16-Sep-83				Well				est 290		01-Jan-30		Steel	4-6	Windmill	USDA		drill date aprox.		
127		31N	52W	3			high nitrates	George Moody	21 Mill Rd	Crawford	NE	69339	01-Aug-96		665-1404	Dave Dunn	Well	45-65			105	45			Plastic	4.5		Chubb	planed domestic but high nitrate levels in well	drill date July 1987, trying to clean up nitrate	problem so mostly used for irrigation and	livestock
149		32N	52W	35				Gordan Moore					25-Jul-96		665-2352	Dave Dunn	Well				175	25			Steel	6	Windmill					
161		32N	52W	35				Arleigh Deines	94 Old Hwy 20	Crawford	NE	69339	29-Jul-96		665-2846	Dave Dunn	Well				60		01-Jan-96		Plastic	6		Chubb		drill date aprox.	electric	
162		32N	52W	35				Willoughby (Bob Pickering)	221 Mill Rd.	Crawford	NE	69339	07-Jul-04		665-3974	Miller	Well						01-Jan-94		Plastic			Chubb		drill date aprox	electric	
168		32N	52W	29				Holmgren Alan (Pat)	HC 92	Crawford	NE	69339	09-Jul-96		665-1335	Dave Dunn	Well				60-70		01-Jan-95		Plastic		Windmill	Chubb		drill date aprox.		
172		32N	52W	17			bad	Dave Dodd	451 Dodd Rd	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well				20				Steel				water yard			
173		32N	52W	15				Rusty Riggs	RR 3	Crawford	NE	69339	12-Jul-96		665-2511	Dave Dunn	Well				30		01-Jan-79		Cement	36	Windmill	Bice of Rapid City		drill date aprox.		
174		32N	52W	14				Rusty Riggs	RR 3	Crawford	NE	69339	12-Jul-96		665-2511	Dave Dunn	Well				30		01-Jan-70			6	Windmill	Chubb		drill date aprox.		
175		32N	52W	15				Bruce Wohlers	HC 92	Crawford	NE	69339	30-Jul-96		665-1104	Dave Dunn	Well				25				Steel				also agricultural	electric		
176		32N	52W	17				Dave Dodd	451 Dodd Rd	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well				60-80		01-Jan-60			6		maybe Chubb		drill date aprox.	well feeds Dave Dodds house	
184	G-088653	32N	52W	35	1056E	260S		Arleigh Deines	211 Mill Rd	Crawford	NE	69339					Well			6 gpm	60	20	09-Mar-96							lat 42.711242	long 103.399872	
185	G-122884	32N	52W	26	1109W	1975N		Marv Hamer	233 Main St	Crawford	NE	69339								10 gpm	70	12	10-Jul-03							lat 42.717222	long 103.388611	
186	G-106923	32N	52W	26	425W	2040N		Jake & Vicki Wasserburger	151 Old Hwy 20 Box 446	Crawford	NE	69339	06-Jul-04		665-2779	Miller	Well		7 gpm		24	17	03-Sep-99		Plastic	4	submersible	Chubb	also agricultural	lat 42.717369	long 103.386067	
187	G-082598	32N	52W	26	1900W	1100S		Elenaor Willoughby & Brock	5768 Sheffield Ave	Riverside	CA	92506					Well			3 gpm	78	0	14-Jul-94							lat 42.723365	long 103.391623	
188	G-125036	32N	52W	25	950E	250S		Robert Reid	192 Old Hw 20	Crawford	NE	69339	09-Jul-04		430-0460	Miller	Well		11		95	30	02-Dec-03	95	Plastic	6	submersible	Reid	also agricultural	lat 42.725607	long 103.381034	
189	G-086991	31N	52W	10	500E	400S		Legend Buttes Golf Course	209 Elm St	Crawford	NE	69339								15 gpm	30	8										
190	G-086992	31N	52W	10	500E	450S		Legend Buttes Golf Course	209 Elm St	Crawford	NE	69339								15 gpm	30	8										
197		32N	52W	27				Mike Witt	Bourning Ranch Box 38	Merriman	NE		05-Aug-96		684-3383	Dave Dunn	Well								Plastic	6		Chubb		undeveloped well		
198		32N	52W	34				Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn	Well										Windmill			windmill broke		
199		32N	52W	26				Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn									Steel	10				undeveloped well		
200		32N	52W	28				Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn									Steel	6	Windmill			fallen down windmill in bushes		
201		32N	52W	28				Earl Soester	RR	Crawford	NE	69339	05-Aug-96		665-2616	Dave Dunn	Well													not visible		
206		32N	52W	21				Dave Dodd	451 Dodd Rd	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well				60-80					6	Windmill			drill date 1950s	windmill broke	
207		32N	52W	17				Dave Dodd	451 Dodd Rd	Crawford	NE	69339	18-Jul-96		665-2012	Dave Dunn	Well										Windmill			old windmill		
208		32N	52W	28				Willis Hoffman	RR 3	Crawford	NE	69339	02-Jul-96		665-2646	Dave Dunn	Well								Steel Galvanized	8				covered with old bucket		
209		32N	52W	21				Dave Moody	RR	Crawford	NE	69339	12-Jul-96		665-2577	Dave Dunn	Well															
210		31N	52W	4				Marvin Rising	RR 3	Crawford	NE	69339	05-Aug-96		665-2536	Dave Dunn	Well													undeveloped well		
211		32N	52W	34				John Mader	1003 5th St	Crawford	NE	69339	22-Jul-96		665-2275	Dave Dunn														old pump jack on hand pump	doesn't work	
212		32N	52W	34				Mary Jo Knoell	RR	Crawford	NE	69339	08-Aug-96		665-2302	Dave Dunn	Well															
213		32N	52W	27				Jerald Wallace	RR 3 Box 2A	Crawford	NE	69339	30-Jul-96		665-1981	Dave Dunn	Well													well dug up covered with dirt not visible		
214		32N	52W	33				Sharon Finley	RR 3	Crawford	NE	69339	05-Aug-96		665-1228	Dave Dunn	Well				35-40		01-Jan-70		Steel	6		ex-husband , Arizona	not in use	drill date aprox., undeveloped well	covered with can at mothers place	
215		32N	52W	33				Sharon Finley	RR 3	Crawford	NE	69339	05-Aug-96		665-1228	Dave Dunn	Well												not in use	old well on hill covered with dirt	settled spot	
216		32N	52W	33				Sharon Finley	RR 3	Crawford	NE	69339	05-Aug-96		665-1228	Dave Dunn	Well				35-40		01-Jan-70		Steel			ex-husband, Arizona	not in use	drill date aprox., undeveloped well	covered with flowerpot	
217		32N	52W	29				Holmgren Alan (Pat)	HC 92	Crawford	NE	69339	09-Jul-96		665-1335	Dave Dunn	Well										Windmill			old windmill broke		
218		32N	52W	35				Arleigh Deines	94 Old Hwy 20	Crawford	NE	69339	29-Jul-96		665-2846	Dave Dunn	Well													old hand pump		
220		32N	52W	4				Willis Hoffman	254 Toadstool Road	Crawford	NE	69339	17-Jun-04	Willis Hoffman	665-2646	Grantham/Miller	Well				35	18	01-Jan-40	35	Steel Galvanized	6	Pump Jack	Pelrun	very little use	drill date aprox.		
221		32N	52W	4				Willis Hoffman	254 Toadstool Road	Crawford	NE	69339	17-Jun-04	Willis Hoffman	665-2646	Grantham/Miller	Well		15 gpm		35	18	01-Jan-43	35	Steel Galvanized	6	Jet Pump	Pelrun	also agricultural for stock, house well	drill date aprox.		
222		32N	52W	4				Willis Hoffman	254 Toadstool Road	Crawford	NE	69339	17-Jun-04	Willis Hoffman	665-2646	Grantham/Miller	Well		8 gpm		35	18	01-Jan-64	35	Steel Galvanized	6	Windmill	Haag	livestock	drill date aprox.		
223		32N	52W	9				Willis Hoffman	254 Toadstool Road	Crawford	NE	69339	17-Jun-04	Willis Hoffman	665-2646	RG/Miller	Well		8 gpm		35	18	01-Jan-60	35	Steel Galvanized	6	Pump Jack	Haag	livestock	drill date aprox.		
224				20				Dave Moody	Box 107	Crawford	NE	69339	29-Jun-04			RG/Miller	Well		25-30 gpm		100	60	01-Jan-60	100	Concrete	36	submersible	Brice Drilling	also agricultural, pipeline well	drill date aprox.	has more wells but wont cooperate	wont allow us to locate known wells with GPS
227		32N	52W	10				Alan Holmgren	Box 494	Crawford	NE	69339	30-Jun-04		665-1722	RG/Miller	Well				30	20				6						
228		32N	52W	10				Alan Holmgren	Box 494	Crawford	NE	69339	30-Jun-04		665-1722	RG/Miller	Well				30	20				6						
229		32N	52W	9				Alan Holmgren	Box 494	Crawford	NE	69339	30-Jun-04		665-1722	RG/Miller					30	20				6						
230		32N	52W	17				John Eldon Wohlers		Crawford	NE	69339	30-Jun-04			RG/Miller	Well										submersible		also agricultural, dist CBR can come to dom well?	hisremarks:Canadian & foreign ownership was issue	tax free- not paying property tax on bldg and pipe	will CBR pay to measure well flow with Chubb?
231		31N	52W	17				John Eldon Wohlers		Crawford	NE	69339	30-Jun-04			RG/Miller	Well										Windmill		asked distance CBR can drill from domestic well?	hisremarks:Canadian & foreign ownership was issue	tax free- not paying property tax on bldg and pipe	will CBR pay to measure well flow with Chubb?
233		32N	52W	10				Russell Garner	14231 Hw 71	Crawford	NE	69339	02-Jul-04		430-3779	Miller	Well				80	60	01-Jan-55	80	Steel Galvanized	4	Jet Pump		also agricultural	drill date aprox.		
235		31N	52W	13				Gordon Pinney	60 Pinney Rd	Crawford	NE	69339	02-Jul-04		665-1785	Miller	Well	20-30			30	7	01-Jan-94	30	Plastic	6	submersible	Chubb		drill date aprox.		
237		32N	52W	25				Doug Zeller	182 Old Hwy 20	Whitney	NE	69367	06-Jul-04		430-3755	Miller	Well				50	6	01-Jan-00	50	Plastic		submersible	Chubb		drill date aprox.		
241		32N	52W	14				George Leeling	11 Annin St.	Crawford	NE	69339	07-Jul-04		665-1286/1215	Miller	Well				21	12	01-Jan-70	21	Plastic	6	submersible	Chubb	also agricultural	drill date aprox.		
243		32N	52W	23				Greg Raben	51 Raben Rd	Crawford	NE	69339	07-Jul-04		665-1261	Miller	Well				30	20	01-Jan-85	30	Steel	6	submersible	Chubb	also agricultural	drill date aprox.		
244		32N	52W	23				Greg Raben	51 Raben Rd	Crawford	NE	69339	07-Jul-04		665-1261	Miller	Well				30	20		30	Steel	6	Jet Pump		also agricultural	old well		
245		32N	52W	23				Greg Raben	51 Raben Rd	Crawford	NE	69339	07-Jul-04		665-1261	Miller	Well				25	12		25	Steel	6	Windmill					

APPENDIX 6

WATER USER SURVEY INFORMATION FOR WATER SUPPLY WELLS IN 2.25-MILE AREA OF REVIEW

Well ID	DNR Regestration No.	Township	Range	Section	Easting	Northing	Water Quality	Owner	Street Address	City	State	Zip Code	Interview Date	Contact Person	Telephone	Interviewer	Supply Source	Screen Interval	Estimated Extraction Rate	Pump test results	Total Depth	Static Level	Drill Date	Casing Depth	Casing Type	Diameter	Pumping Method	Driller	History	Remarks	Remarks_2	Remarks_3
246		32N	52W	17				John Dodd	451 Dodd Rd	Crawford	NE	69339	08-Jul-04		665-2012	Miller	Well				40	9		40		6	submersible	Chubb	also agricultural			
247		32N	52W	16				State (Dodd Lease)	451 Dodd Rd (Dodd)	Crawford	NE	69339	08-Jul-04		665-2012 (Dodd)	Miller	Well				30			30	Steel	6	Windmill					
248		32N	52W	13				Reed/Galbreath (Bruce Wohlers)	14051 Hw 71 (Wohlers)	Crawford	NE	69339	08-Jul-04		665-1104	Miller	Well				30			30		6	submersible			in well pit		
249		32N	52W	14				Bruce Wohlers	14051 Hw 71	Crawford	NE	69339	08-Jul-04		665-1104	Miller	Well				30			30	Steel	6	Pump Jack					
250		32N	52W	24				Pat Drinkwalter	211 Mansfield Rd	Crawford	NE	69339	09-Jul-04		665-1818	Miller	Well				30	20	01-Jan-50	30	Steel	6	submersible			drill date aprox.		
251		32N	52W	19				Bill Eberspecher	3 Rim Rock Rd	Crawford	NE	69339	09-Jul-04		665-2054	Miller	Well				100				Steel	6	Windmill					
252		32N	52W	8				Jerry Golden	1941 Cottonwood Rd	Crawford	NE	69339	09-Jul-04		665-1835	Miller	Well								Stone		Centrifgul		also agricultural	asked about CBR paying for pump test on wells		
253		32N	52W	8				Jerry Golden	1941 Cottonwood Rd	Crawford	NE	69339	09-Jul-04		665-1835	Miller	Well										Pump Jack			asked about CBR paying for pump test on wells		
254		32N	52W	8				Jerry Golden	1941 Cottonwood Rd	Crawford	NE	69339	09-Jul-04		665-1835	Miller	Well										Centrifgul					
255		32N	52W	11				Keith Nixon	232 Paddock St	Crawford	NE	69339	13-Jul-04		665-2897	Miller	Well				30	20		30	Steel		Windmill			alkalai water		
256		32N	52W	9				Willis Hoffman	254 Toadstool Rd	Crawford	NE	69339	13-Jul-04		665-2646	Miller	Well				40	15	01-Jan-70	40	Steel Galvanized	6	Jet Pump	Chubb	Not in use	drill date aprox.		
257		32N	52W	7				Allen Raum	150 Rim Rock Rd	Crawford	NE	69339	13-Jul-04		665-1419	Miller	Well				50	20			Steel	6	Windmill					
258		32N	52W	8				Diane Norman	1934 Cottonwood Rd	Crawford	NE	69339	13-Jul-04		665-1613	Miller	Well															
259		32N	52W	8				Diane Norman	1934 Cottonwood Rd	Crawford	NE	69339	13-Jul-04		665-1613	Miller	Well												also agricultural			
262		32N	52W	15				Rusty Riggs	14121 Hw 2-71	Crawford	NE	69339	14-Jul-04		665-1663	Miller	Well				30	20	01-Jan-80	3	Concrete	3'	submersible	Bice	also agricultural	drill date aprox.		
263		32N	52W	15				Rusty Riggs	14121 Hw 2-71	Crawford	NE	69339	14-Jul-04		665-1663	Miller	Well								Concrete	3'				old well		
436	G-149482	32N	52W	35				Dannie Barcal	60 Old Hwy 20	Crawford	NE	69339	08-Jul-08					9-32	10gpm		37	12	02-Jun-08	0-9 & 32-37	PVC	4.5	submersible	Chubb		DNR Database		
437	G-149270	31N	52W	3				Jon Ereckson	Box 546	Crawford	NE	69339	08-Jul-08					140-200	10gpm		200	54	04-May-07	140	PVC	4.5	submersible	Chubb		DNR Database		
438	G-128947	32N	52W	34				Laurie Sinn	91 Mill Rd.	Crawford	NE	69339	08-Jul-08			Grantham		40-60	20gpm		60	15	06-Jun-03	40	PVC	6	dempster pump	Chubb		DNR Web site lists 55-60 as Chadron Clay		
439	G-142918	32N	52W	14	755	1427		Bruce Wolers	14051 Hwy 71	Crawford	NE	69339	08-Jul-08					20-60	4gpm		60	20	19-Nov-06	20		4	Gould Pump	Jim's Well Service		DNR Database		
440	G-139608	32N	52W	22	335	879		Bruce Wohlers	14051 Hwy 71	Crawford	NE	69339	08-Jul-08						4gpm		240	35	04-Mar-06	240		4	Gould Pump	Jim's Well Service		DNR Database	course gravel 20-30'	
441	G-139607	32N	52W	22	259	876		Bruce Wohlers	14051 Hwy 71	Crawford	NE	69339	08-Jul-08						4gpm		240	35	01-Mar-06	240	PVC	4"	Gould Pump	Jim Prosser		DNR Database	Course gravel 20-30'	
442	G-094931	32N	52W	11				Eldon Wohlers	100 Wohlers Dr.	Crawford	NE	69339	08-Jul-08					40-60	3gpm		60	25	03-Nov-97					Chubb		DNR Database		
443	G-147453	32N	52W	8				Larry Rising	HC 92	Crawford	NE	69339	08-Jul-08					120-140	10gpm		140	18	29-Oct-07	120		4.5"	submersible	Chubb		DNR Database		
445	G-151619	32N	52W	34				Roy Norgard	812 2nd St.	Crawford	NE	69339		Leonard Chubb	665-1462		Well	20-40 140-160	17gpm		160	16	18-Oct-08	140	PVC	4.5"	submersible	Chubb	new well; agriculture (livestock)	replacement well for abandoned well #114	lat 42.4212 long 103.2428	listed in DNR data base
5001								Mrs. Cecil Chubb	701 Main	Crawford	Ne	69339	12-Sep-83		665-1243	RG	Well				280		01-Jan-72	280	Plastic	3		C. Chubb	water lawn and for well drilling	drill date aprox., 40' cemented surface casing	artesian well	C01
5002								Don Garner	409 Main	Crawford	Ne	69339	12-Sep-83		665-1749	RG	Well				25	10			Steel Galvanized	5.25	Jet Pump		water lawn	outside back door		C02
5003								Herb Courtain	618 Main	Crawford	Ne	69339	12-Sep-83			RG	Well				280		01-Jan-64	280	Steel	5		Chubb	some lawn and garden	drill date aprox.	@NW corner of house	artesian well, C03
5004								John Limbach	1100 1st St	Crawford	Ne	69339	12-Sep-83		665-2309	RG	Well				85	est 45				5	submersible		lawn and garden	south side of house		C04
5005								Wright Lathrop	302 Linn	Crawford	Ne	69339	12-Sep-83			RG	Well				40			40	Steel Galvanized	5	submersible			old well located in basement	reamed and cleaned May 1983	C05
5006								Tillie Thomas	141 Linn St	Crawford	Ne	69339	12-Sep-83		665-1271	RG	Well				100		01-Jan-60	100	Steel Galvanized	5.25	Jet Pump	Pelrun		drill date aprox.	located in backyard	C06
5007								Earl Ball	136 Linn	Crawford	Ne	69339	12-Sep-83		665-2378	RG	Well				50	est 20	01-Jan-20	50	Steel Galvanized	6	submersible		water lawn	drill date aprox.	located backyard	no draw down, C07
5008								Ed Peterson	7th and Coates	Crawford	Ne	69339	12-Sep-83		665-1753		Well				48	est 24	01-Jan-77	48	Plastic	6	submersible	Peterson	lawn	drill date aprox.	located backyard	good recharge, C08
5009								Bob Scoggan	119 Linn	Crawford	Ne	69339	12-Sep-83		665-2657		Well				60	est 22	01-Jan-79	60	Plastic	6	submersible	Chubb		drill date aprox.	located backyard	C09
5010								C. A. Hartman	113 Linn	Crawford	Ne	69339	12-Sep-83				Well				30	est 12	01-Jan-27	30	Steel	6			lawn	drill date aprox., located backyard	hand drilled no pump by Bob Scoggan	C10
5011								Calvin Hiner	142 Ash	Crawford	Ne	69339	12-Sep-83		665-2410	RG	Well				110	27	01-Jan-60	110	Steel	6	submersible	Pelrun	lawn and garden	drill date aprox.	located at side of house	submersible by Bob Scoggan, C11
5012								Cecil Avey	311 Annin	Crawford	Ne	69339	12-Sep-83		665-2517	RG	Well				80	est 40	01-Jan-81	80	Plastic	4	submersible	Chubb	lawn and minnows	drill date aprox.	located in backyard	also one abandon well, C12
5013								Cecil Avey	311 Annin	Crawford	Ne	69339	12-Sep-83		665-2517	RG	Well				45	18.5	01-Jun-83	45	Plastic	4	submersible	Chubb	garden	drill date aprox.	located 200' SW of Mason's Laundramat	static @ 19' after pumping all day, C13
5014								Guy Mason	723 E Elm Box 287	Crawford	Ne	69339	12-Sep-83		665-1350	RG	Well				50	14	01-Jan-70	no casing			submersible	Chubb	lawn	drill date aprox.	located backyard	C14
5015								Ed Rhoads	502 Annin	Crawford	Ne	69339	12-Sep-83		665-1150	RG	Well				50			50	Steel Galvanized	6	submersible		also agricultural	>50 yrs old	north of house	doesn't pump dry, C15
5016								Jerry Piper	1109 6th St	Crawford	Ne	69339	12-Sep-83		665-2317	RG	Well				38	18			Steel Galvanized	6			garden	>20 yrs old	located backyard	hand pump and pumpjack, C16
5017								Arthor L. Anderson	406 Linn	Crawford	Ne	69339	12-Sep-83		665-2366	RG	Well				60	19	01-Jan-74	60	Plastic	5.25	submersible	Chubb	lawn and garden	drill date aprox.	located east of house	C17
5018								Clarence Moffet	5th and Ash	Crawford	Ne	69339	12-Sep-83		665-1732		Well				40	28	01-Jan-60	28	Steel Galvanized	6	Jet Pump	Carley?	lawn	drill date aprox.	N of house	C18
5019								Joe Welling	418 Annin	Crawford	NE	69339	12-Sep-83		665-1834	RG	Well		6 gpm		60	30	01-Jan-78	60	Plastic	5	submersible	Chubb		drill date aprox.	located backyard	C19
5020								James Benson	14 Paddock	Crawford	Ne	69339	12-Sep-83		665-2039	RG	Well				100		01-Jan-78	100	Steel Galvanized	6	submersible	Jack Carley?		drill date aprox.	east side of house	C20
5021								Leonard Prosser	216 Paddock	Crawford	Ne	69339	12-Sep-83		665-1154	RG	Well		2.5 gpm		50	30	01-Jan-80	50	Plastic	4.5	submersible	Chubb	lawn	drill date aprox.	located backyard	C21
5022								Jackson Rice	233 Paddock	Crawford	Ne	659339	12-Sep-83		665-2259	RG	Well				50	25		50	Steel Galvanized				no use	>50 yrs old	located backyard	hand pump, not hooked up, C22
5023								Lee Hallsted	314 Paddock	Crawford	Ne	69339	12-Sep-83		665-2306		Well				50	30	01-Jan-31	20	Steel Galvanized	6	submersible	Pelrun		drill date aprox.	located backyard	C23
5024		31N	52W	3				Alvia Leetch	105 E Oak	Crawford	Ne	69339	13-Sep-83		665-2003		Well				40	est 30	01-Jan-79	40	Plastic	6	submersible	Chubb	lawn	drill date aprox.	located backyard	C24
5025		31N	52W	3				Grace McNett	119 Pine	Crawford	Ne	69339	13-Sep-83		665-2081	RG	Well				60									>20 yrs old	located backyard	no pump - no use, C25
5026								Lloyd Pipher	1019 2nd St	Crawford	Ne	69339	13-Sep-83		665-2686	RG	Well				65	20	02-Jan-00	65	Steel Galvanized		submersible	Barnum?		drill date aprox.	located in backyard	C26
5027								City of Crawford	1005 1st St	Crawford	Ne	69339	13-Sep-83			RG	Well				60		01-Jan-77	60	Plastic		submersible	Chubb	lawns	C27		
5028		31N	52W	3				Henry Hanson	115 Oak	Crawford	Ne	69339	13-Sep-83		665-2644	RG	Well				36	10				4			lawn and garden	no pump at this time	C28	
5029								Loren Bell	602 E Main	Crawford	Ne	69339	13-Sep-83		665-1858	RG	Well				80	30	01-Jan-68	20, surface casing		6	submersible	Powers	lawn	drill date aprox.	N side of house	pump out but will have submersible, C29
5030		31N	52W	3				Bruce Corbin	315 Oak	Crawford	Ne	69339	06-Aug-96		665-2387	Dave Dunn	Well				50	30	01-Jan-80	50	Plastic	6	submersible	Chubb	used for lawn but plans to hook up to house	drill date aprox.	located backyard	electric broke said he would fix, C30
5031								Mrs. Ray Bacon	821 1st	Crawford	Ne	69339	13-Sep-83		665-1787	RG	Well										Jet Pump			well drilled by husband who is deceased and she	has no knowledge of any of the above info,	located in basement, C31
5032								Mariellen Soester	915 5th	Crawford	Ne	69339	13-Sep-83		665-2506	RG	Well				114	32	01-Jan-50	surface casing	Steel Galvanized	6	submersible	Pelrun		drill date aprox.	located front yard	C32
5033		31N	52W	3				Inez Zeller	316 Oak	Crawford	Ne	69339	13-Sep-83		665-1823	RG	Well				46	11		46	Steel Galvanized		submersible		yard and garden	>75 yrs old	C33	
5034								Harris Snyder	702 4th	Crawford	Ne	69339	13-Sep-83		665-1830	RG	Well				55	45	01-Jan-10			5				drill date aprox.	hand dug, brick casing?, no casing	C34
5035		31N	52W	3				Gordon Johnson	520 Pine	Crawford	Ne	69339	13-Sep-83		665-2780	RG	Well		<10 gpm		285		01-Jan-80	285	Plastic	6		Chubb	yard, garden, and chickens	drill date aprox.	located backyard	artesian well, C35
5036								Frank Pisaska	231 1/2 Main	Crawford	Ne	69339	13-Sep-83		665-2288	RG	Well				26			26	Steel	6			no use	no pump	located 20' NE of Gray Stucco barn@Lathrop Adition	C36
5037		31N	52W	3				Mrs. Roy Garner Sr.	403 Beech	Crawford	Ne	69339	27-Sep-83		665-2393	RG	Well				63						submersible	Pelrun	also agricultural	>25 yrs old	C37	
5038								Don Bell	307 Coates	Crawford	Ne	69339	23-Sep-83		665-1953	RG	Well				105	12	01-Jan-68	18	Steel Galvanized	6		Powers	no present use	drill date aprox.	located backyard	no pump, C38
5039								Gene Liebentritt	137 Main	Crawford	Ne	69339	26-Sep-83		665-1166	RG	Well				56	12		56	Steel	6	Jet Pump		seldom used	>20 yrs old	C39	
5040								Clyde Blaylock	112 Main	Crawford	Ne	69339	27-Sep-83		665-1335	RG	Well										submersible	Chubb	used in honey house in apiary	>50 yrs old	located old Nash Finch Bldg	C40
5041								Ron Britton	615 Elm	Crawford	Ne	69339	27-Sep-83		665-2354	RG	Well				40	15							irrigation - seldom used	pump jack and hand pump	Abnd	C41
5042								George Leeling	111 Annin	Crawford	Ne	69339	27-Sep-83			RG	Well				90	20	01-Jan-75	20	Plastic	6	submersible	Chubb		drill date aprox.	located backyard	C42
5043								Don Bass	113 Paddock	Crawford	Ne	69339	26-Sep-83		665-1790	RG	Well				60			60	Steel Galvanized	6			irrigation - seldom used	>50 yrs old	located backyard	pump jack - pumps dry, C43
5044								Chet Mansfield	7th St across from football field	Crawford	Ne	69339	27-Sep-83		665-1368	RG	Well				400	17.9	01-Jan-65	400	Steel	4		Carley	no use at present - used to flow	drill date aprox.	ease of house	no pump, C44
5045								Ben Garvin	705 2nd Street	Crawford	Ne	69339	27-Sep-83		665-1774	RG	Well				50	17		50	Steel Galvanized	6			no use at this time plans to fix up next summer	>50 yrs old	C45	
5046								Doug Neff	505 Elm	Crawford	Ne	69339	28-Sep-83		665-1513	RG	Well				24	12			Steel Galvanized	6			no present use	no pump, plan to put pump down next summer	located backyard	C46
5047								Doug Topham	3491 Hwy 20	Crawford	Ne	69339	28-Sep-83		665-1962	RG	Well				140	30	01-Jan-52	140	Steel Galvanized	4				drill date aprox.	located backyard	slow recovery pump?, C47
5048								Mrs. Mabel Carnahan	235 Main	Crawford	Ne	69339	19-Jul-84		665-1266	RG	Well				50		01-Jan-81	50		4.5	submersible	Chubb	also agricultural	drill date aprox.	not plummed into house	C48
5049								Ray Hamaker	612 Elm St	Crawford	Ne	69339	20-Jul-84		665-2376	RG	Well				40	15		40	Steel Galvanized	5	submersible			>70 yrs old	west of house	C49
5050								Ray Hamaker	612 Elm	Crawford	Ne	69339	20-Jul-84		665-2376		Well				50	17	01-Jan-64	12	Steel Galvanized	5	Windmill	Chubb		drill date aprox.	no present use - pumps soap suds	C50
5052		31N	52W	3				Iris Wilkins	111 Oak St	Crawford	Ne	69339	05-Aug-96		665-1723	Dave Dunn	Well													old well, hand pump	doesn't work	C52
5053		31N	52W	3				Alvee Leeth Est.	311 Oak	Crawford	Ne	69339	06-Aug-96		665-2387	Dave Dunn	Well				50				Plastic			Chubb	water yard	electric		C53
5054		31N	52W	3				Bruce Corbin	315 Oak	Crawford	Ne	69339	06-Aug-96		665-2387	Dave Dunn	Well								Steel			Chubb Sr.		old pump jack	broke but might fix	C54
5055		31N	52W	3					West of C54?																					still looking for info	C55	
5056		31N	52W	3				Frank Olbricht	411 Oak St.	Crawford	Ne	69339	05-Aug-96		665-2594	Dave Dunn	Well													old well	C56	
5057		31N	52W	3				Louise Perkins	311 Beach	Crawford	Ne	69339	06-Aug-96		665-2668	Dave Dunn	Well				26	16			Steel					old hand pump (works)	C57	
5058	G-096438	31N	52W	10	1980E	990S		John Dodd	135 Main St.	Crawford	Ne	69339	26-May-98				Well	15-35	10gmp		55	15			PVC			Chubb		Lat 42.680242	Long 103.415786	C58
5059	G-084038	31N	52W	10	2300E	1000S		Warren Madison	117 Coates St	Crawford	Ne	69339	08-Jul-08						12 gpm		60	20	25-Nov-94							Lat 42.680213	Long 103.414597	C59
5060		31N	52W	3				Brian Perkins	323 Beach St	Crawford	Ne	69339	30-Jul-96		665-2542	Dave Dunn	Well								Plastic					electric	broke but might fix	C60
5062		31N	52W	3				Jim Prosser	316 Pine	Crawford	Ne	69339	07-Aug-96		665-2254	Dave Dunn	Well													plugged	C62	
5063		31N	52W					Ray Holcomb	720 Main Street	Crawford	Ne	69339	06-Aug-96			Dave Dunn	Well				est 50				Steel					old well covered with tin can	C63	
5064		31N	52W	3				Marg Jackson	214 Pine	Crawford	Ne	69339	05-Aug-96		665-2199	Dave Dunn	Well								Steel	6				covered with tin pan	C64	
5066	G-127989	31N	52W	10				Dewayne Lambert	327 Fremont Street	Crawford	NE	69339	08-Jul-08					36-56			56	26	14-Apr-03	36	PVC	4.5"		Chubb		DNR web site-lists supply	source as Chadron Clay	
5068	G-145284	31N	52W	10				Robert Buckley	607 Elm Street	Crawford	NE	69339	08-Jul-08					20-40 & 55-75	10gpm		75	16	09-Jan-07	0-20 & 40-55	PVC	4.5	submersible	Chubb				
5069	G-144207	31N	52W	10				Fred Prelle	3491 Hwy 20	Crawford	NE	69339	08-Jul-08					300-360	12gpm		360	30	06-Apr-07	300		4.5	submersible	Chubb				
RC-1	G-068699	31N	52W	3				Crow Butte Resources	86 Crow Butte Rd Box 169	Crawford	NE	69339								2 gpm	350	0	10-Jun-82							lat 42.695612	long 103.410942	RC1
RC-2	G-068704	32N	52W	34				Crow Butte Resources	86 Crow Butte Rd Box 169	Crawford	NE	69339								10 gpm	592	0	28-Jun-82							lat 42.699324	long 103.410973	RC2

NOTES

1) The absence of a registration number indicates the well is most likely not registered with the Nebraska Department of Natural Resources. Whether a water supply well was registered historically was dependent on the landowner for older wells and the drilling subcontractor for newer wells.

2) Pumping rates are provided where available. In many cases, either landowners did not know pumping rates or the wells did not contain pumps due to artesian conditions.

3) Northing and easting are provided in Nebraska State Plane coordinates.

4) "Estimated Rate" indicates the estimated extraction rate (gallons per minute). For artesian wells that do not contain pumps, the rate represents flow at the surface.

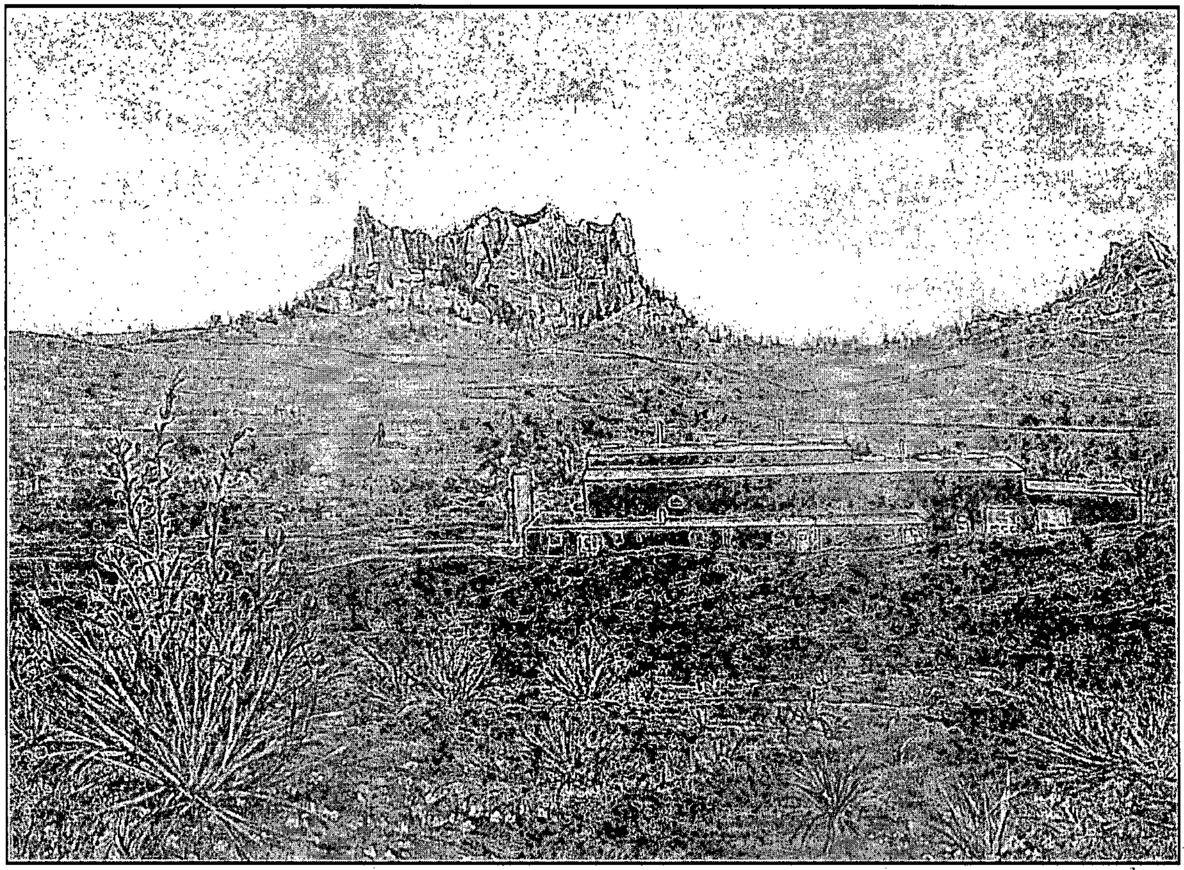
gpm - gallons per minute

Application for

Nebraska Department of Environmental Quality (NDEQ)

Class III Underground Injection Control (UIC) Permit

Volume II – Appendices



Crow Butte Resources, Inc.

86 Crow Butte Road

Crawford Nebraska 69339

January 2010 (Revised)

REPLACEMENT PAGES FOR

VOLUME II

APPENDICES

REPLACEMENT PAGE

FOR APPENDICES

Replace Title Page

REPLACEMENT PAGES

FOR APPENDIX 1

WELL COMPLETION RECORDS

Add the following:

Appendix 1-9

Appendix 1-9
Private Water Well #445
Water Well Registration

Mail to
Department of Natural Resources
PO Box 94676
Lincoln, NE 68509-4676
Phone (402)471-2363

May 2007
DNR Form 145

STATE OF NEBRASKA
DEPARTMENT OF NATURAL RESOURCES
WATER WELL REGISTRATION

Please indicate NA for items unknown

FOR DEPARTMENT USE ONLY

Date Filed 12/18/08 Owner Code No. 93562 Registration No. 6-151619
12182008 - 196107 - WWRF(3) Receipt R23574 Upper Niobrara White NRD
Well ID

1. a. Well Owner's First Name ROY Last Name NORGARD
OR Company Name
b. Attention Name
c. Address 812 2ND ST
City CRAWFORD State NE Zip 69339 Telephone

2. a. Contractor's License No 39035 Contractor's Name LEONARD CHUBB
Contractor's Email Address
b. Drilling Firm Name CHUBB WATER WELLS
Address 3632 HWY. 20
City CRAWFORD State NE Zip 69339 Telephone 308.665.1418
Drilling Firm's Email Address

3. a. Well location NE ¼ of the SE ¼ of Section 34, Township 32 North, Range 52 E☐ W☐, DAWES County.
b. Natural Resources District UPPER NIOBRARA--WHITE
c. The well is ______ feet from the (N☐ S☐) section line and ______ feet from the (E☐ W☐) section line
OR Latitude Degree 42 Minute 42 Second 12
Longitude Degree 103 Minute 24 Second 28

Location of well for a pit is the location of the pump

d. Street address and subdivision, if applicable
Block Lot
e. Location of water use (give legal descriptions) SAME AS 3A
f. If for irrigation, the land to be irrigated is ______ acres.

Location of water use is required on all wells

g. Well reference letter(s), if applicable ______ HHSS PWSID

4. Permits
Management Area Permit Number
Geothermal Permit Number
Municipal Permit Number
Well Spacing Permit Number
HHSS
Surface Water Permit Number
Industrial Permit Number
Transfer Out-Of-State Permit Number
Conduct Permit Number
Other Permit Number
NDEQ

5. Purpose of well (indicate one) ☐ Aquaculture ☐ Commercial/Industrial ☐ Dewatering (over 90 days)
☐ Domestic ☐ Ground Heat Exchanger ☐ Groundwater Source Heat Pump ☐ Irrigation ☐ Injection
☑ Livestock ☐ Monitoring ☐ Observation ☐ Pit (for irrigation) ☐ Public Water Supply (with spacing (46-638))
☐ Public Water Supply (without spacing) ☐ Recovery ☐ Other ______
(further description of use can be provided under other) (indicate use)

6. Wells in a Series.
a. Is this well a part of a series? ☐ Yes go to part b of this section ☑ No go to part 7 of this application
b. If one or more of the wells in the series is currently registered, give all well registration numbers
c. How many wells in the series are you registering at this time?

Appendix 1

6-151619

7. Replacement and decommissioned/modified well information.
   a. Is this well a replacement well? [✔] Yes [ ] No go to part 8 of this application
   b. Registration number of original well N/A If not registered, date original well was constructed (m)___/(d)___/(y)___
   c. Original well last operated (m)___/(d)___/(y)___ d. Replacement well is 60 feet from original well.
   e. Location of water use of original well ________

Please Select One:

f.1. [ ] Original water well decommissioned on (m) 10 /(d) 18 /(y) 08 **OR**

2. [ ] I hereby certify that the original water well will be decommissioned within 180 days after such construction of the replacement water well. **OR**

3. [ ] I hereby certify that the original water well will be modified and equipped to pump 50 gallons per minute or less within 180 days after such construction of the replacement water well. It will be used for one of the following: a. [ ] Livestock
   b. [ ] Monitoring c. [ ] Observation
   d. [ ] nonconsumptive or de minimus use approved by the applicable natural resources district. State use: ______

   If 3d is chosen. NRD signature is required. (Signature can be submitted on NRD Approval form to DNR prior to registration)

   NRD signature________ Date______ **OR**

4. [ ] Decommission/Modification Certification form is submitted by landowner.

8. Pump Information. (Pump information is required if registering a pit)
   a. Is pump installed at this time [✔] Yes [ ] No
   Is pump installed by well owner in section 1? [ ] Yes [✔] No Is pump installed by contractor in section 2? [✔] Yes [ ] No
   If pump installed by pump installer, please fill out license number below
   b. Pump Installer's License No.______ Pump Installer's Name______
   Pump Installer's Email Address______
   Pump Installer's Firm Name______
   Pump Installer's Firm Address______
   City______ State ______ Zip______ Telephone ______
   Pump Installer's Firm Email Address______
   c. Pumping rate 17 gallons per minute ______ Measured X Estimated
   d. Drop pipe diameter 1.25 inches e. Length of drop pipe 140 feet
   f. Pumping equipment installed (m) 11 /(d) 18 /(y) 08 g. Pump Brand RED JACKET
   h. This well is designed and constructed to pump less than 50 gpm [✔] Yes [ ] No **(8H is required on ALL wells)**

9. Well Construction Information.
   a. Total well depth 160 feet. b. Static water level 16 feet. c. Pumping water level 50 feet
   d. Well Construction Began (m) 10 /(d) 18 /(y) 08 e. Well Construction Completed (m) 10 /(d) 18 /(y) 08

Wells drilled prior to stays or moratoriums require NRD signature	**NRD signature**______ Date______ (Signature can be submitted on NRD Approval form to DNR prior to registration)

   f. Bore hole diameter in inches Top 9 Bottom 9
   g. Casing and Screen Joints are Welded [ ] Glued [✔] Threaded [ ] Other ______

10. Well Construction (Casing & Screen)- c, d, e, & g measurements should be in inches to three decimal places

a		b	c	d	e	f	g	h
Placement Depth in Feet		Casing or Screen	Inside Diameter	Outside Diameter	Wall Thickness	Screen Slot Size	Type of Material	Trade Name
From	To							
0	20	CASING	4.454	4.950	0.248			EAGLE
20	40	W SCREEN	4.454	4.950	0.248	.018		CWW
40	140	CASING	4.454	4.950	0.248			EAGLE
140	160	W SCREEN	4.454	4.950	0.248	.018		CWW

REPLACEMENT PAGES

FOR APPENDIX 2

ABANDONMENT RECORDS

Add the following:

Appendix 2-14
Well No. 52 Abandonment Record
Appendix 2-15
Well No. 114 Abandonment Record

Appendix 2-14

Notice of Water Well Decommissioning

For Private well No. 52

Oct 2007
DNR DECO

Submit to:
Department of Natural Resources
301 Centennial Mall South
P.O. Box 94676
Lincoln, Nebraska 68509-4676
Phone (402) 471 2363

STATE OF NEBRASKA
DEPARTMENT OF NATURAL RESOURCES

This form is required to be filed within 60 days of decommissioning of the water well.

NOTICE OF WATER WELL DECOMMISSIONING

FOR DEPARTMENT USE ONLY

Date Filed 12/1/08 Owner Code No. 93371 Registration No. ——

12012008 - 195731 - DecF(1) UPPER NIOBRARA - WHITE NRD

Well ID

1. Well Owner's First Name Steven Last Name Bauersachs

OR Company Name

Attention Name

Address 3475 Hwy 20 PO Box 11

City Crawford State Ne Zip 69339 Telephone

2. Contractor (if applicable) Jim Pinnar Telephone Number 308 665 2254

Address 291 4 Mile Rd Contractor License No. 39982

City Crawford State Ne Zip Code 69337

Email:

3a. Well Registration No ——

3b. Purpose of Well: livestock

3c. Date Well Last Operated ——

3d. Date of Decommissioning 11-16-08

3e. List complete well location: Legal, Footage and/or GPS Coordinates

Well location: NE ¼ of the SW ¼ of Section 10, Township 31 North, Range 52 E☐ W☒, Dawes County.

The well is 2500 feet from the (N☐ or S☒) section line and 2087 feet from the (E☐ W☒) section line.

OR Latitude Degree: Minute: Second: .

Longitude Degree: Minute: Second: .

3f. Location of Water Use: same as 3e

4. Actual Method for Decommissioning of Well

Placement Depth in Feet From	To	Detailed Description of Material
410	20	bentonite chips
20	10	gravel
10	5	bentonite chips
5	3	cement cap
3	0	topsoil

5a. Well Casing Size: 4" 5b. Bore Hole Diameter: unknown

I hereby certify that the information provided on this form is true and accurate to the best of my knowledge.

[signature] 11-26-08

Contractor (**owner) Date

**Owner may sign on wells prior to 7/1/2001 or sandpoint or if well no longer exists and it is unknown when decommissioning occurred

The Department reserves the right to request verification of information provided.

RECEIVED
DEC 01 2008
DEPARTMENT OF NATURAL RESOURCES

Appendix 2

Appendix 2-15
Notice of Water Well Decommissioning
For Private well No. 114

Submit to:
Department of Natural Resources
301 Centennial Mall South
P.O. Box 94676
Lincoln, Nebraska 68509-4676
Phone (402) 471 2363

Oct 2007
DNR DECO

STATE OF NEBRASKA
DEPARTMENT OF NATURAL RESOURCES

This form is required to be filed within 60 days of decommissioning of the water well.

NOTICE OF WATER WELL DECOMMISSIONING

FOR DEPARTMENT USE ONLY

Date Filed 11/16/09 Owner Code No. 93562 Registration No. ———

11162009 - 201693 - DecF(1) UPPER NIOBRARA-WHITE NRD

Well ID

1. Well Owner's First Name ROY Last Name NORGARD

OR Company Name

Attention Name

Address 812 2ND ST

City CRAWFORD State NE Zip 69339 Telephone

2. Contractor (if applicable). CHUBB WATER WELLS Telephone Number (308) 665.1418

Address 3632 HWY. 20 Contractor License No. 39035

City CRAWFORD State NE Zip Code 69339 +

Email:

3a. Well Registration No. N/A NEW WELL G-151619

3b. Purpose of Well: LIVESTOCK

3c. Date Well Last Operated. 10-18-08 3d. Date of Decommissioning. 10-18-08

3e. List complete well location: Legal, Footage and/or GPS Coordinates

Well location: NE ¼ of the SE ¼ of Section 34, Township 32 North, Range 52 E☐ W☑, DAWES County.

The well is ______ feet from the (N☐ or S☐) section line and ______ feet from the (E☐ W☐) section line.

OR Latitude Degree: 42 Minute: 42 Second: 12 .

Longitude Degree: 103 Minute: 24 Second: 28 .

3f. Location of Water Use:

4. Actual Method for Decommissioning of Well

Placement Depth in Feet		Detailed Description of Material
From	To	
0	6	FILLDIRT (CASING REMOVED)
6	15	BENTONITE CHIPS
15	160	GRAVEL

5a. Well Casing Size: 5 5b. Bore Hole Diameter: 9

I hereby certify that the information provided on this form is true and accurate to the best of my knowledge.

[signature] 11-12-09

Contractor (**owner) Date

**Owner may sign on wells prior to 7/1/2001 or sandpoint or if well no longer exists and it is unknown when decommissioning occurred

The Department reserves the right to request verification of information provided.

RECEIVED
NOV 16 2009
DEPARTMENT OF NATURAL RESOURCES

Appendix 2

REPLACEMENT PAGES

FOR APPENDIX 5

PUMP TEST #6 REPORT

Replace the following pages:

Document Errata and Additions Insert

Figure 1-1 Project Location Map

Figure 1-2 North Trend Pump Test Layout

Appendix 5

DOCUMENT ERATTA AND ADDITIONS INSERT

North Trend Hydrologic Testing Report – Test #6
Petrotek Engineering Corporation
December 2009

The following corrections and additions were made by Jack Cearley of ARCADIS-US, Inc., to the above referenced report on August 01, 2008 and December 11, 2009, under the direction of Lee Snowhite, Cameco Resources.

ERATTA

Table 5.2: On page ii, change Table 5.2 to **Table 5.1.**
Table 5.3: On page ii, change Table 5.3 to **Table 5.2**.

ADDITIONS:

A hard copy of water level data was added to Appendix C, in addition to an existing CDROM containing the same data.

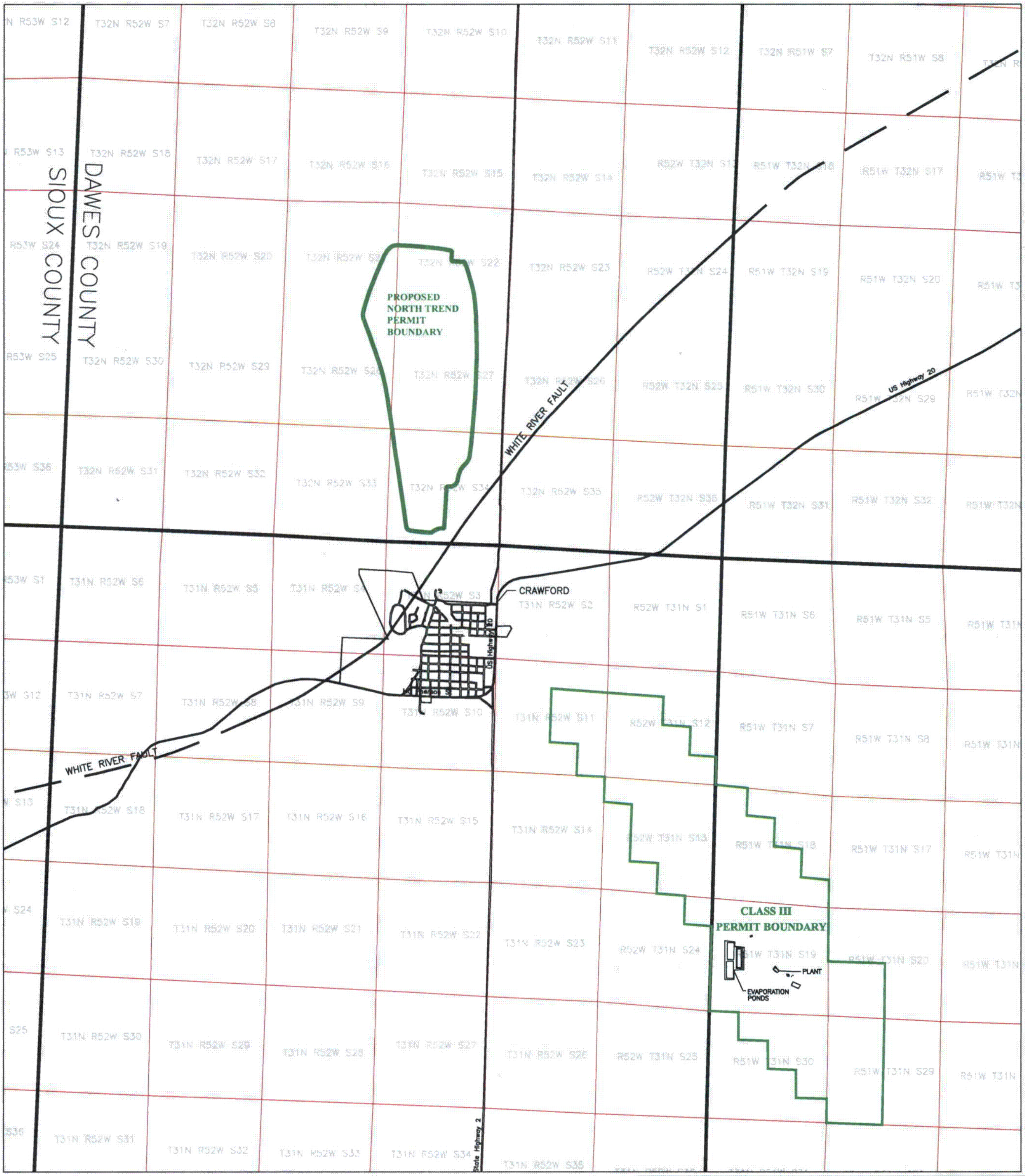
Addition of the following cover sheets to Appendices section:

Appendix A	Completion Reports
Appendix B	Type Curve Matches
Appendix C	Water Level Data

CHANGES:

Due to changes in the North Trend Expansion Area (NTEA) permit boundary, the following figures were replaced with up-to-date figures:

Figure 1-1	Project Location Map
Figure 1-2	North Trend Pump Test Layout



LEGEND

N
W E

0 0.625 1.25 2.50
SCALE IN MILES 1" = 1.25 MILES

CROW BUTTE RESOURCES, INC.

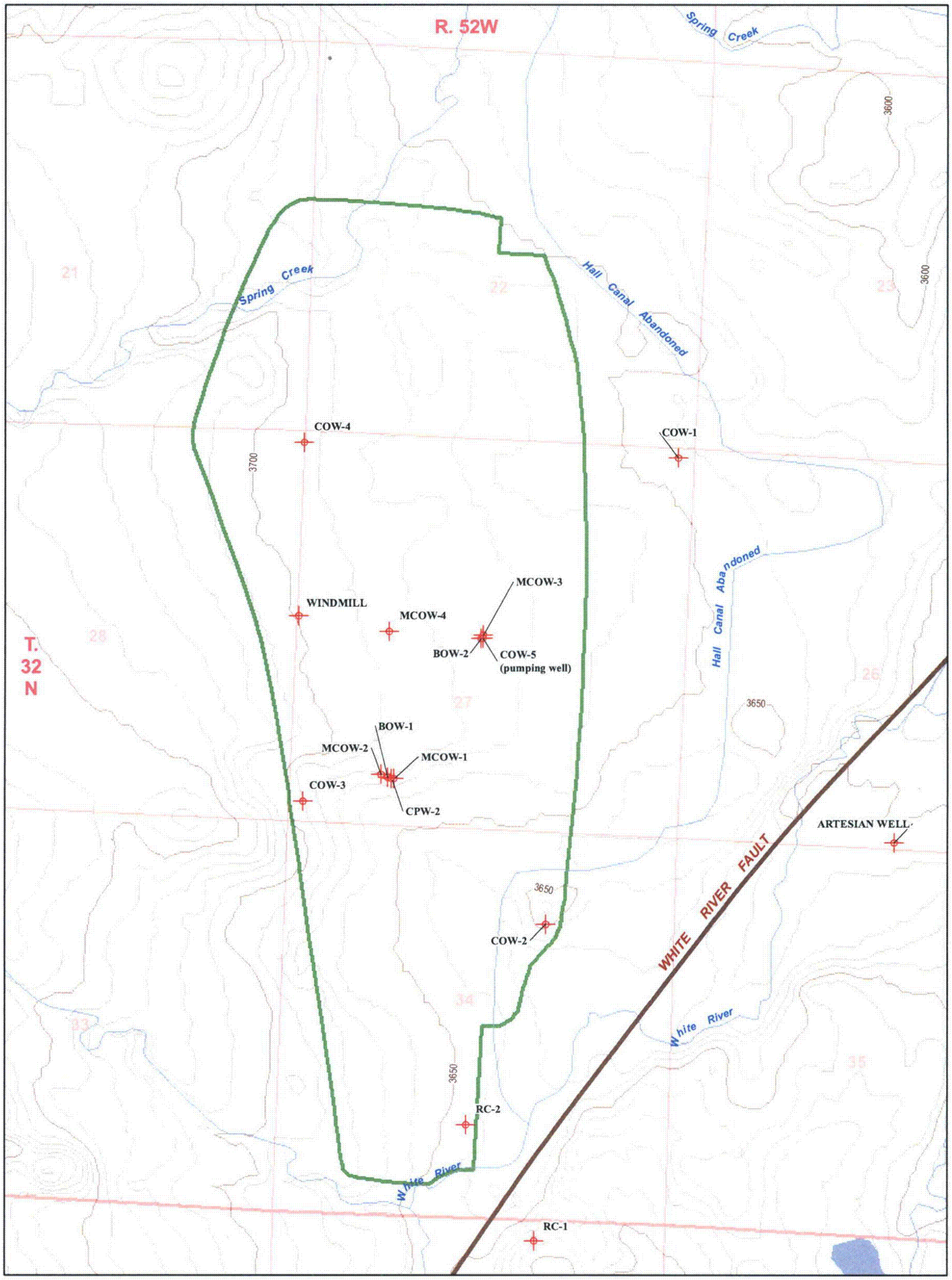
FIGURE 1-1
PROJECT LOCAITON MAP

PROJECT: CO001322_UIC MAPPED: JC CHECKED: J.CEARLEY

FILE: PumpTestRpt_Fig 1-1.AI @ 12/11/2009

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

Appendix 5



LEGEND

- North Trend Monitoring Well
- Elevation Contours (in Feet)
- Proposed North Trend Expansion Area

N
W E

0 1,500 3,
Scale in Feet

CROW BUTTE RESOURCES, INC.

FIGURE 1-2
NORTH TREND
PUMP TEST LAYOUT

PROJECT: CO001322 MAPPED: JC CHECKED: J. CEARY

FILE: K:\...UIC\ArcMaps\PumpTestRpt_Fig1-2.mxd @ 12/11/09

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

Appendix 5

REPLACEMENT PAGES

FOR APPENDIX 6

WELL USER SURVEY

Replace the following:

Appendix 6

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

Appendix 6 Water User Survey Information For Water Supply Wells in 2.25-Mile Area of Review"

WITHIN THIS PACKAGE... OR BY SEARCHING USING THE TITLE.

D-01
D-02