4 ENVIRONMENTAL IMPACTS

The objective of the mining and environmental monitoring program is to conduct an operation that is economically viable and environmentally responsible. The environmental monitoring programs, which are used to ensure that the potential sources of land, water and air pollution are controlled and monitored, are presented in Section 6.0.

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 CPF and the TCEA.

4.1 Land Impacts

4.1.1 Land Surface Impacts

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

- Construction of a satellite process facility located approximately 5.7 miles west of the CPF. This satellite facility will be housed in a building approximately 130 feet long by 100 feet wide and will contain IX and associated equipment capable of processing 6,000 gpm of production flow and 1,500 gpm of restoration flow (**Figure 1.3-11**).
- Construction of solar evaporation ponds located in conjunction with the satellite facility and a deep well for disposal of wastewater.
- A deep well injection building and associated facilities.
- Access roads, as required.
- Expansion of the CPF in response to the increase in the IX resin handling, elution, precipitation, thickening and drying circuits to handle the additional production from the TCEA. The current layout of the CPF, including recent modifications, is provided in **Figure 1.3-10**.

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 1.3.2.2 since 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 TCEA are based on the studies conducted by CBR and discussed in Section 3. 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 CBR project over the past fifteen years of commercial operation.

Construction of the TCEA will require disturbance of an estimated 671 acres for the satellite facility, wellfields, evaporation ponds and road improvements. Of this total, approximately 14 acres will be associated with the satellite facility, deep disposal well, and evaporation ponds. Surface disturbances will include construction of access roads, facility site grading, construction of evaporation ponds, and contouring for control of surface runoff. All areas disturbed will be reclaimed during final decommissioning activities. The planned schedule for construction, production, restoration, and decommissioning was presented in Section 1.

The primary surface disturbances associated with solution mining are the sites containing the processing facilities, associated facilities, facilities and evaporation ponds. 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 short-term impacts.

Due to the relatively minor nature of disturbances created by in-situ 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.

These surface impacts are unavoidable and will last for the duration of the project until final decommissioning. Mitigation measures for land surface impacts are discussed in Section 5.1.

4.1.2 Land Use Impacts

The principal land use for the TCEA and the 2.25-mile review area is grazing livestock. Rangeland accounted for 42.8 percent of the land use in the TCEA and surrounding 2.25-mile area of review (AOR) as discussed in Section 3.1. The secondary land use within the TCEA license boundary is cropland. This cropland is primarily wheat, although a small proportion is used for alfalfa hay. Cropland accounted for 18.7 percent of the land use in the TCEA and the AOR. Land use was discussed in detail in Section 3.1.

For the proposed disturbance of 671 acres for the proposed satellite facilities, wellfields, evaporation pond areas and roadways, cropland accounts for 384.0 acres or 57.2 percent of the total area. Rangeland accounts for 265.9 acres or 39.6 percent of the total area. Rangeland rehabilitation (4.53 acres) and structural biotope (16.63 acres) are the only other impacted land uses. **Figure 4.1-1** depicts the proposed wellfield areas and the current types of land use.

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 671 acres associated with the satellite facility, wellfields, evaporation ponds, and roads. As discussed in Section 2.2, livestock and livestock products had a value of $28.61 per acre, indicating that livestock production on impacted rangeland within the TCEA has a potential value of approximately $7,610.

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 384.1 acres associated with the satellite facility, wellfields, evaporation ponds, and roads. In 2007 Dawes County had 44,100 acres harvested for 70,170 tons of alfalfa hay and 43,445 acres harvested for 1,337,320 bushels of winter wheat (NASS 2009). These harvests resulted in yields of 1.6 tons of alfalfa hay and 30.8 bushels of wheat per acre harvested. Based on these yields, the lost annual crop production in the TCEA would be as much as 615 tons of hay and up to 11,833 bushels of wheat.

The principal land use for the 14 acre site associated with the proposed satellite facility, evaporation ponds, and disposal well is rangeland, primarily for livestock forage. Livestock and livestock products had a value of $28.61 per acre. Based on this average yield, construction activities in a 14 acre area would result in the lost livestock production of approximately $400 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 Three Crow project should not have a significant impact on local agricultural production.

Considering the relatively small size of the area impacted by operations, the exclusion of agricultural activities from this area over the course of the Three Crow project will not significantly impact local or regional agricultural production. The limited 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.

4.2 Transportation Impacts

4.2.1 Access Road Construction Impacts

As noted in Section 3.2, Nebraska State Highway 2/71 and U.S. Highway 20 converge at Crawford. Nebraska Highway 2/71 lies to the east of the TCEA. The main access route to the TCEA is via State Highway 2/71 south from the City of Crawford, then west along Four Mile Road. Highway 20 provides access to the City of Crawford from points east and west. Four Mile Road is a dirt county road that crosses the southeast corner of TCEA along the boundary between Sections 28 and 33 T31N R52W, and then runs adjacent to the southern boundary of the TCEA along the south ends of Sections 29 and 30 T31N R52W and Section 25 T31N R53W (**Figure 3.1-2**). This road provides access to residences and agriculture within and in the vicinity of the license area. Four Mile Road is accessed from Highway 2/71.

The junction of the Burlington Northern Santa Fe (BNSF) and DM&E Railroads is located in the City of Crawford. No railways cross the TCEA 2.25-mile AOR. This rail line accommodates a significant amount of rail traffic, primarily from the coal mines in northeastern Wyoming.

The proposed project will have no impact on railroad operations in the area.

Access roads will need to be constructed from the existing transportation corridors to the satellite facility. The main access roads will be designed to allow safe access from public roads by employees, contractors, and delivery vehicles. The 2008 average daily traffic counts for a segment of Highway 2/71 near the Four Mile Road intersection was 895 vehicles, including 115 heavy commercial vehicles. Traffic levels on SH-2 increase to 915 vehicles just south of the City of Crawford, and are generally lower to the south of Four Mile Road on Highway 2/71 (NDOR 2009) Traffic associated with the operation of the proposed facility should not adversely impact existing traffic.

4.2.2 Transportation of Materials

Transportation of materials to and from the satellite facility is discussed in the following sections:

4.2.2.1 Shipments of Construction Materials, Process Chemicals, and Fuel from Suppliers to the Site

Shipments of construction materials, process chemicals, and fuel from suppliers will be received at the satellite facility. These shipments will generate additional noise in the area as discussed in Section 3.7. Since the site access roads will be surfaced with gravel, the shipments will also generate additional dust. Air quality impacts and mitigation are discussed in Sections 4.6 and 5.5.

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

Additionally, wellfield construction materials will be received periodically throughout the operational phase of the project. These shipments are expected to occur at a frequency of once per month.

4.2.2.2 Shipment of 11(e)2 By-product Material from the Site to a Licensed Disposal Facility

Low level radioactive waste or unusable equipment contaminated with 11(e)2 by-product material will be generated during operations and will be transported to a licensed disposal site. Because of the low volume of radioactive 11(e)2 by-product material generated, these shipments will be infrequent (averaging two per year if using roll off containers).

11(e)2 by-product material shipments will be handled as Low Specific Activity (LSA) material. All shipments will comply with all applicable DOT and NRC regulations governing the transportation of this material.

4.2.2.3 Shipments of Uranium-laden Resin from the Three Crow Satellite Facility to the CPF and Return Shipments of Barren, Eluted Resin from the CPF back to the Three Crow Satellite Facility

Resin will be transported to and from the satellite facility in a 4,000 gallon capacity tanker truck. It is currently anticipated that one load of uranium-laden resin will be transported to the CPF for elution and one load of barren, eluted resin will be returned to the satellite facility on a daily basis. The transfer of resin between the two sites will occur on a portion of Hwy. 2/71, country roads and private roads. CBR has established a primary access route and an alternate access route (**Figure 4.2-1**). The total miles for the primary access route between the two sites will be 13.3 miles (11.8 miles on public roads and 1.5 miles on private roads) and for the alternate route, 8.7 miles (8 miles on public roads and 0.7 miles on private roads). A more detailed discussion of the access routes is presented in Section 4.6.1.

Resin or eluate shipments will be treated similarly to 11(e)2 by-product material shipments in regards to Department of Transportation (DOT) and NRC regulations. Shipments will be handled as LSA material for both uranium laden and barren eluted 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.

4.2.2.4 Impacts to Public Roads

The additional traffic generated by construction and operation of the proposed TCEA may result in degradation of public road surfaces. In particular, the additional traffic may adversely impact local gravel roads maintained by Dawes County. These impacts are expected to be minimal since the additional traffic is not significant in comparison with current traffic levels.

Mitigation measures for impacts to public roads are discussed in Section 5.2.

4.3 Geologic Impacts

4.3.1 Geologic Impacts

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% or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10% 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 Pine Ridge 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 by localized scale by injection operations during mining and restoration operations, and will be more than offset by production within each wellfield pattern.

4.3.1.1 Soil Impacts

Construction of the facilities at the TCEA will affect soils. With proper implementation of Best Management Practices, effects to soils are not expected to be significant within the TCEA.

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 TCEA 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 TCEA would continue until the area is revegetated.

Wind erosion is also possible at the TCEA, particularly in the eastern half of the project area. Various soils meet the criteria for high 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 locally obtained gravel, and timely reclamation.

Water erosion is also possible at the TCEA, especially in areas disturbed by road and wellfield construction. 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 calculated from 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 with gravel, 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 TCEA could result from soil loss. Sedimentation could alter water quality and the fluvial characteristics of area drainages. Installation of appropriate erosion control measures as required by CBR's Construction Stormwater NPDES authorization (see Section 4.4.1) and avoidance of erosive soils will aid in reducing sedimentation.

Activity on the site has the potential to compact soils. Soils sensitive to compaction do exist on the site. Compaction of the soils could decrease infiltration and promote higher runoff. Construction and traffic will be minimized where possible, and soils will be loosened prior to 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 that works in all situations has yet been found.

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 the TCEA 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 would 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 TCEA. 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 (SPCC) Plan will be implemented. The SPCC plan will include accidental discharge reporting procedures, spill response, and cleanup measures.

Soil Impact Mitigation Measures

Best Management Practices (BMPs) have been included in the project description and will be followed to control erosion, minimize disturbance, and facilitate reclamation. The following mitigation measures will be valuable in reducing the effects to soil resources at the TCEA. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document. Fundamentally, efforts will be made to preserve existing vegetation where practical.

Sediment Control

- Divert surface runoff from undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Surface drainage shall not be directed over the unprotected face of the fill.
- Operations and disturbance on slopes greater than 40 percent need special sediment controls and should be designed and implemented appropriately.
- 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 best management practices do not result in compliance with applicable standards, modify or improve such best management practices to meet the controlling standard of surface water quality.

Topsoil

- Topsoil should be removed 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 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, and 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

- 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.
- 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 regarded material to minimize surface runoff.

Implementation of the above BMPs, SPCCs, and SWPPPs will minimize effects to soils associated with the construction of the TCEA.

4.4 Water Resources Impacts

4.4.1 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 U.S. Environmental Protection Agency (EPA) 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 CPF todate 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. 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 the SHEQMS 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 satellite facility and related facilities will be minimal.

4.4.2 Surface Water Impacts of Operations

4.4.2.1 Surface Water Impacts from Sedimentation

Protection of surface water from stormwater runoff during on-going wellfield construction related to operations is regulated by the NDEQ as discussed in Section 4.4.1.

4.4.2.2 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 4.4.3.3 discusses 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. In addition to the administrative and engineering controls routinely implemented by CBR, it is expected that surface water impacts from potential accidents at the satellite facility and related facilities will be minimal.

4.4.3 Groundwater Impacts

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

4.4.3.1 Groundwater Consumption

Groundwater impacts and consumption related to the Three Crow operation will be fully assessed in an Industrial Groundwater Permit application that is required by NDEQ. Information from the existing Groundwater Permit for the CPF 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 CPF license area, and on the formation characteristics from the Three Crow 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 Three Crow operation is expected to be on the order of 0.5% to 1.5% of the total mining flow (6,000 gpm). Additional consumptive volume (1,500 gpm) 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.

4.4.3.2 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 into the monitor well ring 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 CPF 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 since the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. **Table 3.11-1** provides a summary of excursions reported for the CPF license area.

4.4.3.3 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 evaporation pond leak or wellfield accident, potential contamination of the shallow aquifer (Brule), as well as surrounding soil, could occur. 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 evaporation ponds at Three Crow will be designed and built to NRC standards using impermeable synthetic liners. A leak detection system will also be installed, and all evaporation ponds will be inspected on a regular basis. In the event that a problem is detected, the contents of any given evaporation pond can be transferred to another evaporation pond while repairs are made. The proposed evaporation pond design and operation was discussed in greater detail in Section 3.12 and 4.13.2.2.

Over the course of the current licensed operation, CBR has experienced several leaks associated with the inner evaporation pond liner on the commercial evaporation ponds. These small leaks are virtually unavoidable since 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 evaporation pond level and locating the leak to allow repairs. In none of these situations was the shallow groundwater affected since the outer pond liner functioned as designed and prevented a release of the evaporation pond contents. All pond leaks, causes, and corrective actions are reported to the NRC and the NDEQ (NDEQ 2002).

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

Another potential cause of groundwater impacts from accidents could be releases 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 PVC, high density polyethylene with butt welded joints, or equivalent. All piping is leak tested prior to production flow and following repairs or maintenance.

4.5 Ecological Resource Impacts

4.5.1 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:

- Removal of vegetation such that following reclamation, the disturbed area(s) would not have adequate cover (density) and species composition (diversity) to support pre-existing land uses, including wildlife habitat;
- 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;
- Reclamation is not accomplished in compliance with Executive Order 13112 (Invasive Species);
- Introduction and establishment of noxious or other undesirable invasive, non-native plant species 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 would occur;
- Incidental take of a special-status species to the extent that such impact would 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.

4.5.2 Vegetation

As described in detail in Section 3, a total of nine well fields, satellite facility, evaporation ponds and access roads will be constructed in 2014 with an expected mine life of operation of approximately five years. As shown in **Figure 4.1-1**, wellfield development will be constructed in areas dominated by cultivated areas and mixed grass prairie vegetation, TCEA, Areas within Sections 28, 29, 30 and 33 T31N 52W will be developed and contain wellfields and a significant amount of project-related infrastructure.

Vegetation removal and soil handling associated with the construction and installation of well fields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. However, since 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, the impacts would include those described below.

Direct impacts would include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types) due to soil disturbance and grading activities. 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 and/or changes in vegetative density; reduction of wildlife habitat; and changes in visual aesthetics.

The total number of acres currently identified as having the potential for disturbance within the 1,643-acre TCEA license area over the long-term operation of the project will be approximately 671 acres (**Table 4.5-1**). Initially, the construction of the satellite building(s)/associated facilities, evaporation ponds, Mine Unit No. 1 and needed roadways would have short-term surface disturbances of approximately 100 acres (approximately 6 percent of the total permit boundary acreage). The production building and associated facilities would disturb an area of 1.8 acres (area within fence-line of production facilities) and the evaporation ponds an area of 11.6 acres (area within fence-line of ponds). These structures, except for approximately 2.23 acres of the evaporation ponds, are located within Mine Units 1, 2 and 3. **Table 4.5-1** provides a breakdown of the area of disturbance by the type of habitat cover acreage.

Over the life of the project (10 years), it is currently estimated that 41 percent of total TCEA license area acreage would be disturbed due to site development and operation. The likelihood of impact is greatest for the primary vegetation cover types of cultivated fields (384 acres) and mixed grass prairie (266 aces), which occupy approximately 97 percent of the total acreage with the potential for disturbance (671 acres). Cultivated and mixed grass prairie habitat cover (946 and 579 acres, respectively) account for 58 percent and 35 percent, respectively, of the total permit acreage of 1643 acres. There are no plans to disturb riverine and deciduous streambank forest habitat cover types within the permit boundary.

The majority of new roads are located within proposed wellfields. An existing road will serve as the entrance roadway to the satellite production facility and offices. This road will be upgraded.

Estimated acreage disturbances was based on a 40-foot wide entrance road and 20-foot wide mine unit roads. Road locations and distances can be seen in **Figure 1.1-6.**

The proposed deep disposal well will be located to the east of the fenced-in area of the satellite facilities (**Figure 1.3-10**), located within mixed grass prairie habitat consisting of an area of approximately 50 x 50 feet. Potential impacts are considered minimal, which is based on the operating history of the deep disposal well located at the current CBR operating facilities.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of invasive, non-native species within the TCEA. Non-native species invasion and establishment as a result of previous and current disturbance has become an increasingly concern 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 TCEA has a relatively high level of noxious weeds and other unwanted invasive, non-native species in the areas adjacent to roads, particularly Four Mile Road (**Figure 3.5-1**), but to a lesser degree in areas located farther from roads.

In general, the duration of effects on cultivated agricultural land and mixed-grass prairie vegetation are significantly different. Cropland areas can be readily returned to production through fertilizer treatments and compaction relief. However, disturbed native prairie tracts require reclamation treatments and natural succession to return to pre-disturbance conditions of diversity (both species and structural). Reestablishment of mixed-grass prairie to pre-disturbance conditions would be influenced by factors that are both climatic (growing season, temperature, and precipitation patterns) and edaphic (physical, chemical, and biological) conditions in the soil.

Previously planted agricultural fields would be recontoured to approximate pre-contours and ripped to depths of 12 to 18 inches to relieve compaction. If mixed-grass prairie tracts are 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 (well fields 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.

4.5.3 Surface Waters and Wetlands

Surface disturbances associated with the proposed facilities would not affect surface waters in the TCEA. Cherry Creek, an ephemeral stream, is the only potential available surface waters within the TCEA, with the creek being desiccated by man-made activities (i.e., mixed grass prairie surrounded by croplands) and without defined banks and streambed. In addition, no wetlands have been identified within the project area. Therefore, impacts to wetlands and surface waters are not anticipated.

4.5.4 Wildlife and Fisheries

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of members 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 poaching, 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.

4.5.5 Small Mammals and Birds

The direct disturbance of wildlife habitat in the TCEA 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 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 disturbance of the 1,643 acre project area would have a low effect on common wildlife species. The primary 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 be 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 use suitable habitats to the extent that they are available. The primary small mammals in the TCEA include, but are not limited to, eastern cottontail, deer mouse, 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.

4.5.6 Big Game Mammals

The principal wildlife impacts likely to be associated within the proposed project include: (1) a direct loss of certain big game habitat, most likely deer and pronghorn; (2) the displacement of these big game species; (3) an increase in the potential for collisions between wildlife and motor vehicles; and (4) an increase in the potential for poaching and harassment of wildlife.

In general, direct habitat removal used by big game mammals is expected to be minimal, as the project area is predominantly used for agricultural production. Since 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 various big game populations should remain essentially unchanged from current conditions.

In addition to the direct removal of habitat due to the development of wells and associated satellite facilities, disturbances from drilling activities and traffic would affect wildlife use 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 envisioned that most big game mammal 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 intensive activities such as drilling and road building diminishes and the well fields are put into production. By the time the well fields are under full production, construction activities 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 big game mammals would be significantly displaced under full field development. 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 well field 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. However, due to the proximity to the City of Crawford and locations of farm residences in the project area, the incidence of vehicle collision impacts to big game mammals is anticipated to occur infrequently and no long-term adverse effects are expected.

Based on the foregoing, long-term adverse effects are not expected on any local big game mammal populations.

4.5.7 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. Other potential effects involve increased public access and subsequent human disturbance that could result from new construction and production activities.

4.5.8 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 use of leks and/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 miles of leks. If disturbance activities within the 0.25-mile lek buffer areas are be 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 activities should be limited within a one-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.

4.5.9 Raptors

As noted in Section 3.5.8.3, few raptors and no nests were observed during the 2008 field survey. The potential impacts to raptors within the TCEA include: (1) temporary reductions in prey populations; and (2) mortality associated with roads.

The development of proposed well fields pads, evaporation ponds and satellite facilities would disturb an estimated 266 acres of mixed grass prairie, a potential habitat for several species of small mammals that serve as prey items for raptors. This impact would affect approximately 16 percent of the total project area, although this is not likely to be a limiting factor of raptor use within this area. The small amount of short-term change in prey base populations created by the construction activities is minimal in comparison to the overall status of the rodent and lagomorph populations. While prey populations 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 that is 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 TCEA.

There will be no new public roads constructed. However, there will be increased traffic due to site operations on current county roads such as Four Mile Road. 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 to public vehicle use for roads located near active raptor nests 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.

4.5.10 Fish and Macroinvertebrates

Suitable habitat for fish and macroinvertebrates exists within the White River and its tributaries. However, the construction, operation, and maintenance of the project are not expected to affect these habitats. There are no surface impoundments located within the permit boundary.

4.5.11 Threatened and Endangered Species

For Dawes County, the Nebraska Game and Parks Commission lists four threatened or endangered species (NGPC 2008). The list is based upon documented occurrences of listed species and expert knowledge about the distribution of listed species and suitable habitat compiled on a county by county basis. Three of the species are fish and the fourth is the Swift Fox. Given the absence of surface water at the TCEA, the fish are not addressed further.

4.5.11.1 Eskimo Curlew

The Eskimo Curlew (*Numenius borealis*) is a relatively short, slender curlew with a slightly down curved bill. The bird's northward migrations route encompasses the eastern portion of Nebraska, but it has been reported that the curlew has migrated through all regions of the state during the months of Marsh, April, May and June. Newly plowed fields, burned prairies and marshes are particularly attractive to migrating curlews. It feeds in the plowed fields by 8 or 9 am, and can be observed consuming grasshopper egg pods, earthworms and locusts.

In the project area, there is potential feeding habitat for the bird. Yet, there haven't been any possible or confirmed sightings within the area (AGC Nebraska Chapter 2007). It is unlikely that the bird uses the area for anything but a migratory access way. Upon review of the bird's absence in the area, it is concluded that the negotiated alternative would have no effect on the Eskimo Curlew. The Eskimo Curlew is not included on the county by county list noted above.

4.5.11.2 Mountain Plover

The Mountain Plover is currently being considered for listing under its federal status, and it is listed as threatened in the State of Nebraska. Nebraska law provides additional protection by requiring state agencies to ensure that their actions, or actions authorized or funded by them, do not jeopardize the mountain plover (NPGC 2008). The plover prefers nesting in arid flats in very short grass with a lot of bare ground, often times near prairie dog colonies.

There is potential habitat for the plover in southern Dawes and Sioux counties, and there been recent scattered observations in the neighboring Box Butte County (NPGC 2008). It is possible that they may occur in isolated instances in the project area, but because prairie dogs are likely controlled and there isn't a lot of bare ground space in the area, strong plover nesting habitats are limited. Further, no nests were observed during field studies.

Because there is plover potential in the project area, measures can be taken to reduce effects to the bird. (1) Disallow construction activities during the critical nesting season: the last two weeks of April through the second week of July. (2) If construction activities cannot be avoided during these periods, a presence–absence survey of suitable Mountain Plover habitat in which ground disturbing activities are proposed would be conducted.

After review of the bird's status and potential occurrence within the TCEA, it is concluded that the proposed project with the above-referenced mitigation measures will not have adverse effects on the Mountain Plover. The Mountain Plover is not included on the county by county list noted above.

4.5.11.3 Swift Fox

The swift fox is widely distributed throughout the Great Plains, and small, disjunct populations exist in the western third of Nebraska and Kansas (USFWS 1995). High-quality swift fox habitat is present within the Oglala National Grassland, immediately northwest of the TCEA. The TCEA contains mixed-grass prairie, which is considered suitable habitat for the swift fox; however, the this area is a mosaic of grassland and cropland, which does not favor swift fox use, though this species can use areas with mixed land uses (USFWS 2001). Mixed grass prairie makes up approximately 35 percent (579 acres) of the project license area.

Since swift fox are known to occur within the region, and suitable mixed-grass prairie habitat occurs throughout the TCEA, potential impacts may result from project implementation. Construction activities 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 for adequately caring for their young. In addition, vehicular traffic associated with the construction and operation of project facilities could result in vehicle collisions resulting in direct mortality.

Because the potential for the displacement of swift fox from construction and operational activities exists within mixed-grass prairie, mitigation measures will be made to avoid and/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. The procedures in Attachment 1 are specific to drilling of boreholes, therefore these procedures have been expanded to include Three Crow project development activities, including construction, operational activities (e.g., wellfield development, satellite facility facilities, and access roadways) and decommissioning. The modified survey protocol to be used for the swift fox at the TCEA is presented in **Appendix K** of Volume II of this application.

Based upon the analysis of the effects of project implementation, the current and potential status of this species in the TCEA, and more suitable habitats in the region, it is concluded that the proposed project and planned mitigation measures will result in no adverse effect on the swift fox.

4.5.11.4 Whooping Crane

The whooping crane (*Grus americana*) is listed as endangered by the USFWS and NGPC, with the potential to occur in Dawes County. The whooping crane is an occasional spring and fall migrant along the Platte Valley in Nebraska, 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). Conclusively, no impacts to the Whooping Crane are anticipated to occur on the TCEA Site. The Whooping Crane is not included on the county by county list noted above.

4.5.11.5 Reptiles, Amphibians, and Fish

No threatened or endangered reptiles, amphibians, or fish species have been recorded in the TCEA, and none are expected to occur.

4.5.12 Cumulative Impacts

Cumulative impacts to ecological resources are not anticipated to occur as no substantive impairment of ecological stability or diminishment of biological diversity within the TCEA. Of the total 1,643 acres within the permit boundary, 384 acres (approximately 23 percent of the total acreage) consist of cultivated habitat **(Table 4.5-1)**. The mine units are comprised of approximately 380 acres of this cultivated habitat. Mixed grass prairie comprises 266 acres of the TCEA, which is 16 percent of the total license area acreage. The majority of this acreage (approximately 254 acres) is located within the proposed mine unit boundaries.

4.6 Air Quality Impacts

The primary new emission source of nonradiological 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 TCEA. Approximately 6-8 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.

The operations of the satellite facility will not result in major emissions of these nonradiological emissions and would therefore not be considered a major source of emissions under state permitting regulations, especially since the TCEA project will be located in an National Ambient Air Quality Standards (NAAQS) attainment area for all criteria pollutants and there are no Prevention of Significant of Deterioration (PSD) issues (see discussions below). This statement also would apply to the construction activities, which pose higher impact risks than the operations phase. Other nonradiological emissions occurring during operations would be fugitive dust emissions generated by activities such as onsite traffic related to operations and maintenance, employee traffic to and from the site, resin transfers from the satellite facility to the main CPF, and heavy truck traffic delivering supplies to the site and product from the site. Dust emissions associated with the operational phase will be less than the construction phase.

4.6.1 Particulate Emissions

The amount of dust generated during operations can be estimated from the following equation taken from "Supplement No. 8 for Compilation of Air Pollutant Emission Factors" (EPA 1978).

$$E = (0.81s) \times \frac{S}{30} \times \frac{365-w}{365}$$

Where:

E = emission factor, lb TSP per vehicle-mile
s = silt content of road surface material, 40%
S = average vehicle speed, 30 miles per hour
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 0.25 lb TSP per vehicle-mile. The distance from the City of Crawford to the satellite facility is approximately 8.3 miles. Approximately 4.0 miles of this distance is on improved roads and 4.3 miles is on dirt or trail roads. CBR expects that most employees at the satellite facility will travel from the City of Crawford. Assuming ten employees and a 7 day workweek, there would be 70 round trips per week and the weekly mileage on dirt or trail roads would be 602 miles. Deliveries and other travel may require up to 50 round trips per week which would be an additional 430 miles per week on dirt or trail roads.

The distance from the satellite facility via the primary access route to the CPF is 13.3 miles of which 9.3 miles are on dirt or trail roads. Assuming 2 round trips per day for resin transfer and an additional 10 round trips per day for facility personnel traveling between the sites, the total mileage on dirt or trail roads will be approximately 1,562 miles per week. This estimate is based on a 7 day work week.

The total travel on dirt and trail roads for personnel, resin transfer, deliveries and incidental travel will be approximately 2,595 miles per week. With an emission factor of 0.25 lb TSP per vehicle-mile, there will be a total dust emission of approximately 16.9 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 TCEA would be minimal. Mitigation measures such as the application of water or dust control chemicals to unpaved roads will be implemented as necessary.

4.6.2 Criteria Pollutant Regulatory Compliance Issues

The statements in this section apply to both construction and operations phase of the proposed satellite facility.

The National Ambient Air Quality Standards (NAAQS) for PM_{10} are 150 micrograms per cubic meter (24-hour average), and 50 micrograms per cubic meter (annual average). The NAAQS standards for other pollutants are presented in **Table 3.6-15**. All counties within the 80 km radius of the project are in attainment of NAAQS. Concentrations of the criteria pollutants from the TCEA operations will not be expected to exceed the regulated or "threshold" level for one or more of the NAAQS pollutants within the 80 km radius.

In addition to the NAAQS ambient air quality standards, there are national standards for the Prevention of Significant Deterioration (PSD) of air quality (see discussions in Section 2.5.6). The PSD program is administered by the State of Nebraska and South Dakota, with their programs designed to protect the air quality in area that are in attainment with the NAAQS and to prevent degradation of air quality in areas below the standard (designed as clean air areas). The PSD requirements establish allowable pollution "increments" that may be added to the air in each area while still protecting air quality. The increment is the maximum allowable deterioration of air quality. The maximum allowable increments applicable to Nebraska and South Dakota are shown in **Table 3.6-24.**

The allowable increments vary by location across the states. Those areas characterized as Class I (i.e., National Parks and Wilderness Areas) and allow less incremental pollution increase. Class III areas are planning areas set aside for industrial growth. The areas classified as Class II are essentially all other areas of the state not designated as Class or Class III. There are no Class I National Park and Wilderness Areas in Nebraska. The State of South Dakota has two Class I Areas: Badlands and Wind Cave National Parks. The Wind Caves National Park is the closer of the two to the TCEA, being a distance of approximately 63 miles. Therefore, no impacts associated with PSD requirements would be expected based on the estimated amount of emissions from the TCEA operations.

4.7 Noise Impacts

4.7.1 Noise Impacts of Construction

The project area is surrounded by agricultural lands and rural residences. The existing ambient noise in the vicinity of the Project area is dominated by intermittent, low levels of traffic noise from Four Mile Road, which is used primarily to access local residences and agricultural lands, and by intermittent noise from agricultural equipment. Nebraska SH 2/71 is located about 1.5 miles east of the TCEA boundary. U.S. Highway 20 (Hwy 20) is located less than one mile from the northwest corner of the TCEA. A Burlington Northern Santa Fe (BNSF) rail line is located east of SH 2/71 and is approximately 2.9 miles from the TCEA boundary at the closest point. Traffic noise from the highways and trains on the BNSF rail line would be intermittently audible to receptors within and in close proximity to the TCEA.

Increased vehicle travel and the operation of construction equipment within the TCEA during the construction phase of the project would result in a slight increase in noise impacts to residents. Noise from construction equipment could raise noise levels as much as 9 dBA during the construction phase of the project. Noise from construction would not be generated during nighttime hours. Construction activities would typically occur over an 8-hour work day, 5 days per week. Increased noise levels would be intermittent and temporary. The resulting increase in vehicle noise from construction and construction traffic, (including movement of heavy equipment, which would be much less dense and slower than typical highway traffic) would be barely perceptible over the existing ambient noise that is intermittently dominated by vehicle noise from Four Mile Road. Noise from construction and construction traffic would be temporary and would briefly add to existing highway noise.

4.7.2 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 the City of Crawford for work and from resin transfer to the CPF. Train usage would not increase as a result of operation. Processing equipment at the satellite site would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be less than noise levels generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise, intermittently dominated by vehicle noise from Four Mile Road.

4.8 Historic and Cultural Resources Impacts

Field investigations were conducted in January 2006 on a 2,100-acre area of anticipated potential development encompassing the TCEA. The proposed 1,643 acres that makes up the TCEA are totally included within this acreage. Three historic sites and three isolated prehistoric artifacts were located and identified. As noted in Section 3.8.1, these resources are not likely to yield information important prehistorical or historical information and are not considered eligible for the National Register of Historic Places.

4.9 Visual/Scenic Resources Impacts

4.9.1 Environmental Consequences

The visible surface structures proposed for the TCEA include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing facility. The project will use existing and new roads to access each wellhouse and the satellite facility.

Each wellhead cover would consist of a weatherproof structure placed over each well. Each structure would be approximately 3 feet high and 2 feet in diameter. Each wellhouse consists of a small shed. The facility building would be approximately 100 feet by 130 feet in size. A permanent disturbance area around each wellhouse would be sized to provide an adequate vehicle turn-around. There would be an estimated 10 to 12 wellhouses in the TCEA.

Electric distribution lines would connect wellhouses to existing electric distribution lines. The distribution poles would be approximately 20 feet high. The poles would be wooden so that their natural color harmonizes with the landscape.

Short-term Effects

Temporary and short-term effects during the construction period to the visual character of the landscape at each well pad would result from wellhouse construction, well drilling, and associated construction of ancillary facilities, such as access roads and electric distribution lines. Drilling and other construction activities would typically occur 8 to 12 hours per day during the regular work week.

Following completion of facility installation, temporary disturbance areas would be reclaimed to pre-construction conditions. Only permanent disturbances associated with operations and maintenance of the facilities will remain following post-construction restoration.

Long-term Effects

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

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 Four Mile Road and the residences within or in close proximity to the TCEA, but would be subordinate to the rural landscape.

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 sensitive 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.

The objective of VRM Class III is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. The existing rural/agricultural landscape would be retained, but would be modified with a noticeable, but minor, industrial component. Line and textural contrasts of the well houses, the satellite facility structures, and associated access roads and distribution lines would be visible from sensitive viewing areas; however, contrasts would be low to moderate. The VRM Class III objectives would be met by proposed long-term project facilities.

4.10 Social and Economic Impacts

The social and economic impacts to the City of Crawford and surrounding areas during the construction of the original CPF were slight given the relatively small scale of activities. The future construction activities for the satellite facility will be even smaller in scope. CBR estimates that four to seven temporary construction workers will be involved in constructing the satellite facilities.

The preliminary evaluation of socioeconomic impacts of the CPF was completed in 1987 as reported in the original 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, positive 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 CPF 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, estimated to be an additional nine years as of January 2010. However, the positive impacts from the current operation will begin to decline as reserves are depleted in the next five 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. As discussed in further detail below, the mine currently employs a workforce of approximately 67 employees and 2 contractors employing 14 contractors. The majority of these employees are hired from the surrounding communities.

In summary, monetary benefits accrue to the community from the presence of the CBR 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 satellite facility.

4.10.1 Tax Revenues

Table 4.10-1 summarizes the recent tax revenues from the CBR project in U.S. Dollars.

Future tax revenues are dependent on uranium prices which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of uranium produced by CBR. Spot market values for U_3O_8 peaked at about $125 per pound in 2007 have since fallen to around $40.75 per pound as of June 21,, 2010 (UxC 2010). It is likely that market values will not return to the 2007 high in the near future and that future tax revenues will more likely be representative of 2008 and 2009 levels.

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 CPF; however, the incremental contribution to taxes would be on the order of $1.0 million to $1.2 million per year in combined taxes.

It is anticipated that the transition from operations at the current permitted CBR facilities to the proposed Three Crow and North Trend Satellite operations would allow the uninterrupted continuation of these contributions towards the funding of Dawes County government subdivisions. Beneficiaries of CBR contributions to the General Fund, and therefore to Dawes County government subdivisions, include school districts, fire districts, county and municipal government agencies, and the White River Natural Resource District. Assuming uranium prices remain consistent with recent 2008-2009 prices, CBR tax revenue contributions from the proposed project are likely to account for a proportion of annual contributions of tax revenues to state funds similar to the levels from current operations.

4.10.2 Temporary and Permanent Jobs

4.10.2.1 Current Staffing Levels

CBR currently employs approximately 67 employees and 2 contractors employing 14 people on a full-time basis. Short-term contractors and part time employees are also used 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. Total employment in Dawes County in

November 2008 was 4,747 out of a total labor force of 4,833 (BLS 2010). Based on these statistics, CBR currently provides approximately 1.5 percent of all employment in Dawes County. In 2008, CBR's total payroll was over $3,941,000. Of the total Dawes County wage and salary payments of $86,633,000 in 2008, the CBR payroll represented about 5 percent.

Total CBR payroll for the past five years was:

2005	$2,382,000
2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,216,870*

*Estimate

The average annual wage for all workers in Dawes County was $49,167 for 2008. By way of comparison, the average wage for CBR was about $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including overtime, bonus or benefits.

4.10.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects to supplement the existing workforce for the proposed Three Crow operation with an additional 10 to 12 full time employees, 4 to 7 full time contractor employees, and 10 to 15 part time employees and short-term contractors for construction activities. The full- and part-time employees will be needed for the satellite facility and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) may also increase by four to seven employees depending on the desired production rate. It is anticipated that the majority of the proposed Three Crow full time and part time workforce and contractors would be available from the current labor force in Dawes County. As of January, 2009, total unemployment in Dawes County was 216 individuals or 4.5 percent of the total work force of 4,799 (BLS 2010). CBR expects that any new positions will be filled from this pool of available labor. These additional positions should increase payroll by about $40,000 per month, or $400,000 to $480,000 per year.

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 five 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.

Because skills and services required for the proposed Three Crow project would be available in the existing local labor force, it is not anticipated that the proposed project would require the migration of additional workers into the nearby City of Crawford and City of Chadron, or unincorporated Dawes County. In the event that proposed project requirements for specialized skills could not be met with the current workforce or local labor force, a small number of workers could be hired from outside of Dawes County. However, any such labor needs would be a negligible change in the population of Dawes County. It is not anticipated that there would be any change in the local population from implementation of the proposed project.

Because no changes in employment or population are anticipated as a direct result of implementation of the Proposed Action, no impacts to housing availability, including public housing, are expected. There would be no short- or long-term employees that would require temporary housing; therefore the proposed project would not affect the lodging capacities of nearby communities.

There would be no noticeable increase in the local population from the construction, operation, and maintenance of the proposed project; consequently, there would be no increase in the need for law enforcement and fire safety, medical facilities, public schools, grocery stores, or other community resources in Dawes County.

No increases in existing levels of domestic water usage in Dawes County are expected, nor are effects to existing domestic water facilities anticipated from an increase in population. In addition, the water requirements of the Three Crow construction and operations would not affect municipal water systems.

Electricity, water, propane and other fuel, sanitary water, wastewater treatment required for construction and operations will be provided by the utilities that currently provide these services to existing CBR operations. The proposed project may increase the quantities of electricity, water, propane and other fuel consumed by CBR activities for a limited period of time during because operations at satellite facility, would commence as operations in the CPF license area is winding down. However, the scope of production at Three Crow would be similar to current operations in the CPF license area. It is anticipated that fuel and utility requirements would also be similar. No substantial increases are likely for new operations at the Three Crow project over existing operational uses.

It is not anticipated that construction activities would increase costs to other customers supplied by the affected utilities, or increase the requirement for utility services beyond the capacities of the providers. There would be no substantial uses of electricity for construction activities. Fuel would continue to be provided by local suppliers. There would be no interruption of fuel deliveries to other customers from increased propane, diesel and gasoline usage at Three Crow construction sites.

The Solid Waste Agency of Northwest Nebraska currently has the capacity for approximately 99 years of service, and would not be affected by the receipt of construction wastes or trash from the satellite facility. Other wastes are managed on site by CBR. Provision of waste services by local waste disposal providers would not be affected, as wastes are managed on-site by CBR.

4.10.3 Impact on the Local Economy

It is anticipated than the monetary benefits and costs from the Three Crow operations would be similar to current CBR operations. In addition to providing a significant number of well-paid jobs in the local communities of the Cities 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 five years were:

2005	$4,570,000
2006	$4,396,000
2007	$5,167,000
2008	$7,685,000

2009	$7,838,700

The vast majority of these purchases were made in the City of 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 (CPF utilities for instance), there are additional expenses that are expected to be higher (i.e., wellfield development for the proposed satellite facilities). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds produced. Local purchases that will be made annually for Three Crow operations are estimated to be $3.7 to $4.4 million. Most of these purchases will continue to be made in the City of Crawford and Dawes County. In addition, mineral royalty payments accrue to local landowners. Production royalties of $325,000 were paid to land owners in 2009. Additional royalty payments would be made to TCEA land owners. Most of the landowners are residents of the Dawes County; therefore beneficial impacts to county revenues and local businesses were accrued through the spending and circulation of these dollars in the local economy.

4.10.4 Economic Impact Summary

As discussed in this section, the CBR project currently provides a significant economic impact to the local Dawes County economy. Approval of this license amendment request would have a positive impact on the local economy as summarized in **Table 4.10-2**. Approval of the proposed TCEA License Amendment would continue the current economic impact through the anticipated end of production (2020). The Proposed Action requires no in-migrating workforce from outside of the local area that currently provides the CBR labor force (primarily communities in Dawes County). Consequently, no increases in housing or community service demands would occur, and existing and planned facilities would not be adversely affected.

4.11 Environmental Justice

As discussed in Section 3.10.3, the nearest minority populations resided within the City of Crawford, located 2.8 miles north-northeast of the TCEA. Races in the City of Crawford consist of white non-Hispanic (93.0%), American Indian (4.7%), Hispanic (2.0%), person reporting two or more races (1.9%) and other race (0.9%) (City-Data.com 2010). The total percentage is greater than 100 percent because Hispanics could be counted in other races.

As discussed in Section 3.10.3, no concentrations of minority populations were identified as residing in rural areas near the proposed TCEA. There would be no disproportionate impact to minority population from the construction and implementation of the Three Crow Project.

Lower income levels are characteristic of predominantly rural populations and small communities that serve as a local center of agricultural activity. No adverse environmental impacts would occur to the population within the TCEA from proposed project activities; therefore, there would be no disproportionate adverse impact to populations living below the poverty level in these Block Groups.

4.12 Public and Occupational Health Impacts

4.12.1 Nonradiological Impacts

As previously discussed in this section, overall emissions associated with equipment and facility operations during site preparation, construction and operations would be expected to be minimal and should not affect the local ambient air quality. Nonradiological emissions include NO_x, CO, SO_2, VOC and particulate matter (operating equipment and fugitive dust due to traffic on unpaved areas). During operations, a gaseous and airborne effluent will consist of air ventilated from the process building ventilation system and vented from process vessels and tanks. This gaseous effluent would primarily contain radon gas as previously discussed in Sections 3.11.2.2 and 4.12.2.3. The gaseous and airborne effluent will not contain any significant non-radiological emissions.

In addition to gaseous and airborne effluents, there would be three types of wastes generated at the proposed satellite facility: liquid, solid and sanitary. The operational-generated liquid wastes would be disposed of through a deep disposal well and evaporation ponds. Such liquid wastes would consist of: wellfield bleed streams; facility washdown water; groundwater restoration water; laboratory wastewaters; liquids resulting from rainwater/snow fall and spills within the curbed process areas. Accumulations of rainfall/snowmelt and any spills within the curbed bulk chemical, lubricant storage facility and the fuel diked area will be removed and disposed of as per the site's Spill Prevention, Containment and Countermeasure Plan. Well development water in the wellfields will be collected in dedicated tanker trucks and transported to the main satellite processing facility for disposal in the deep disposal well or evaporation ponds.

There would be 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 CPF implements injection limits and requires monthly monitoring for 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 satellite facility.

Solid wastes generated would consist of waste such as spent resin, resin fines, filters, miscellaneous pipe and fittings, and domestic waste. These wastes are classified as contaminated or noncontaminated waste according to radiological survey results. Contaminated byproduct waste that cannot be decontaminated is packaged and stored until it can be shipped to a licensed waste disposal site or licensed mill tailings facility. Non-contaminated solid waste is collected on the site on a regular basis and disposed of in a sanitary landfill permitted by the NDEQ. CBR's estimate of annual quantities of non-contaminated generated solid waste for Three Crow is presented in Section 4.13.2.3. No significant non-radiological impacts associated with management of relative small quantities of solid wastes would be expected.

The TCEA is expected to only generate a small amount of hazardous waste and is expected to be classified as a Conditionally Exempt Small Quantity Generator. The potential for any adverse impacts due to the handling and disposal of hazardous waste would be minimal due to the small quantities handled and operational procedures in the SHEQMS *Program Volume VI, Environmental Manual.* The SHEQMS document is reviewed annually and the sections updated as required.

Sanitary liquid waste will be disposed of in an on-site wastewater treatment system (i.e., septic) permitted by the NDEQ under the Class V Underground Injection Control (UIC) Regulations. Periodic removal of septic tank solids will be performed by companies or individuals licensed for such activities by the State of Nebraska. There have been no problems associated with operating a similar sanitary system at the current commercial operating facility, and no problems would be expected for the Three Crow operations.

For any spill, the free liquids would be recovered and any contaminated soils would be removed and placed in an offsite disposal site approved for the type of waste generated.

In summary, the design and construction of the satellite facility will concentrate on minimizing the potential for releases of nonradiological waste materials. For example, CBR would use diking or flow cut-off and flow isolation procedures for radiological and nonradiological spill control. A quality assurance and quality control system will be used, which would involve pre-operational testing of equipment, periodic testing and regular inspection of equipment (e.g., pipelines, manifolds), and associated monitoring on line flows and pressures with automatic shutdowns in response to flow or pressure changes. Consequently, any spills should be small with little impacts on the environment. For any spill, the free liquids would be recovered and disposed of in the deep disposal well or evaporation ponds and any contaminated soils would be removed and placed in an offsite disposal site approved for the type of waste generated.

4.12.2 Radiological Effects

An assessment of the radiological effects of the TCEA must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The TCEA will have a production flow capacity of approximately 6000 gpm and will use fixed bed downflow IX columns to separate uranium from the pregnant production fluid. The facility will also have a capacity to treat 1500 gpm of restoration solution. The restoration process will use fixed bed downflow IX columns to remove the uranium and RO to remove the dissolved solids. Waste disposal at the satellite will be via a deep injection well with a two cell evaporation pond to provide surge capacity. The satellite facility will not have any precipitation equipment. The loaded IX resin will be transferred from the columns to a resin trailer for transport to the CPF, for regeneration and stripping. The reclaimed resin will be transported back to the TCEA satellite and reused in IX columns.

The uranium bearing regenerant at the CPF is treated in the uranium precipitation circuit. The precipitated uranium is vacuum dried.

The only airborne radiological emission from the facility will be radon-222 (radon) gas. Radon is present in the ore body and is formed from the decay of radium-226. Radon is dissolved in the lixiviant as it travels through the ore body to a production well, where the solution is brought to the surface. The concentration of radon in the production solution is calculated using methods found in Reg. Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (March 1987).

MILDOS-AREA (December 1998) was used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site specific radon release estimates, meteorological and population data, and other parameters.

In the following sections, the assumptions and methods used to arrive at an estimate of the potential radiological impacts of the TCEA coupled with the CPF is discussed briefly. A detailed presentation of the source term and other MILDOS-AREA parameters is included in **Appendix M.** The anticipated effects are compared to the naturally occurring background levels. This background radiation, arising from cosmic and terrestrial sources, as well as naturally occurring radon gas, comprises the primary radiological impact to the environment in the region surrounding the proposed project.

4.12.2.1 Exposure Pathways

The TCEA is an in-situ uranium facility. The only source of planned radioactive emissions from the facility 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 MILDOS-AREA modeling. A human exposure pathway diagram addressing planned and unplanned radiological emissions is presented in **Figure 4.12-1.**

The facility will have pressurized downflow IX columns capable of processing 6000 gpm of production solution. The satellite facility will also have IX and RO equipment with a capacity of 1500 gpm to process restoration solutions.

Within the pressurized columns, the radon will remain in solution and be returned to the formation. It will not be released to the atmosphere. There will be minor releases of radon during the air blow down prior to resin transfer to the resin trailer. The air blow down 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 atmosphere.

In the source term calculation, Cameco estimates that 10 percent of the contained radon found in the 6000 gpm flow processed by pressurized downflow 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 and 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. It is estimated that 25 percent of the radon produced in the production fluids will be released in the wellfield.

Atmospheric emissions of radon will lend its presence to all quadrants of the area surrounding the TCEA and the CPF. 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 4.12-1** shows 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.

4.12.2.2 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 satellite facility will have evaporation ponds used to store waste solutions, prior to deep well injection. The surge ponds will be double-lined with impermeable synthetic liners. There is a leak detection system 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 TCEA will be by deep well injection. The deep well will be completed at a depth of 3500 to 4000 ft, isolated from any underground source of drinking water by approximately 1800 ft of Pierre Shale. The well will be constructed under a permit from the NDEQ and meet all requirements of the Underground Injection Control program.

The satellite facility processing building 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 it ruptures.

Since no routine liquid discharges of process water are expected, there are no definable water-related pathways.

4.12.2.3 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 4.12-1**, 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 presented in Appendix N, the modeled emission rate of radon from the facility is 5446 Ci/yr which includes releases from IX, production and restoration activities.

The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the TCEA, NTEA and CBR CPF was also estimated using MILDOS-AREA. To show compliance with the annual dose limit found in 10 CFR § 20.1301, CBR has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the collective site operations of the satellite facility, North Trend Satellite Facility and the CPF is less than 100 mrem per year. The results of the MILDOS-AREA simulation are presented in **Table 4.12-1**. The coordinates of all receptors are listed in Appendix M along with the source values and the locations of the sources. Receptor locations and appropriate identifiers are shown in **Figure 4.12-2**. **Table 4.12-1** shows the estimated TEDE from operation of the TCEA, CPF and the NTEA.

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

1. The maximum TEDE is 32.3 mrem/yr.
2. Receptor Three Crow 1 is the closest resident in the downwind direction for the satellite facility. The estimated TEDE at this location is 32.3 mrem/yr.
3. Since 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.

4.12.2.4 Population Dose

The annual population dose commitment to the population in the region within 80 km of the CBR project (TCEA, NTEA and CBR CPF) is also predicted by the MILDOS-AREA code. The results are listed in **Table 4.12-2**, where the dose to the bronchial epithelium is expressed in person-rem. For comparison, the dose to the population within 80 km 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 4.12-2** and also combined with dose to the region within 80 km of the facility to arrive at the total radiological effects of one year of operation at the CBR project.

For comparison of the values listed in **Table 4.12-2**, 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 TCEA, NTEA and the CPF would be to increase the dose to the bronchial epithelium of the continental population by 0.00057 percent.

4.12.2.5 Exposure to Flora and Fauna

There are two primary potential pathways for radiological exposures to flora and fauna: radon emissions and accidental spills of radiological containing fluids (e.g., lixiviant).

4.12.2.6 Radon Releases

Radon emissions at satellite uranium in situ facilities such as the proposed satellite facility (i.e., no yellowcake dryer and associated facilities) are considered the primary air contaminant during operations. Radon emissions during normal operations are considered the most important pathway foe exposure to flora and fauna due to deposition of ra-222 decay products on surface water, surface soils and vegetation. The MILDOS_AREA model provides an estimate of surface deposition rate as a function of distance from the source for the Ra-222 decay products and calculates surface concentrations.

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

The potential exists for individual fauna (e.g., small mammals and birds) that are mobile to have contact with higher, but short-term, contact with concentrations of Ra-222 than the public due to the potential proximity to releases. However, due to the typical mobility of such animals, it is likely that individuals would receive an intermittent exposure, as opposed to a constant concentration for the entire year.

There are currently no regulatory dosimetric standards for the protection of flora and fauna, with radiological protection frameworks being traditionally focused on the protection of man. Historically, the International Commission on Radiological Protection (ICRP) has maintained a position towards human health versus non-human species with the position that protection of humans from radiation exposure implicity ensures an adequate protection of other living organisms, therefore the environment (Brechignac 2009 [ICRP 1977 and 1991]). However, the development of a system capable of ensuring adequate protection of the environment against the harmful effects of ionizing radiation is currently being debated (Brechignac 2002).

<u>Fluid Discharges</u>

There are currently no planned discharges from the Three Crow operations, with waste waters being discharged to evaporation ponds or a Class I deep disposal well. Therefore, any fluid discharges would be associated with spills, e.g., pipeline break or leak. Spills of this type would be expected to occur within the restricted wellfield areas and between the wellfields and satellite process facility. Since the satellite processing building, fuel tanks, and chemical tanks are constructed on pads that are engineered to contain any spill from a pipe rupture, leaking vessel or inadvertent spill. Therefore, it is unlikely that any spills in the processing area would reach soils and vegetation. CBR operating procedures provide for ongoing monitoring of operational activities and for a rapid corrective action response to any spill, which would result in cleanup of the spilled material and, if applicable, removal of any contaminated soil and vegetation.

Long-term experience at CBR has shown that single-event spills typically do not cause significant contamination of soil and vegetation.

There is limited potential for wildlife or domestic animals to consume contaminated vegetation or seeds. Other than the potential for accidental spills discussed above which would be immediately assessed and cleaned up, Three Crow operations would not be expected to significantly impact food source such as vegetation and seeds that local animals depend upon.

The MILDOS-AREA model was used to assess the potential radiological impact on human health.

4.12.3 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 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 be 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 in situ leach facilities in NUREG/CR-6733 (NRC 1980a, CNWRA 2001). 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 the SHEQMS, Volume VIII, *Emergency Manual,* have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in the SHEQMS Volume VII, *Training Manual,* have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. The SHEQMS Program Volume II, *Management Procedures,* 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. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to 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".

4.12.3.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. The use of hazardous chemicals at CBR is regulated by the Occupational Health and Safety Administration (OSHA). CBR is subject to the Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119.

Of the highly hazardous chemicals, toxics, and reactives listed in Appendix A to 29 CFR §1910.119, none will be used at the satellite facility. As a satellite facility, Three Crow will use oxygen, carbon dioxide, and sodium bicarbonate for addition to the injection solution. Sodium sulfide may be used as a reductant during groundwater restoration activities. All other operations requiring process chemicals described in NUREG/CR-6733 will be performed at the CPF.

CBR construction, operating, and emergency procedures have been developed to implement the codes and standards that regulate hazardous chemical use.

<u>Oxygen</u>

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. As currently practiced at the CPF, CBR will install wellfield oxygen distribution systems at the Three Crow site. Combustibles such as oil and grease will burn in oxygen if ignited. CBR ensures that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1 (CGA 1996). Construction of oxygen systems in the wellfield are covered by procedures contained in the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a spill or fire involving oxygen systems are contained in the SHEQMS Volume VIII, *Emergency Manual.*

Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points is currently performed at the C PF to protect workers from undetected leaks of carbon dioxide. Operation of carbon dioxide systems is currently covered by procedures contained in the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a leak involving carbon dioxide are contained in the SHEQMS Volume VIII, *Emergency Manual.*

Sodium Bicarbonate

Sodium carbonate is primarily an inhalation hazard. CBR typically uses soda ash and carbon dioxide to prepare sodium carbonate for injection in the wellfield. Soda ash storage and handling systems are designed to industry standards to control the discharge of dry material. Operation of sodium carbonate systems is currently covered by procedures contained in the SHEQMS Volume III, *Operations Manual.* Emergency response instructions for a spill involving sodium carbonate or soda ash are contained in the SHEQMS Volume VIII, *Emergency Manual.*

4.12.3.2 Radiological Risk

Tank Failure

A spill of the materials contained in the process tanks at the satellite facility will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the processing building. Oxygen, hydrogen peroxide, carbon dioxide, propane and fuel will be stored in outside storage tanks. The tanks at the satellite facility will contain injection and production solutions and IX resin. Elution, precipitation, and drying will be performed at the CPF. The satellite facility will be designed to control and confine liquid spills from tanks should they occur. The facility 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 facility 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 or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

Facility Pipe Failure

The rupture of a pipeline within the satellite processing area 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 the SHEQMS Volume VIII, *Emergency Manual.* These procedures also provide instructions for emergency notification including notification to NRC in compliance with the requirements of 10 CFR 20.2202 and 20.2203.

4.12.3.3 Groundwater Contamination Risk

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 processing facility 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 each other. These spacing requirements have proven effective for monitoring horizontal excursions at CBR and will be employed at the satellite facility or as otherwise provided in the final permit. Monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the satellite facility. The program was discussed in detail in Section 5.7.8.

Section 3.11.1.2 provided a discussion of horizontal excursions reported at the current CBR 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 (NRC 2000).

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 and methods approved by NRC and NDEQ. Construction and integrity testing methods were discussed in detail in Section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the NDEQ and discussed in detail in Section 6.2.

Procedures for these activities are contained in the SHEMQS Program Volume III, *Operating Manual.*

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 four acres. Shallow monitor wells are sampled biweekly for approved excursion indicators. CBR proposes to implement the current approved excursion monitoring program at the satellite facility, subject to NRC/NDEQ approval. The program was discussed in detail in Chapter 5 of the Technical Report.

4.12.3.4 Pond Failure

An accident involving 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 the SHEQMS 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 Reg. Guides 3.11 and 3.11.1 (NRC 1977 and 1980b). Any time six 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 for the excursion parameters on a quarterly basis.

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.

4.12.3.5 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the satellite facility would result in either a release of barren or pregnant lixiviant solution, which would contaminate the ground in the area of the break. All piping from the satellite facility, to and within the wellfield will be buried for frost protection. Pipelines are constructed of PVC, high density polyethylene (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 CPF, 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 sump. 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.

4.12.3.6 Transportation Accident Risk

Transportation of materials to and from the 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.
- Shipments of uranium-laden resin from the satellite facility to the CPF and return shipments of barren, eluted resin from the CPF back to the satellite facility.

The first two types of transportation risks do not present an increase over the risks associated with operation of the current CBR facility since production from Three Crow is planned to replace declining production at the current facility. The shipment of loaded IX resin from Three Crow 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 (4.0×10^{-7}/km for rural interstate, 1.4×10^{-6}/km for rural two-lane road, and 1.4×10^{-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 (CNWRA 2001). For Three Crow, uranium-loaded and barren resin will be routinely transported by tank truck from the satellite facility to the CPF. For the Crown Point site, 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:

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 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, bicarbonate, hydrogen peroxide and soda ash.

Accidents Involving Radioactive Wastes

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

Accidents Involving Resin Transfers

One of the potential additional risks associated with operation of a satellite facility is the transfer of the IX resin to and from the satellite facility.

Resin will be transported to and from the 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 CPF for elution and one load of barren eluted resin will be returned to the satellite facility on a daily basis.

The transfer of resin between the satellite facility and the CPF will occur on Hwy. 2/71 and county and private roads. CBR has established a primary access route and an alternate access route. The primary access route will entail 4.0 miles of travel on Hwy. 2/71, 7.8 miles on country roads and 1.5 miles on CBR private roads (**Figure 4.2-1**). The alternate route will consist of 1.0 mile on Hwy. 2.71, 6.2 miles on county roads and 1.5 miles on CBR private roads. The planned access routes are discussed in more detail in Sections 4.2.2.3 and 4.6.1.

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 (LSA material for both uranium-laden and barren eluted resin. Pertinent procedures include:

- 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.
- Licensed and trained CBR drivers will transport the resin between the satellite facility and the CPF.
- CBR's current emergency response plan for yellowcake and other transportation accidents to or from the CBR site is contained in the SHEQMS 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 CPF will receive training for responding to a resin transfer transportation accident.

Currently, CBR 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 CPF or the 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.

4.12.3.7 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 and 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 Section 3.3.4.

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

4.13 Waste Management Impacts

This section describes the waste management impacts from the satellite facility. The effluents of concern at ISL operations include the release or potential release of radon gas (radon-222), radionuclides in liquid process streams, and dried yellowcake. Yellowcake processing and drying operations are conducted at the CPF. Loaded IX resin from the satellite facility will be transported to the CPF for elution, precipitation, drying, and packaging.

The yellowcake drying facilities at the CPF are comprised of one vacuum dryer. The current license allows for the addition of a second dryer. By design, vacuum dryers do not discharge any uranium when operating. Effluent controls for yellowcake drying at the CPF have been reviewed by NRC and approved in the current license. The current waste streams and management programs were described in Section 3.12.

4.13.1 Gaseous and Airborne Particulates

The primary radioactive airborne effluent at the satellite facility will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the satellite facility for separation of uranium. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the satellite building. Venting any released radon-222 gas to atmosphere outside the satellite building minimizes employee exposure. Small amounts of radon-222 may also be released via solution sampling and spills, filter changes, IX resin transfer, RO system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The impacts from release of radon gas were discussed in Section 4.12.2.

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. These impacts were previously discussed in Section 4.12.2. There are no significant amounts of process chemicals that will be used at the satellite facility. There are no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.13.2 Liquid Waste

4.13.2.1 Sources of Liquid Waste

As a result of in-situ leach mining, there are several sources of liquid waste. The potential wastewater sources that exist at the satellite facility will be similar to those currently generated and managed at the CPF. These sources of wastewater include the following:

<u>Water Generated During Well Development</u>

This water is recovered groundwater and has not been exposed to any mining process or chemicals; however, the water may contain elevated concentrations of naturally-occurring radioactive material if the development water is collected from the mineralized zone. The water will be discharged directly to the solar evaporation pond and silt, fines and other natural suspended matter collected during well development will settle out in the pond. Well development water may also be treated with filtration and/or RO and used as plant make-up water or disposed of in the deep disposal well. The quantity of waste water generated by well development activities is estimated at approximately 2.5 million gallons per year based on the current operation.

Liquid Process Waste

The operation of the satellite facility results in one primary source of liquid waste, a production bleed as previously discussed. This bleed will be routed to either the deep disposal well or an evaporation pond. Process bleed is estimated at 0.5% to 1.5% of the process flow of 6,000 gpm. The impact of this process bleed was discussed in Section 1.

Aquifer Restoration Waste

Following mining operations at Three Crow, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities:

5. Groundwater Transfer;
6. Groundwater Sweep;
7. Groundwater Treatment; and,
8. Wellfield Circulation.

Only the groundwater sweep and groundwater treatment activities will generate wastewater. During groundwater sweep, water is extracted from the mining zone without injection, causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity. The impact of this restoration waste stream was discussed in Section 3.12.2.1.

4.13.2.2 Liquid Waste Disposal

Two methods of disposal are proposed for the satellite facility.

Deep Disposal Well

CBR has operated the deep disposal well at the CPF license area for over ten years with excellent results and no serious compliance issues. CBR expects that the liquid waste stream at the satellite facility will be chemically and radiologically similar to the waste disposed in the current deep disposal well.

CBR plans to install a deep disposal well at the satellite facility as the primary liquid waste disposal method. CBR has found that permanent deep disposal is preferable to evaporation in evaporation ponds. All compatible liquid wastes at the satellite facility will be disposed of in the planned deep disposal well. No adverse environmental impacts are expected from this type of disposal since the liquid waste is permanently isolated in an unusable geologic formation. At the time of preparation of this amendment request and ER, a permit application is under preparation for submittal to the NDEQ for a Class I UIC Permit for the satellite facility.

Evaporation Pond

Evaporation pond design, installation and operation criteria are those found in Reg. Guide 3.11. The evaporation pond configuration at the satellite facility will be similar to the existing ponds at the CPF. The exact number and capacity of the ponds will depend upon the performance of the deep disposal well as far as waste water disposal rate.

Each pond will have the capability of being pumped to a water treatment plant before disposal. A variety of treatment options exist depending upon the specific chemical contaminants identified in the wastewater. In general, a combination of chemical precipitation and RO is adequate to treat the water to a quality that falls well within NPDES criteria.

As noted in Section 3.12.2.1, CBR currently maintains three commercial and two R & D evaporation ponds at the CPF. There have been no adverse environmental impacts from the operation of these ponds. CBR does not expect any adverse impacts from operation of similar ponds at Three Crow.

4.13.2.3 Solid Waste

Solid waste generated at the satellite facility is expected to include spent resin, resin fines, empty reagent containers, miscellaneous pipe and fittings, and domestic trash. The solid waste will be segregated based on whether it is clean or has the potential for contamination with 11(e).2 byproduct materials.

Non-contaminated Solid Waste

Non-contaminated solid waste is waste which is not contaminated with 11(e).2 byproduct material or which can be decontaminated and re-classified as non-contaminated waste. This type of waste may include trash, piping, valves, instrumentation, equipment and any other items which are not contaminated or which may be successfully decontaminated. Release of contaminated equipment and materials is discussed in further detail in Section 5 of the License Amendment Application.

CBR estimates that the proposed satellite facility would produce approximately 700 yd^3 of non-contaminated solid waste per year. Non-contaminated solid waste will be collected on the site in designated areas and disposed of in the nearest permitted sanitary landfill.

11(e).2 Byproduct Material

Solid 11(e).2 byproduct waste consists of solid waste contaminated with 11e.(2) byproduct material that cannot be decontaminated.

11(e).2 byproduct material generated at ISL facilities consists of filters, personal protective equipment (PPE), spent resin, piping, etc. CBR estimates that the proposed satellite facility would produce approximately 60 yd^3 of 11(e).2 byproduct materials per year. These materials will be stored on site until such time that a full shipment can be shipped to a licensed waste disposal site or licensed mill tailings facility.

Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Nebraska. Disposal of solid materials collected in septic systems must be performed by companies or individuals licensed by the State of Nebraska. NDEQ regulations for control of these systems are contained in Title 124.

Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Based on waste determinations, CBR is a Conditionally Exempt Small Quantity Generator (CESQG). To date CBR only generates universal hazardous wastes such as spent waste oil and batteries. CBR estimates that the proposed satellite facility would produce approximately 800 liters of waste oil per year. Waste oil is disposed of by a licensed waste oil recycler. CBR has management procedures in place in the SHEQMS Program Volume VI, *Environmental Manual,* to control and manage these types of wastes.

Table 4.5-1 Acres Disturbed by Three Crow Satellite Facility, Evaporation Ponds, Wellfields and Roads

Disturbed Area	Type of Habitat Cover				Total
	Cultivated	Mixed Grass Prairie	Range Rehabilitation	Structure Biotype	
	Acres				
Mine Units (9)	379.87	253.94	3.52	8.86	646.12
Satellite Facilities (Inside Mine Unit (MU) boundary)	--	1.8	--	--	1.8
Evaporation Ponds (Inside MU Boundary)	0.03	5.52	--	6.0	11.6
Evaporation Ponds (Outside MU boundary)	--	0.46	--	1.77	2.23
Roadways (inside MU boundary)	4.14	3.10	--	--	7.24
Roadways (outside MU boundary)	0.1	1.17	1.01	--	2.28
Total Disturbed Acres	**384.14**	**265.99**	**4.53**	**16.63**	**671.3**

Note: The Satellite Facilities, roadways and a major part of the evaporation ponds are located within mine units. Therefore, the disturbance acreages associated with these assets are subtracted from the mine unit acreages and listed separately. Disturbances outside of the mine units are listed separately.

Table 4.10-1 Tax Revenues from the Current Crow Butte Project

Type of Taxes	2009	2008	2007	2006	2005
Property Taxes	914,000	1,120,000	1,102,000	627,000	351,000
Sales and Use Taxes	136,000	140,000	90,000	238,000	185,000
Severance Taxes	403,000	512,000	1,066,000	545,000	338,000
Total	**1,453,000**	**1,772,000**	**2,258,000**	**1,410,000**	**874,000**

Table 4.10-2 Current Economic Impact of Crow Butte Uranium Project and Projected Impact from TCEA

Activity	Current Crow Butte Operation	Estimated Economic Impact due to Three Crow Expansion Area
Employment		
Full Time Employees	67	+ 10 to 12
Full Time Contractor employees	2	+ 4 to 7
Part Time Employees and Short Term Contractors	3	+ 4 to 7**
CBR Payroll, 2009	$4,216,870*	+ $400,000 to $480,000
Taxes		
Property Taxes	$914,000	-
Sales and Use Taxes	$136,000	-
Severance Taxes	$403,000	-
Total Taxes	$1,453,000	+ $1,000,000 to $1,200,000
Production Royalties		
Royalty Payments, 2009	462,000	+ 325,000
Local Purchases		
Local Purchases, 2009	$7,838,700	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	**$13,970,570**	**+ $5,375,000 to $6,355,000**

*Estimated

**All construction workers

Table 4.12-1 Estimated Total Effective Dose Equivalent (TEDE) to Receptors Near the Crow Butte Central Processing Facility

Receptor #	Description	Distance from Main Facility (km)	TEDE* (mrem/y)
1	R1	1.3	5.6
2	R2	2.8	4.1
3	R3	3.3	5.2
4	R4	4.4	2.7
5	R5	5.4	2.8
6	Crawford	6.3	2.6
7	R7	4.4	4.6
8	R8	4.1	4.7
9	R9	3.6	6.5
10	R10	3.0	11.2
11	R11	3.3	6.0
12	R12	2.4	13.6
13	R13	1.5	22.1
14	R14	1.1	23.0
15	R15	0.6	26.3
16	R16	1.3	7.6
17	R17	1.4	4.8
18	Ehlers	0.7	11.1
19	Gibbons	1.0	21.3
20	Stetson	1.3	15.6
21	Knode	3.3	5.2
22	Brott	1.9	10.6
23	SP1	0.8	13.9
24	SP2	0.9	22.2
25	SP3	1.1	20.8
26	McDowell	4.9	4.2
27	Taggart	4.8	4.6
28	Franey	4.9	5.8
29	Bunch	4.4	6.5
30	Dyer	2.5	2.9
31	NT-1	12.0	6.3
32	NT-2	9.8	3.9
33	NT-3	9.2	3.7
34	NT-4	8.9	3.0
35	NT-5	8.2	3.1
36	NT-6	13.7	2.0
37	NT-7	12.9	1.67
38	NT-8	2.8	12.0
1	Three Crow-1	8.3	32.3
2	Three Crow-2	11.3	1.1
3	Three Crow-3	6.8	2.3
4	Three Crow-4	5.3	3.2
5	Three Crow-5	12.4	1.4
6	Three Crow-6	9.9	2.3
7	Three Crow-7	3.5	2.4
8	Three Crow-8	9.6	2.1

*No differences in TEDE between age classes were observed.

Table 4.12-2 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 80 km of the facility	201
Natural background by population within 80 km of the facility	21439
Dose received by population beyond 80 km of the facility	783
Total continental dose	985
Natural background for the continental population	1.73×10^{8}
Fraction increase in continental dose	5.7×10^{-6}

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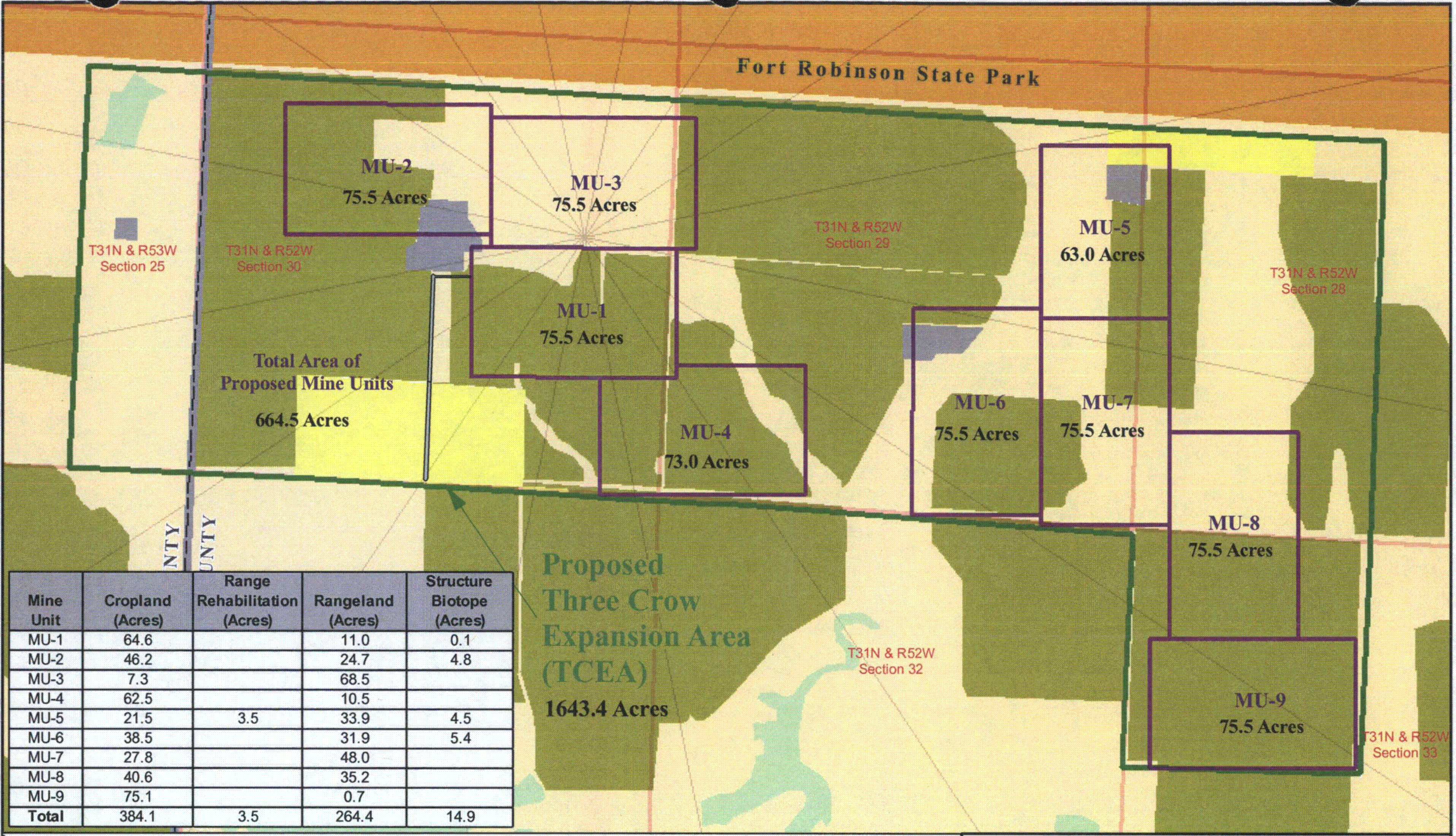


Mine Unit	Cropland (Acres)	Range Rehabilitation (Acres)	Rangeland (Acres)	Structure Biotope (Acres)
MU-1	64.6		11.0	0.1
MU-2	46.2		24.7	4.8
MU-3	7.3		68.5	
MU-4	62.5		10.5	
MU-5	21.5	3.5	33.9	4.5
MU-6	38.5		31.9	5.4
MU-7	27.8		48.0	
MU-8	40.6		35.2	
MU-9	75.1		0.7	
Total	384.1	3.5	264.4	14.9

Legend

Land Use

- Cropland
- Forested Land
- Rangeland
- Range Rehabilitation
- Structure Biotope
- Recreational Land

- Mine Unit Boundary
- Proposed Three Crow Expansion Area
- Grid Sector

Acres of Disturbance
Outside of Mine Units--
4.51 Total
0.10 Cropland
1.63 Rangeland
1.01 Range Rehabilitation
1.77 Structure Biotope

0 1,000 2,000
Scale in Feet

PROJECTION: NAD_1927_STATE_PLANE_NEBRASKA_NORTH_FIPS_2601

N W E

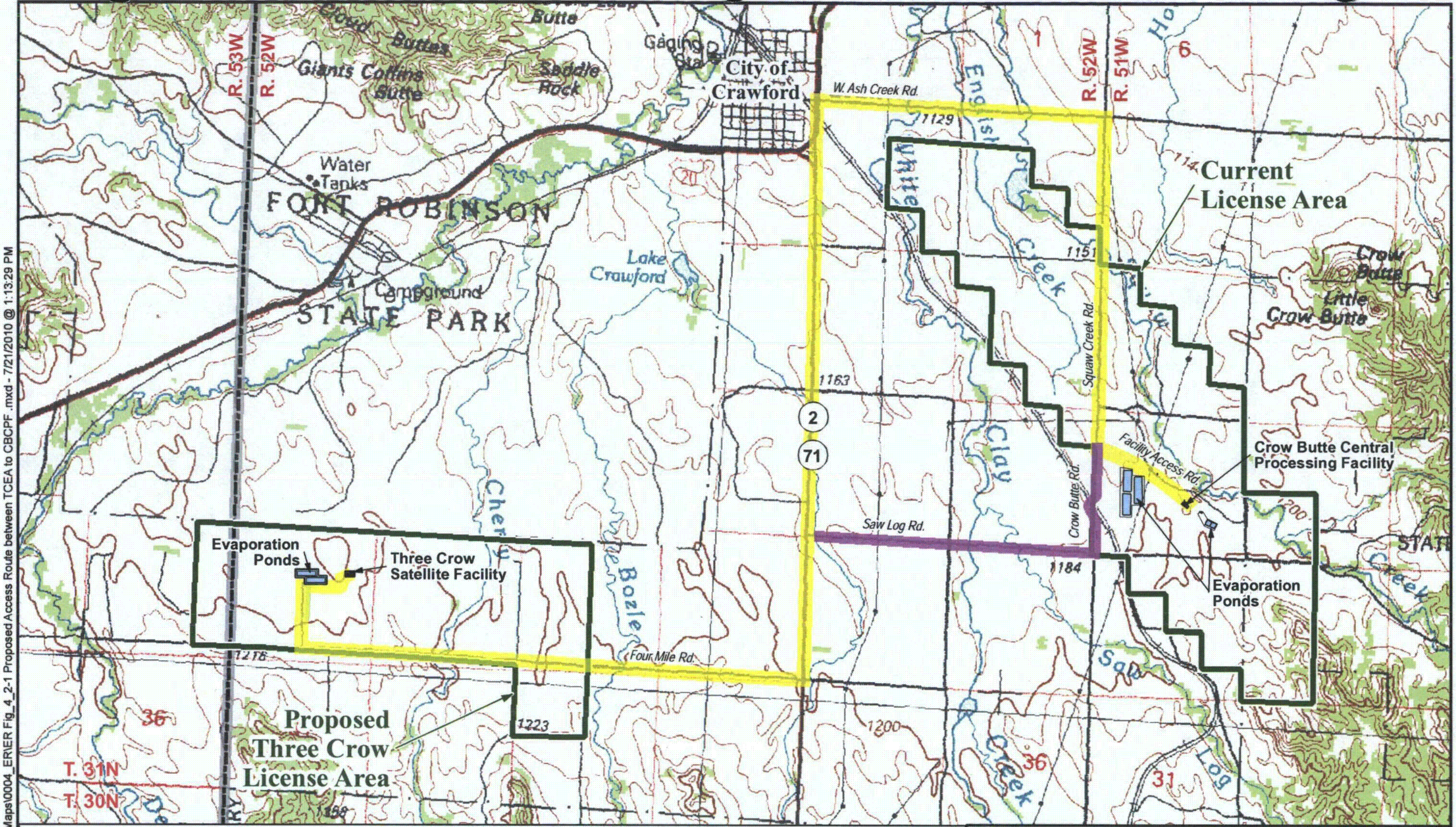
CROW BUTTE RESOURCES, INC.

FIGURE 4.1-1
THREE CROW
WELLFIELD LAND USE

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0004_ERIER Fig_4_1-1 Three Crow WellField Land Use.mxd - 7/20/2010 @ 11:03:54 PM



LEGEND

- Evaporation Pond
- Facility Building
- Primary Access Route
- Alternate Access Route

0 3,000 6,000

Scale in Feet

PROJECTION:
NAD_1927_STATE_PLANE_
NEBRASKA_NORTH_FIPS_2601

CROW BUTTE RESOURCES, INC.

FIGURE 4.2-1
PROPOSED ACCESS ROUTE BETWEEN THREE CROW SATELLITE FACILITY AND CROW BUTTE CENTRAL PROCESSING FACILITY

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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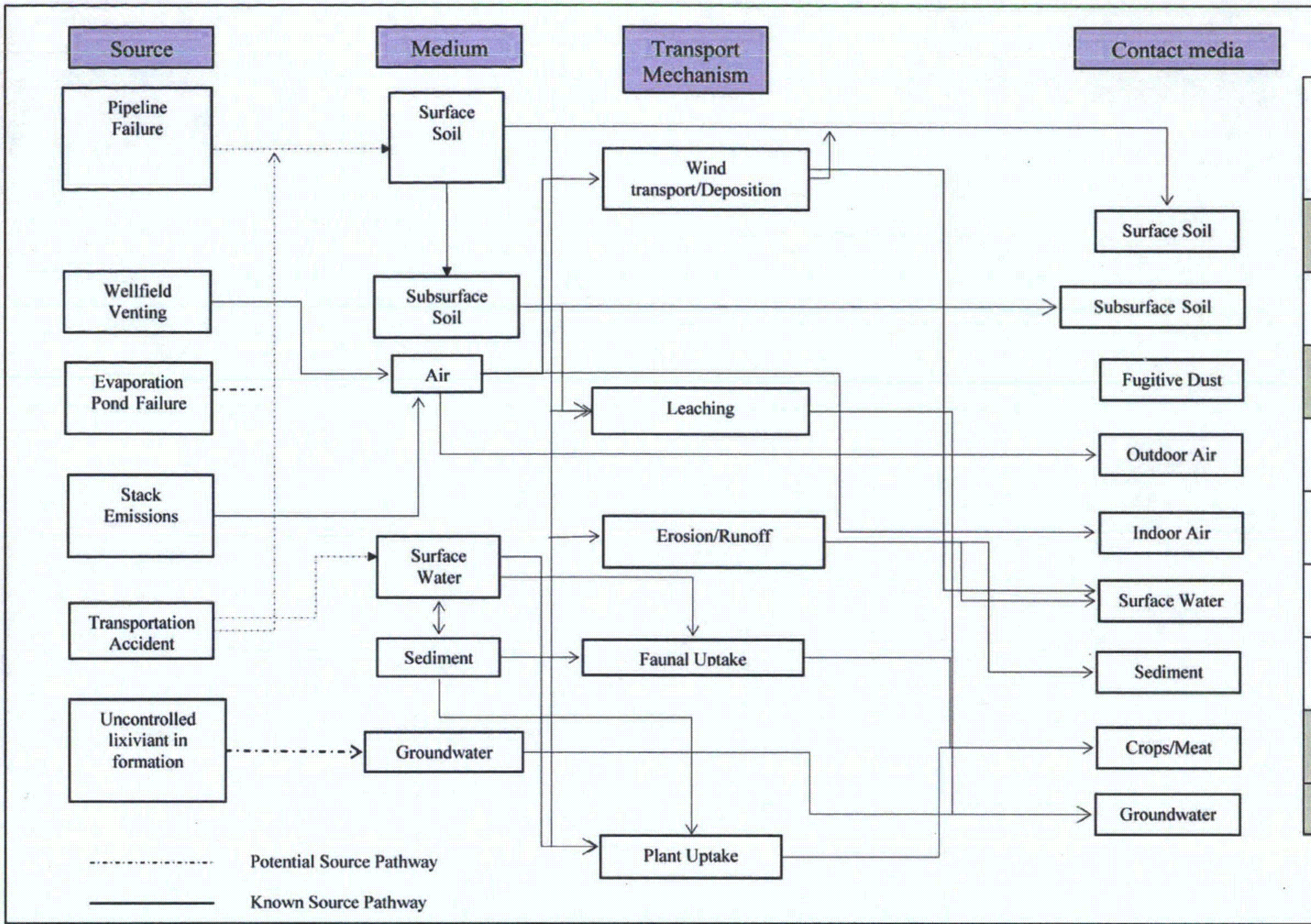
K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0004_ERIER Fig_4_2-1 Proposed Access Route between TCEA to CBCPF .mxd - 7/21/2010 @ 1:13:29 PM



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 4.12-1
THREE CROW
HUMAN EXPOSURE PATHWAYS FOR KNOWN AND POTENTIAL SOURCES OF RADIOLOGICAL EMISSIONS

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: LW

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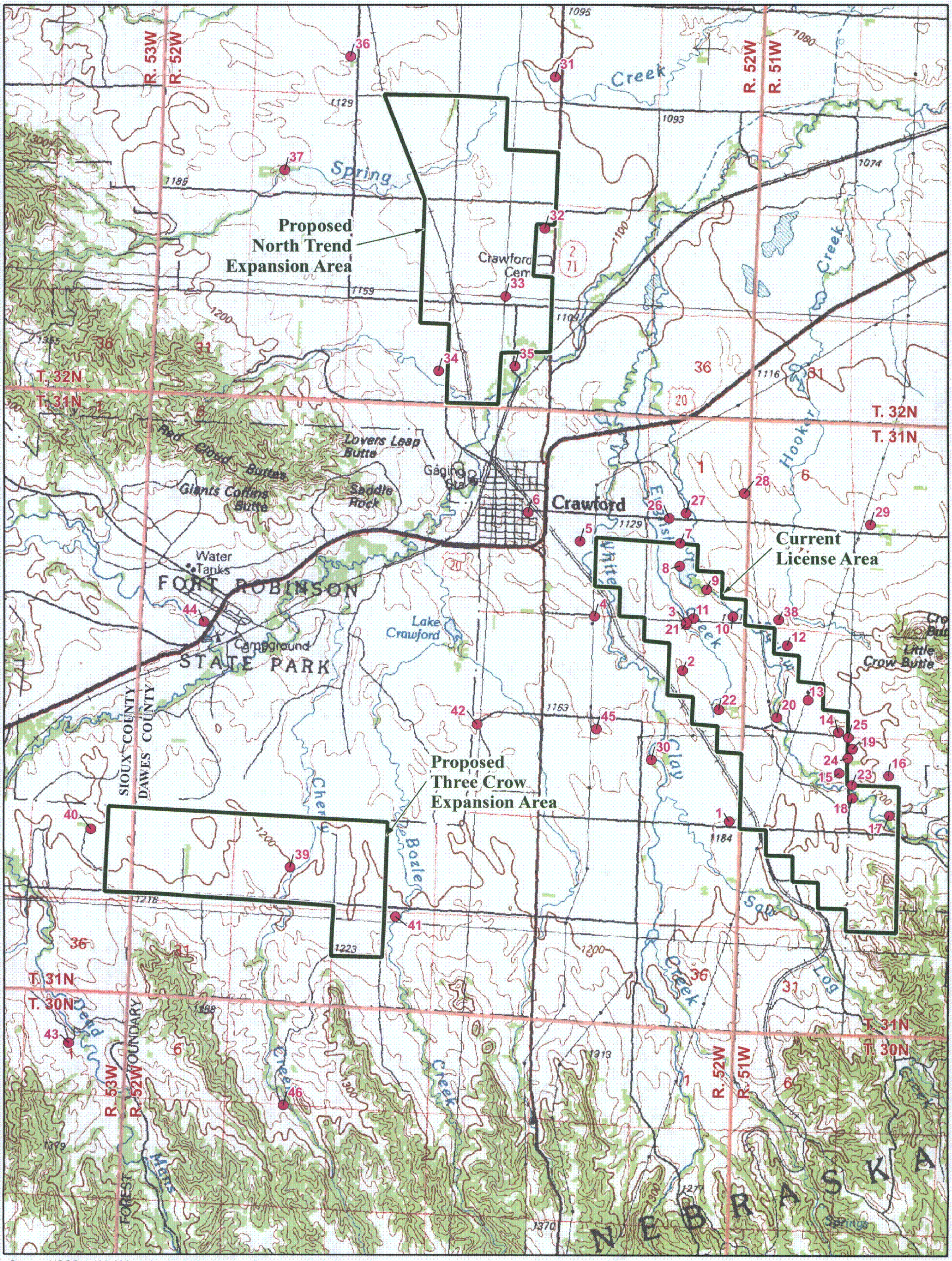

Source: USGS 1:100,000 scale topographic map - Crawford (1984), NE

LEGEND

● Receptors

N
W E

0 4,000 8,000

Scale in Feet

CROW BUTTE RESOURCES, INC.

FIGURE 4.12-2
MILDOS RECEPTORS

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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5 MITIGATION MEASURES

5.1 Land Use Impact Mitigation Measures

The following section addresses the final decommissioning methods of disturbed lands including wellfields, satellite facility 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, 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 decommissioning.

The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 5.1.4.
- Determination of appropriate cleanup criteria for structures (Section 5.1.5) and soils (Section 5.1.6).
- Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 5.1.5.
- Decontamination of items to be released for unrestricted use to levels consistent with NRC requirements.
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.
- Perform final site soil radiation surveys.
- Backfill and re-contour 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 CBR facilities. These activities and procedures will apply to the TCEA 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. As required by 10 CFR 40.36 (f), records of information important to TCEA decommissioning will be maintained in the office of the onsite Radiation Safety Officer. Such information shall meet the criteria of 10 CFR 40.42 (g) (4) and (5).

5.1.1 General Surface Reclamation Procedures

The primary surface disturbances associated with the TCEA-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 short-term impacts.

The 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 premining condition. For the CBR area, the reclaimed lands should be capable of supporting livestock grazing and providing habitat for 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 so as 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, sedimentation and re-establish natural trough drainage patterns.

The following sections provide reclamation procedures for the facility sites, wellfield production units, evaporation ponds, and access and haul roads. Reclamation schedules for wellfield production units will be discussed separately because they are dependent upon the progress of mining and the successful completion of groundwater restoration. Cost estimates for bonding calculations are discussed in Section 7 and include all activities that are anticipated to complete groundwater restoration, decontamination, decommissioning, and surface reclamation of wellfield and satellite facilities installed. These cost estimates are updated annually to cover work projected for the next year of mining activity.

5.1.1.1 Topsoil Handling and Replacement

In accordance with NDEQ requirements, topsoil is salvaged from building sites (including the 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 3.3.6, topsoil thickness varies within the TCEA. Topsoil thickness is usually greatest in and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil stripping depths may vary in depth, depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, field mapping and Soil Conservation Service Soil Surveys will be utilized to determine approximate topsoil depths.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles are generally located on the leeward side of hills to minimize wind erosion. Stockpiles are not located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles are seeded as soon as possible after construction with the permanent seed mix.

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 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.

5.1.1.2 Contouring of Affected Areas

Due to the relatively minor nature of disturbances created by in-situ mining, there are only a few where 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 temporary during the operating period. These changes will mitigated 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 reestablishment 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 reestablished 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 run off and eliminate depressions where water could accumulate.

5.1.1.3 Revegetation Practices

Revegetation practices are 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 Resource Conservation Service as required by the NDEQ.

5.1.2 Process Facility Site Reclamation

Following removal of structures as discussed in Section 5.1.5, subsoil and stockpiled topsoil will be replaced on the disturbances from which they were removed during construction, as practicable. 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. Motorgraders 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.

5.1.3 Evaporation Pond Decommissioning

5.1.3.1 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 (e.g., sprinklers), treatment and disposal in the deep well, or transportation to another licensed facility or disposal site. There are currently no plans for treating and discharging the pond water to public waters under an NPDES permit.

5.1.3.2 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.

5.1.3.3 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 a 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 a 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 discussed in Section 5.1.6 will be removed and disposed at a 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.

5.1.3.4 On Site Burial

At the present time, on site burial of contaminants is not anticipated. However, depending upon the availability of a NRC licensed disposal site at the time of decommissioning, on site burial may become a potential alternative. Should this occur, pond locations would be considered initially as the on site disposal locations for contaminated materials. Appropriate licensing with the regulatory agencies would be obtained prior to any on site disposal of contaminated wastes.

5.1.4 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 will be salvaged.
- Removal of buried well field piping.
- Wells will be plugged and abandoned according to the procedures described below.
- 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 a NRC licensed disposal facility.

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

5.1.4.1 Well Plugging and Abandonment

All wells no longer useful to continue 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 well that could be transferred to the landowner for domestic or livestock use.

The objective of the CBR well abandonment program is to seal and abandon all wells in such a manner as to assure the groundwater supply is protected and to eliminate any potential physical hazard.

Prior to abandoning a well, data will be gathered (static water level, under-ream interval, casing depth) for use in a well abandonment spreadsheet that accounts for formation pressures, mining injection pressures, static water level, casing depth, materials used and weight of material used. Based on that information, adjustments can be made to the amount of bentonite chips to be used to plug the well screens, and also to calculate the minimum weight (lbs/gallon) of abandonment mud to be used to fill the hole to the surface and keep formation and mining pressures from allowing water to rise in the borehole. A prepackaged bentonite filled tube is currently used for plugging of the well screens. These tubes are placed into the screens by filling the well to the surface with water from a water truck, and then dropping the bentonite tubes down the well. The water is allowed to run while the tubes make their descent into the screens. The drill rig then trips drill pipe into the well and tags the bentonite to make sure it has reached the targeted depths. The drill stem is raised approximately 10 feet and a Plug-gel abandonment mud is mixed. If the weight of the abandonment mud needs to be increased, an amount of barite may be added to increase the weight. Likewise, a drilling additive (Dris-pac) to improve the ability of the abandonment mud to carry the barite may be added. In situations where it appears that the operating pressure and formation pressure are great enough to make it difficult to mix heavy mud, cement slurry may be substituted to fill the casing to the surface. All abandoned wells will remain above the surface until the wellfield is reclaimed. This will allow for the continuation of monitoring and observation of the integrity of the abandonment fluid. If needed, additional abandonment fluids will be added.

The plugging method is approved by the NDEQ and is generally as summarized below:

- A mechanical plug may be placed above the screened interval.
- Thirty to fifty feet of coarse bentonite chips will be added to provide a grout seal.
- A plug gel 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 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. CBR must submit a notarized affidavit to the NDEQ detailing the significant data and the procedure used in connection with each well plugged. The DNR also requires filing a well abandonment notice for all registered wells.

5.1.4.2 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.

5.1.5 Removal and Disposal of Structures, Waste Materials and Equipment

5.1.5.1 Preliminary Radiological Surveys and Contamination Control

Prior to satellite building decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

5.1.5.2 Removal of Process Buildings and Equipment

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

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

- Removal to a new location within the CBR site for further use or storage;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other non-restricted use by others.

It is most likely that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts were unsuccessful, the material would be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a licensed disposal site or properly licensed facility if contaminated.

<u>Building Materials, Equipment and Piping to be Released for Unrestricted Use</u>

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with license conditions contained in SUA-1534 and NRC guidance.

The CBR release limits for alpha radiation are as follows:

- Removable of 1,000 dpm/100cm^2
- Average total of 5,000 dpm/100 cm^2 over an area no greater than one square meter
- Maximum total of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2

Monitoring for beta contamination is a current license requirement. This requirement has been eliminated in subsequent ANSI standards, including ANSI/HPS N13.12 (ANSI 1999). In addition, CBR has routinely made these measurements but has never found them limiting.

Decontamination of surfaces will comply with the CBR ALARA policy, to reduce surface contamination as far below the limits as practical.

Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an NRC-licensed facility for disposal. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427.

Disposal at a Licensed Facility

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

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling.
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the satellite building.
- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.
- All other miscellaneous contaminated material will be transported to a licensed disposal facility.

Release for Unrestricted Use

If a piece of equipment or structure is to be released for unrestricted use, it will be appropriately surveyed before leaving the licensed area. Both interior and exterior surfaces will be surveyed to detect potential contamination. Radioactivity levels would be determined on the interior surfaces of pipes, drain lines, or duct work by making measurements in all traps and other appropriate access points, provided that contamination at these locations would be expected to be representative of contamination on the interior of the pipes, drain lines or duct work. If the shape, size, or presence of inaccessible surfaces prevents an accurate and representative survey, the material will be assumed contaminated and properly disposed of. Appropriate decontamination procedures will be used to clean any contaminated areas and the equipment resurveyed and documentation of the final survey retained to show that unrestricted use criteria were met prior to releasing the equipment or materials from the site. The current release criteria are based on NRC guidelines. The criteria to be used for release to unrestricted use will be the appropriate NRC guidelines at that time. Release surveys will be based on the release methods discussed in Section 1.4.3.

If a process building is left on site for unrestricted use by a landowner, the following basic decontamination procedures will be used. Actual corrective procedures will be determined by field requirements as defined by radiological surveys.

After the building has been emptied, the interior floors, ceiling and walls of the building and exterior surfaces at vent and stack locations will be checked for contamination. Any remaining removable contamination will be removed by washing. Areas where contamination was noted will be resurveyed to ensure removal of all contamination to appropriate levels.

Process floor sumps and drains will be washed out and decontaminated using water and, if necessary, acid solutions. If the appropriate decontamination levels cannot be achieved, it may be necessary to remove portions of the sump and floor to disposal.

Excavations necessary to remove trunklines or drains will be surveyed for contaminated earthen material. Earthen material that is found to be contaminated will be removed to a licensed disposal facility prior to backfilling the excavated areas.

The parking and storage areas around the building will be surveyed for surface contamination after all equipment has been removed.

Decontamination of these areas will be conducted as necessary to meet the standards for unrestricted use.

5.1.5.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed of at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. CBR currently maintains agreements with two such facilities located in the states of Utah and Wyoming for disposal of 11e.(2) byproduct materials generated by mining operations. A contract for disposal at a minimum of one facility will be maintained current as required in NRC License SUA-1534.

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

5.1.6 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

5.1.6.1 Cleanup Criteria

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

The proposed limits and ALARA goals for cleanup of soils are summarized in **Table 5.1-1** and described below.

The existing radium-226 criterion in 10 CFR Part 40, Appendix A, was used to derive a dose criterion (Benchmark Approach) for the cleanup of byproduct materials. The Benchmark Dose was modeled using the RESRAD code (Version 6.22). The RESRAD runs are shown as Appendix A of the *Wellfield Decommissioning Plan for Crow Butte Uranium Project* presented in **Appendix N**. The results show that a concentration of 537 pCi/g for natural uranium in the top 15 cm layer of soil for the resident farmer scenario is equivalent to the Benchmark Dose derived from a concentration of 5 pCi/g of radium-226.

ALARA considerations require that an effort be made to reduce contaminants to as low as reasonably achievable levels. The ALARA goals are normally based on a cost-benefit analysis. For the cleanup of gamma-emitting radionuclides, the cost of cleanup becomes excessively high as soil concentrations and/or gamma emission rates become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels along with appropriate field survey and sampling procedures result in near background radium-226 concentrations for the site. In addition, the presence of a mixture of radium-226 and uranium will tend to drive the cleanup to even lower radium-226 concentrations. It is therefore believed that no specific ALARA goal is required for surface radium-226.

CBR proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. According to the RESRAD runs presented in **Appendix N**, the ratio of radium-226 dose rate per pCi/g to the uranium dose rate per pCi/g is 120. It is also shown by calculation that the ratio of radium-226 to uranium emission rates is 30. Therefore, if the action level for pure radium-226 results in cleanup of the site to less than 5 pCi/g, the action level should result in the cleanup of pure uranium to 30 times 5 or 150 pCi/g.

The uranium concentration should be limited to – at most – 230 pCi/g for all soil depths because of chemical toxicity concerns. Using the most conservative daily limit corresponding to the National Primary Drinking Water Standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day.

CBR desires to reduce subsurface concentrations to a maximum of two-thirds of the proposed limit of 15 pCi/g radium-226. The subsurface uranium goal has not been reduced since it has not been demonstrated that these levels can be detected with readily available field instruments.

Section 2.5 of **Appendix N** demonstrates that spills of process solutions at the CPF are not likely to contain substantial amounts of thorium-230. CBR believes that development of soil cleanup criteria for thorium-230 is not appropriate at this time. In the unlikely event that a situation exists where thorium-230 is present in significant quantities, cleanup criteria will be developed using the radium-226 Benchmark approach and submitted to the NRC for approval prior to final site decommissioning.

5.1.6.2 Excavation Control Monitoring

CBR will use 17,900 cpm as its gamma action level, as determined with a Ludlum Model 44-10/2221 NaI detection system or equivalent held at 18 inches above ground surface. The gamma action level, defined as the gamma count rate corresponding to the soil cleanup criterion, will be used in the interpretation of the data. This action level will be used with caution, or until a new action level is developed.

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

The 17,900 cpm action level was based on an evaluation of the correlation between gamma count rates and ra-226 concentration in soil using data from the few spill-related contaminated areas that existed at the CPF area. CBR believes that 17,900 cpm is a conservative value since the contaminated areas were small in size. The measured gamma emission rate per unit ra-226 concentration from small areas is normally lower than that which would be measured using large areas, such as 100- m^2 area. Therefore cleanup to 17,900 cpm should ensure that each 100- m^2 area meets the radium-226 soil cleanup standard.

Section 6.3 of **Appendix N** discusses the development of the 17,900 counts per minute (cpm) action level. It does however allow for a revision of the number should it later be determined not appropriate.

5.1.6.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas, including 10 m buffer zones.

CBR will divide the area systematically into 100 m^2 grid blocks and sample all grid blocks containing gamma count rates exceeding the gamma action level. The samples will be five-point composites, and analyzed at an offsite laboratory for radium-226 and natural uranium.

CBR will sample the remaining grid blocks with average gamma count rates ranking in the top 10 percent.

If any grid blocks within the top 10 percent fail the cleanup criteria, CBR will sample the second ten percent of grid blocks. This will continue until all grid blocks pass within a 10 percent grouping. To meet the cleanup criterion, each of the sampled grid blocks must satisfy the following inequality,

$$\sum \frac{C_i}{Cc} < 1$$

where C_i is the concentration of the constituent and C_c is the concentration of the constituent that is equivalent to the Benchmark Dose.

CBR will remediate the grid blocks failing this inequality or propose alternatives consistent with Appendix A of 10 CFR 40.

After all sampled grids have met the inequality, an EPA-recommended statistical test will be done to determine whether the mean of the equality defined above for all grid blocks is 1 or less at the 95 percent confidence level, using Equation 8-13 of draft NUREG/CR-5849 (NRC 1992). If the mean of the sample concentrations is less than the criterion but the data fail the statistical test, CBR will follow procedures similar to those recommended in Section 8.6 of draft NUREG/CR-5849 (NRC 1992).

5.1.6.4 Subsurface Soil Cleanup Verification and Sampling Plan

For subsurfaces, CBR will adopt different survey and sample protocols, depending on the type and size of excavation. CBR will rely more on sampling and radium-226 and natural uranium analysis over surveying, to verify cleanup of subsurface excavations. The protocols are summarized in site procedures.

5.1.6.5 Temporary Ditches and Impoundments Cleanup Verification and Sampling Plan

CBR will adopt survey and sample protocols for temporary ditches and surface impoundments on a case-by-case basis. Ditches and impoundments can extend from the surface to the subsurface. For the purpose of decommissioning, the surfaces will be considered as part of adjacent soil surfaces. The subsurfaces will be surveyed and sampled systematically, based on their size and geometry. As with other subsurfaces, CBR will rely more on sampling and radium-226 and uranium analysis over surveying to verify cleanup of ditches and impoundments. Surveying is applicable in larger impoundments, however, wherein the effects of geometry are not as pronounced, particularly in areas not influenced by adjacent walls.

5.1.6.6 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The criteria that CBR will use to select the commercial laboratory will follow the guidance published in the Multi-Agency Radiological Laboratory Analytical Protocols Manual (NRC 2004). The commercial laboratory will adhere to a well-defined quality assurance program that addresses the laboratory's organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, standard operating procedures (SOPs), sample receipt, handing, storage, records, and appropriate licenses.

The analytical work performed by the commercial laboratory will adhere to CBR-defined Data Quality Objectives (DQOs). Part of the DQO process is specific analytical sensitivities required by CBR. The minimum sensitivity required for each sample will be 0.5 pCi/g dry weight for each analyte, with an estimated overall error of $\pm$ 0.5 pCi/g.

CBR will expect the reporting equivalent of an EPA Contract Laboratory Program Level 3 data package from the commercial laboratory.

CBR will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports.

5.2 Transportation Impact Mitigation Measures

The additional traffic generated by construction and operation of the proposed TCEA may result in the degradation of public road surfaces, particularly local gravel roads maintained by Dawes County. These impacts are expected to be minimal, since the additional traffic is not significant in comparison with current traffic levels. CBR contributes to the maintenance of these local roads through tax payments to Dawes County. In addition, CBR has voluntarily assisted Dawes County with materials to maintain county roads at the current operation. In the past, these materials have included gravel, road signs, and new culverts. CBR will continue to support Dawes County to mitigate impacts from company operations.

5.3 Soils 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 Three Crow site. BMPs and mitigation measures relevant to soil resources are also discussed in the water quality and reclamation sections of this document.

5.3.1 Sediment Control

- Divert surface runoff from undisturbed area around the disturbed area.
- Retain sediment within the disturbed area.
- Surface drainage shall not be directed over the unprotected face of the fill.
- Operations and disturbance on slopes greater than 40 percent need special sediment controls and should be designed and implemented appropriately.
- 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 best management practices do not result in compliance with applicable standards, modify or improve such best management practices to meet the controlling standard of surface water quality.

5.3.2 Topsoil

- Topsoil to be removed should be removed 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 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, and 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.

5.3.3 Roads

Construct and maintain roads to minimize soil erosion by:

- Restricting the length and grade of roadbeds;
- Surfacing roads with durable material;
- 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.

5.3.4 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 regraded material away from the area and into protected channels;
- Shape and compact regraded material to allow surface drainage and ensure long-term stability; and,
- Concurrently reclaim regarded 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 best management practices (BMPs), spill prevention control and countermeasures (SPCCs), and storm water pollution prevention plan (SWPPPs) will minimize effects to soils associated with the construction of the satellite facility.

5.4 Water Resources Impact Mitigation Measures

5.4.1 Groundwater Quality Impact Mitigation Measures

Impacts to groundwater quality in the mining zone are mitigated by groundwater restoration activities following completion of mining. The primary purpose of restoration is to ensure that affected water in the exempted aquifer cannot impact an adjacent underground source of drinking water. To accomplish this purpose, the goal of groundwater restoration is to return the affected ground water in the mining zone to conditions suitable for the uses for which they were suitable before mining. It should be noted that the methods used for groundwater restoration result in a consumptive use of the groundwater resources, particularly during the groundwater sweep phase. Water usage was discussed in Section 3.4.1.

The methods to achieve this objective for the affected groundwater are described in the following sections. Before discussing restoration methodologies, a discussion of the ore body genesis and chemical and physical interactions between the ore body and the lixiviant is provided.

5.4.1.1 Ore Body Genesis

The uranium deposit in the TCEA is similar to that found in the CPF license area. It is a roll front deposit in fluvial sandstone and is similar to those in the Wyoming such as the Gas Hills, Shirley Basin and the Powder River Basin. The origin of the uranium in the deposit could lie within the host rock itself either from the feldspar or volcanic ash content of the Chadron Sandstone. The source of the uranium could also be volcanic ash of the Chadron Formation which overlays the Chadron Sandstone. Regardless of the source of the uranium, it has precipitated in several long sinuous roll fronts. The individual roll fronts are developed within subunits of the Chadron Sandstone. The Chadron Sandstone is divided into local subunits by thin clay beds that confined the uranium bearing waters to several distinct hydrological subunits of the sandstone. These clay beds are laterally continuous for hundreds of feet but control the deposition of the uranium over greater distances as other clay beds exert vertical control when the locally controlling beds pinch out. Precipitation of the uranium resulted when the oxidizing water containing the uranium entered reducing conditions. These reducing agents are likely hydrogen sulfide (H_2S) and, to a lesser degree, organic matter and pyrite. More detailed discussions of the geochemical description of the mineralized zone are presented in Section 3.3.2.

Solution mining of the deposit is accomplished by reversing the natural processes that deposited the uranium. Oxidizing solution is injected into the mineralized portion of the Chadron Sandstone to oxidize the reduced uranium and to complex it with bicarbonates. Pumping from recovery wells draws the uranium bearing solution through the mineralized portion of the sandstone. The presence of reducing agents will increase oxidant requirements over that necessary to only oxidize the uranium.

Since the deposition of the uranium was controlled between clay beds within the Chadron Sandstone, the mining solutions will be largely confined to this portion of the sandstone by selectively screening these intervals. This will limit the contamination and thus the required restoration of unmineralized portions of the sandstone.

5.4.1.2 Chemical and Physical Interactions of Lixiviant with the Ore Body

The following discussion is based on a range of lixiviant conditions from 0.5 to 3.0 grams per liter total carbonate and a pH from 6.5 to 9.0 standard units (S.U.). This represents the normal range of operating conditions for the TCEA in-situ mining operations.

Ion Exchange

The principal IX reaction is the exchange of sodium from the lixiviant onto exchangeable sites on ore minerals with the release into solution of calcium, magnesium and potassium. This reaction can be shown as follows:

$$Ca_{clay} + 2\ Na^{+}_{solution} = 2\ Na_{clay} + Ca^{++}_{solution}$$

Similar reactions can be written for magnesium and potassium. Due to higher solubility of their sulfate and carbonate compounds and their low concentrations in Chadron Sandstone and the ore, magnesium and potassium in solution have no impact. The limited solubility of calcium carbonate ($CaCO_3$), and to a lesser degree, calcium sulfate, may lead to the potential for calcium precipitation.

Laboratory tests have indicated that the maximum calcium IX capacity of the ore in a sodium lixiviant with 3.0 g/L total carbonate strength is 1.21 milliequivalents of calcium per 100 grams of ore. This equates roughly to ½ pound of calcium or about 1.2 pounds of calcium carbonate per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized since laboratory testing is run in such a way as to indicate the maximum amount of calcium that can be exchanged. Somewhat less than this amount will be released and only a portion of that precipitated. There is no way to directly control the buildup of calcium in the lixiviant circuit. In practice, the lixiviant carbonate concentration and the lixiviant pH is controlled. The formation characteristics dictate an equilibrium calcium concentration in the lixiviant system and IX and/or precipitation will occur until the equilibrium is satisfied. The production bleed represents a departure from this equilibrium and as such has some effect on the amount of calcium exchanged. If the bleed is kept generally small, on the order of 0.5 percent, the effect of the bleed on the IX is small.

Precipitation

In the presence of carbonate ions and bicarbonate ions in the lixiviant system, calcium ions will precipitate provided the limit of saturation has been reached. Calcium precipitation is a function of total carbonate, pH and temperature. For example, at 15° C, a pH of 7.5 S.U., and 1 g/L carbonate in lixiviant, the equilibrium solubility of calcium is approximately 40 to 100 ppm. Some uncertainty is seen in these numbers due to the effect of ionic strength and supersaturation considerations. However, these figures illustrate the effect of carbonate concentration and pH on the equilibrium solubility of calcium.

The amount of calcium produced depends on the IX that is taking place, while the precipitation of calcium is a function of the lixiviant chemistry, and the degree of supersaturation that is observed in the system. As a first approximation, the proportion of calcium precipitation occurring above ground and underground will occur in the ratio of the residence times. In other words, if the residence time is much longer underground than it is above ground, as is the case for most in-situ leach operations including those projected for the TCEA, then more of the calcium will precipitate underground than above ground. The calcium precipitation is a function of turbulence in the solution, changes in dissolved carbon dioxide (CO_2) partial pressure or pH, and the presence of surface area. The most likely places for calcium to precipitate are underground where the ore provides abundant surface area for precipitation, at or near the injection or production wellbore where changes in pressure, turbulence and CO_2 partial pressure are all observed, and on the surface in the filters, in pipes, and in tanks. If all the calcium were to precipitate (based on 1.2 pounds of $CaCO_3$ per ton of ore) the precipitate would occupy about 0.15% of the void space in that ton of ore.

Calcium may be removed from the system in two ways:

- Filters will be routinely backwashed to the evaporation ponds and periodically acid cleaned, if necessary, to remove precipitated calcium carbonate from the filter housing or filter media; and
- The solution bleed (approximately 0.5 to 1.0 percent) taken to create overproduction and a hydrologic sink in the mining area serves to eliminate some calcium from the system.

Should precipitation of calcium carbonate at or near the wellbore of the wellfield wells become a problem, these wells may be air lifted, surged, water jetted, or acidified to remove the precipitated calcium. Any water recovered from these wells containing dissolved calcium carbonate or particulate calcium carbonate is collected and placed into the waste disposal system. A liquid seal is maintained on any calcium carbonate in the evaporation ponds. Upon decommissioning, calcium carbonate from the facility equipment and pond residues will be disposed of in either a licensed tailings pond or a commercial disposal site.

The other possible precipitating species that has been identified is iron, which could precipitate as either the hydroxide or the carbonate, causing some fouling. Such fouling is usually evidenced by a reduction in the IX capacity of the resin in the extraction circuit. Should this fouling become a serious problem, the resin can be washed and the wash solution disposed of in the waste disposal system. Due to the small amount of iron present in the Chadron Sandstone, iron precipitation has not been a problem in mining operations to date.

Hydrolysis

Hydrolysis reactions, which involve minerals and hydrogen or hydroxide ions, do not play an important role in the ore/lixiviant interaction. In the pH range of 6.5 to 9.0 S.U., the concentration of hydrogen and hydroxide ions is so small that these types of reactions do not occur to any great degree. The only potential impact would be a small increase in the dissolved silica content of the lixiviant system and a possible small increase in the cations associated with the siliceous minerals. The hydrolysis reaction does not have a significant effect on operations.

Oxidation

The oxidant consumers in the Chadron Sandstone are hydrogen sulfide in the groundwater, uranium, vanadium, iron pyrite, and other trace and heavy metals. The impact of these oxidant consumers on the operation of the facility is a general increase in the oxidant consumption over that which would be required for uranium alone. The second effect is a release of iron and sulfate into solution from the oxidation of pyrite. A third effect is an increase in the levels of some trace metals such as arsenic, vanadium and selenium into solution. As mentioned previously, the iron solubilized will most likely be precipitated as the hydroxide or carbonate, depending on its oxidation state. Any vanadium that is oxidized along with the uranium will be solubilized by the lixiviant, recovered with the uranium and could potentially contaminate the precipitated yellowcake product. Hydrogen peroxide precipitation of uranium is used to reduce the amount of vanadium precipitated in the product. Oxidation will also solubilize arsenic and selenium. The restoration program will return these substances to acceptable levels. A final potential oxidation reaction is the partial oxidation of sulfur species, increasing the concentrations of compounds such as polythionates, which can foul IX resins. In in-situ operations with chemistries similar to the TCEA, these sulfur species are completely oxidized to sulfate, which poses no problems.

Organics

Organic materials are generally not present in the TCEA ore body at levels greater than 0.1 to 0.2 percent. Where present organic materials effectively increase the oxidant consumption and reduce uranium leaching. On longer flow paths, organic material could potentially re-precipitate uranium should all of the oxidant be consumed and conditions become reducing. Another potential impact of mobilized organics could be the coloring and fouling of leach solutions. As the aquifer is maintained in the pH range of 6.5 to 9.0 S.U., mobilization of the organics and coloring of the leach solution is avoided.

5.4.1.3 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 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.

EPA groundwater protection standards issued under the authority of the Uranium Mill Tailings Radiation Control Act (UMTRCA) are required to be followed by ISL licenses of the NRC and its Agreement States. The EPA regulations issued under UMTRCA authority provide the principal standards for uranium ISL operations and groundwater protection, while the UIC regulations are considered additional requirements for ISL operations. CBR is required to restore groundwater quality to the standards listed in Criterion 5B(5) of 10 CFR Part 40, Appendix A as required by the UMTRCA, as amended. Under EPA requirements, groundwater restoration at ISL facilities must meet the UMTRCA standards and not those associated with the Safe Drinking Water Act or analogous state regulations.

Under Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA, at the point of compliance (mining zone after restoration), the concentration of hazardous constituent must not exceed:

a. The Commission approved background concentration of that constituent in the groundwater;

b. The respective value given in **Table 5.4-1** for the UMTRCA values if the constituent is listed in the table and of the background level of the constituent is below the value listed; or

c. Alternate concentration limit established by the Commission.

CBR will comply with these provisions as to groundwater restoration limits. The NRC is currently developing rulemaking on groundwater protection standards in an effort to eliminate dual jurisdiction and interactions with the EPA. Such new rulemaking could affect the groundwater restoration limits, but the new language will emphasize that UMTRCA would govern.

Establishment of Baseline Water Quality

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 "baseline restoration wells". A minimum of six wells for each four acres is sampled to establish the mine unit baseline water quality. A minimum of three samples is collected from each well. The samples are collected at least 14 days apart. The samples are analyzed for the parameters listed in **Table 5.4-1**.

Appendix L contains the restoration tables for Mine Units 1 through 10 in the CPF license area. These tables provide the baseline average and the range for all restoration parameters as well as the NDEQ restoration standard approved for that mine unit in the NOI.

Establishment of Restoration Goals

Groundwater restoration standards are established by the Nebraska Department of Environmental Quality (NDEQ), with concurrence of the NRC and EPA. The NDEQ restoration values are established for each mine unit and are approved with the Notice of Intent to Operate submittals according to the following analysis:

- The restoration parameters that have numerical groundwater standards established in NDEQ Title 118 (NDEQ 2006) or other established agency approved documents must be restored to the standard (maximum contaminant level [MCL]) unless the standard is exceeded by the mean of the preoperational sampling values (baseline mean).
- If the baseline concentration exceeds the applicable MCL as noted above, 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 a wellfield average of the preoperational sampling data. These values (based on 3 samples from injection and production wells) would be averaged to obtain the assigned restoration value.
- The restoration values for the major cations (Ca, Mg, K, Na) allow 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 5.4-1**. All of the parameters listed in this table as parameters with numerical water standards (Title 118 or other sources) are subject to change by the NDEQ based on these procedures. NDEQ establishes the final groundwater restoration standards.

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. 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.

Restoration goals are established by NDEQ to ensure that, if baseline water quality is not achievable after diligent application of best practicable technology (BPT), the groundwater is suitable for any use for which it was suitable before mining. NRC considers these NDEQ restoration goals as the secondary goals.

Prior to any mining in a mine unit, the groundwater restoration values that have been established based on the above procedures, are submitted to the NDEQ for approval. The restoration values for each mine unit would be based on current NDEQ Title 118 numerical standards and wellfield averages at the time the notice of intent is submitted to the NDEQ. All data to verify the selection of these wells would be submitted.

The primary goal of restoration is on a parameter-by-parameter basis to return the average wellfield unit concentration to baseline conditions. The secondary goal of groundwater restoration is on a parameter-by-parameter basis to return the average wellfield unit concentration to the numerical class-of-use standards established by the NDEQ. Groundwater restorations activities are in accordance with a groundwater water restoration plan approved by the NDEQ and NRC.

It is anticipated that the Class III UIC Permit issued for the TCEA will have similar requirements as described above. **Table 5.4-1** lists the 27 parameters used at the CBR project to determine groundwater quality. The current MCLs from Title 118 are listed as well as the restoration standards from the Class III UIC Permit. The restoration value for each mine unit is based on the current Title 118 standard at the time the Notice of Intent is approved by the NDEQ.

5.4.1.4 Groundwater Restoration Methods

Introduction

Restoration activities in the CPF license area have proven that the groundwater can be restored to the appropriate standards following commercial mining activities. As shown in **Table 1.1-1**, Mine Units 2 through 5 are currently undergoing restoration. Mine Unit 1 groundwater restoration has been approved by the NDEQ and the NRC. On February 12, 2003, the NRC issued the final approval of groundwater restoration in Mine Unit 1 at CBR. This approval was the culmination of three 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 CPF processing building. 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 (R & D) 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:

a. Groundwater transfer.

b. Groundwater sweep.

c. Groundwater treatment.

d. 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. Safety and handling issues associated with the use of sodium sulfide are discussed in Section 1.3.2.5 (Process Related Chemicals). Instructions and safety precautions on the use of sodium sulfide are included in Crow Butte's *Environmental, Health, and Safety Management System, Volume III Operating Manual* (Restoration Reductant [Sodium Sulfide]).

The CPF Class III UIC Permit requires a minimum of a six month period for stability monitoring of a Mine Unit to demonstrate the success of restoration activities (stabilization). As shown by historical Mine Unit 1 restoration data, six months may not be sufficient to assure stability for all monitored constituents. Stability monitoring may continue beyond the six month period as necessary. Stability monitoring will conclude, instead, when stabilization samples show that restoration goals on a mine unit average for monitored constituents are met and there is an absence of significant increasing trends for a minimum of four quarters. At the end of the stabilization period, when restoration parameters have been achieved and there is absence of significant increasing trends for any of the restoration parameters, a request would be made to the NDEQ for acceptance of restoration completion for the mine unit. The NDEQ would either accept the restoration of the mine unit, or extend the stabilization period or require further restoration.

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 water with chemistry similar to that in **Table 2.4-15** column "Typical Water Quality During Mining at CPF" 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, less than 300 feet from the mining patterns, will ensure 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 hydraulic conductivities on the order of 10^{-11} cm/sec as outlined in Section 3.4.3 of this application. Likewise, the underlying Pierre Shale is over 1,200 feet thick and acts as a significant aquitard. The vastly different piezometric 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.

CBR is currently conducting a pilot study using bioremediation to complete restoration of Mine Unit 4 at the existing CPF. This bioremediation test was initiated on December 17, 2008. The injection of emulsified oil substrate (EOS, a registered product of EOS Remediation), was completed on April 08, 2009. The wells in the study area were shut down for 30 days. The wells are being sampled periodically to determine the effects of the EOS on the formation. Based on the results of this study, bioremediation may or may not be used at the TCEA. If the tests are successful, and use at the TCEA appears to be a viable restoration alternative, a request for a license amendment will be submitted to the NRC.

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. The number of pore volumes that would be displaced during groundwater restoration would be as follows: 3 pore volumes through IX treatment; 6 pore volumes through the RO; and 2 pore volumes of recirculation. There were 9 pore volumes used for Mine Unit 1 at the current CBR operations. 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.

The calculated pore volume for the entire Three Crow Wellfield would be 1,011,663,888 gallons. This is based on a calculated square footage of 15,544,844 ft^2 of the potential wellfield area, an average under-ream interval of 30 feet and a 29% open pore space value.

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 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 IX 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 activities.

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, is dependent upon 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.

Groundwater Treatment

Following the groundwater sweep step, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX, 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 5.1-1**.

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.

A portion of the restoration recovery water can be sent to the RO unit. The use of a 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 5.4-2** 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 may be added to the wellfield injection stream to control the amount of "bleed" in the restoration areas.

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 hydrogen sulfide. 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 the efficiency of the RO in removing total dissolved solids (TDS) and the reductant in lowering the uranium and trace element concentrations.

Wellfield Recirculation

At the completion of the Groundwater Treatment Stage, wellfield recirculation may be initiated. In order to homogenize the aquifer, pumping from the production wells and re-injecting the recovered solution into injection wells may be performed to recirculate 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 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 regulatory agencies 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.

5.4.1.5 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 5.4-1**. The sampling frequency will be one sample per month for a period of four quarters months, and if the 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.

The CPF's Class III UIC Permit requires a minimum of a six month period for stability monitoring of a Mine Unit to demonstrate the success of restoration activities (stabilization). As shown by historical Mine Unit 1 restoration data, six months may not be sufficient to assure stability for all monitored constituents. Stability monitoring may continue beyond the six month period as necessary. Stability monitoring will conclude, instead, when stabilization samples show that restoration goals on a mine unit average for monitored constituents are met and there is an absence of significant increasing trends. The NDEQ approves the stabilization period.

5.4.1.6 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 Semiannual Radiological Effluent and Environmental Monitoring Report submitted to NRC. 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 5.4-1**. If restoration activities have returned the wellfield average of restoration parameters to concentrations at or below those approved by the NRC and 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 5.4-1**. At the end of a six-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 the mine unit be declared restored. Following agency approval, wellfield reclamation and plugging and abandonment of wells will be performed as described in Section 5.1.

5.5 Air Quality Impact Mitigation Measures

Operational activities within the TCEA will cause a minimal increase in fugitive dust emissions. These emissions will be minimized on the mine property by strict enforcement of site speed limits. As discussed in Section 4.6, vehicle speed has a linear effect on the production of total suspended particulates (TSP). Speed limits at the current operation are 25 MPH or less. Similar controls will be implemented at the TCEA.

Dust emissions from county roads are expected to be a minimal incremental increase over those produced by current traffic levels. Implementation of dust mitigation measures (such as the application of water or dust control chemicals) to unpaved county roads are generally cost prohibitive. In the past, CBR has donated road surfacing materials to Dawes County for use on roads near residences that were adversely impacted by fugitive dust from CBR and public traffic.

5.6 Visual and Scenic Resource Impact Mitigation Measures

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

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

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

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

Table 5.1-1 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

Table 5.4-1 NDEQ Groundwater Restoration Standards

Parameter	NDEQ Title 118 Groundwater Standard	NDEQ Restoration Standard[1]	NRC UMTRCA Groundwater Protection Standards
Ammonium (mg/l)	Not Listed	10.0	--
Arsenic (mg/l)	0.010	0.010	0.05
Barium (mg/l)	2.0	2.0	1.0
Cadmium (mg/l)	0.005	0.005	0.01
Chloride (mg/l)	250	250	--
Chromium *mg/l)	--	--	0.05
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	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	0.05
Radium (pCi/L)	5.0	5.0	--
Selenium (mg/l)	0.05	0.05	0.01
Sodium (mg/l)	Reserved	Note 2	--
Sulfate (mg/l)	250	250	--
Uranium (mg/l)	0.030	0.030	
Ra-226 & Ra-228 (pCi/l)	--	--	5
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	--
TDS (mg/l)	500	Note 4	--

Notes:

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 total dissolved solids value.

4 The restoration value for Total Dissolved Solids (TDS) shall be the baseline mean plus one standard deviation.

Source: NDEQ Class III UIC Permit Number NE0122611 (except for NRC UMTRCA Groundwater Protection Standards)

Source: NRC UMTRCA Groundwater Protection Standards (Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA

Table 5.4-2 Typical Reverse Osmosis Membrane Rejection

Name	Symobl	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.

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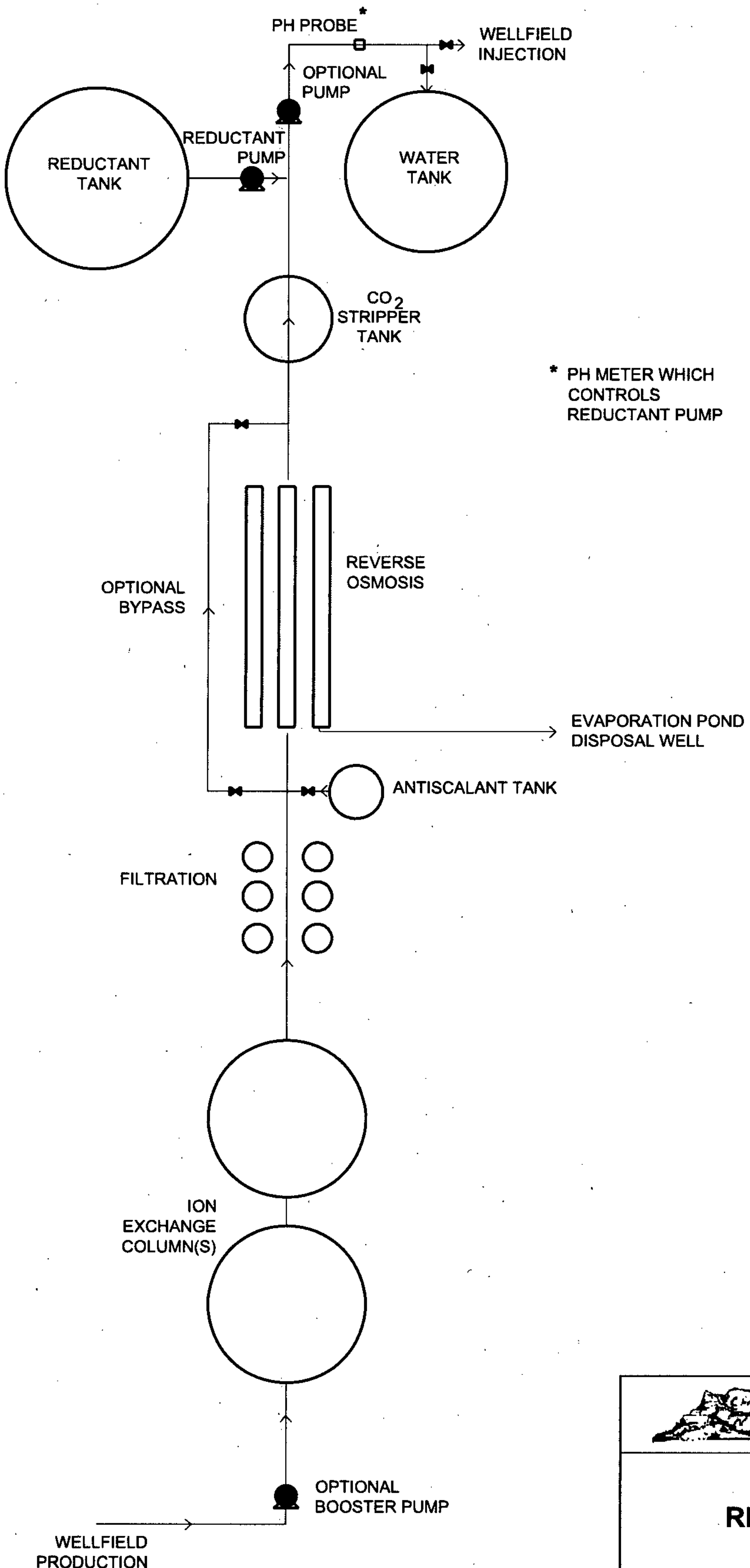

CROW BUTTE RESOURCES, INC.

FIGURE 5.1-1
RESTORATION PROCESS FLOW DIAGRAM

PROJECT: CO001396.02 | MAPPED BY: JC | CHECKED BY: JEC

ARCADIS 630 Plaza Drive, Ste. 100 Highlands Ranch, CO 80129 P: 720-344-3500 F: 720-344-3535 www.arcadis-us.com

PATH: K:\CBR_[illegible]CO001396_ThreeCrow\1_ACAD\ARCADIS_NewDrawings\RestorationProcessRevised.dwg LAYOUT: ER DATE: [illegible]/2/2010 3:36 PM

6 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 Radiological and Nonradiological Monitoring

6.1.1 Introduction

This section discusses the environmental sampling program that CBR implemented to assess preoperational and operational radiological background conditions in the vicinity of the TCEA. The results of this program, in contrast to the operational monitoring program implemented during satellite operations, will be used to determine the effects on the environment, if any, of the TCEA facilities.

The TCEA preoperational radiological monitoring was initiated in 2007. The program was designed to meet the criteria outlined in Reg. Guide 4.14 (NRC 1980). Alternatives to specific requirements of the guide were developed and implemented where appropriate. The primary basis for the alternate procedures was that Reg. Guide 4.14 was developed to address uranium "milling" operations producing yellowcake and the proposed satellite facility is a "wet" process that limits a number of concerns addressed in Reg. Guide 4.14. For example, there are limited air particulate and radon emissions due to lack of ore and overburden piles, tailings pond(s), yellowcake drier, and less disturbance area. However, the NRC advised CBR in 2009 that similar alternate approaches to the preoperational and operational monitoring (completed data collection and planned monitoring) for the proposed NTEA were unacceptable. Therefore, based on guidance from the NRC on NTEA, the TCEA preoperational and operational monitoring plans implemented in 2007 have been revised to adhere to NRC guidance.

Monitoring data collected from the first quarter of 2007 through the first quarter of 2010 are presented in this application. Following NRC approval, a revised monitoring plan will be implemented to collect 12 months of preoperational monitoring data. Once the data have been collected and analyzed, the results will be reported to the NRC.

The TCEA preoperational monitoring data collected to date indicate that the existing background concentrations of the radionuclides of interest are in the range of baseline data previously collected by CBR for the CPF license area.

The results of the TCEA preoperational radiological monitoring are organized by environmental media to allow ready comparison of monitoring data collected during both periods. A discussion of the scope of the monitoring program precedes the presentation of the data.

6.1.2 Baseline Air Monitoring

6.1.2.1 Selection of Air Monitoring Stations

Reg. Guide 4.14 recommends that preoperational air monitoring should be conducted for air particulates, radon gas and direct radiation at three locations at or near the site boundary, one at or close to the nearest resident or occupiable structure(s) (if within 10 km of site) and one at a control or background location.

Five air monitoring locations were selected in 2010 as follows:

- Three monitor sites along the northern license boundary of the TCEA (locations TCA-1 through TCA-3). The locations were selected based on the three predominant wind roses and the site boundary.
- One monitor located at the nearest resident, which is the resident located within the TCEA license boundary in Section 29 T31N R52W.
- One monitor located to the east of the TCEA license boundary that serves as the background control location.

CBR based the sample locations for the air monitors on the anticipated satellite facility location, proposed license boundaries and predominant wind rose for the TCEA site, which was based upon the CBR project wind rose shown in **Figure 6.1.-2**. The local wind direction is predominantly from south-southwest direction approximately 45 percent of the time. Winds can also be from the northeast. The boundary sample locations were determined based upon this data.

The wind rose was developed from data generated at a CBR onsite MET station. The MET monitoring station on the CBR site monitored temperature, precipitation, evaporation, wind speed and direction, and the standard deviation of the wind direction. The local meteorological station was operated from April 1982 through April 1984 during initial permitting for the current licensed area. From this information joint frequency data was compiled. Further information on meteorological conditions is contained in Section 2.5.

Figure 6.1-1 contains a map of the TCEA showing the monitoring locations. As noted, the air monitoring locations were designated as TCA-1, TCA-2, TCA-3 (site boundary) TCA-4 (nearest residence); TCA-5 (background control).

6.1.2.2 Air Particulate Monitoring Program

Reg. Guide 4.14 recommends that a total five particulate monitoring stations be established as discussed above in Section 6.1.2.1. Initially, CBR determined that air particulate monitoring as defined by Reg. Guide 4.14 was not appropriate for the TCEA. The basis for this was that activities at the TCEA will involve the operation of a satellite facility, which will not include drying, handling, or packaging of yellowcake. All drying and packaging operations will be performed at the CPF. Therefore, there are no operations at the satellite facility that could cause a significant release of airborne particulate radionuclides. However, CBR did conduct air particulate monitoring for four quarters in 2007 at sampling station AM-15 of the TCEA (south side of license boundary near the center of the TCEA (**Figure 6.1-2**).

The analytical results for AM-15 are depicted in **Table 6.1-1** and are compared to the background control sampler used for background for the CPF located at the northeast corner of the City of Crawford (SW quarter of SW quarter of Section 2 T31N R52 W). Uranium concentrations ranged from <1.00 E^{-16} to 8.01 E^{-16} uCi/ml, radium-226 <1.00 E^{-16} to 3.02 E^{-16} uCi/ml, and lead-210 7.60 E^{-15} to 3.71 E^{-14}.

CBR has since determined in discussions with NRC staff that since the satellite facility is considered to be a "mill" as defined by the NRC, air particulate monitoring should be conducted as required by Reg. Guide 4.14. Therefore, five air particulate monitoring sites were established as discussed in Section 6.1.1. Following NRC approval, the air monitoring will be conducted and incorporated into the operations monitoring program. One-year of quarterly data for each of the five sites will be submitted to the NRC once the data have been collected and a report prepared.

The airborne particulate samples are collected on the inlet filter of a regulated vacuum pump on a Type A/E 47 mm glass fiber filter paper. The low volume air samplers employed is the Eberline RAS-1 system that consists of a vacuum pump, an airflow regulator, a rotameter-type airflow indicator, and filter paper holder. The RAS-1 samplers are placed in protective enclosures that provided protection from the elements while allowing unimpeded sampling of the ambient air.

Clean filters are installed in the filter holder at the beginning of each sampling period. The pump flow rate is adjusted as necessary. The filter replacement schedule is determined based on the dust loading at a particular location. In general, historical operations of samplers at the CPF have shown that samplers can run for one to two weeks without a significant reduction in the flow rate due to dust loading.

At the end of the calendar quarter, the composite filter samples for each monitor are submitted to the contract laboratory for radiometric analysis using standard Chain of Custody Procedures. The filters are composited according to location. The composite samples are analyzed for the concentrations of natural uranium, radium-226, lead-210 and thorium-230.

The flow rate on the RAS-1 pumps is calibrated at six-month intervals using accepted calibration methods to ensure the accuracy of the volume of air sampled. Records of sampler calibration are available on file at the CPF.

CBR will continue to operate all five samplers as part of the operational air particulate monitoring.

Radon Gas Monitoring Program

Reg. Guide4.14 recommends collection of radon gas samples at each of the air particulate monitoring stations (5 or more sample points). Continuous samples or at least one week per month representing about the same time of the month will be performed. Analysis is as radon gas.

Air monitoring in 2007 and 2008 involved radon gas sampling performed at quarterly intervals at air monitoring locations AM-6 (control), AM-15, AM-16, AM-17, AM-18, AM-19, AM-20 and AM-21 (**Figure 6.1-2**). Monitoring was performed using RadTrak® Type DRNF outdoor air radon detectors. RadTrak® cups contain a sensitized chip covered with a selectively permeable material allowing only the infiltration of radon. The sensitized chip records alpha disintegrations from radon daughters, allowing determination of average radon concentrations. The analysis of quarterly sampling has a sensitivity of 30 pCi/l-days. The semiannual interval was chosen to ensure that monitoring results meet the lower limit of detection (LLD) requirement of 0.2 pCi/l (2 x 10^{-10} µCi/ml) from Reg. Guide 4.14 and to be consistent with the semiannual intervals approved by NRC for the current operational monitoring.

Air monitoring for radon gas was performed for the TCEA for two time periods: 1/101/2007 – 7/12/2007 and 7/12/2007 – 1/11/2008. The RadTrak® detector located at AM-6 (control for CPF) was also used as the background site.

The results of the 2007 - 2008 radon sampling are presented in **Table 6.1-2.** The average values were the 1/10/2007 – 7/12/2007 sampling period were relatively constant with the exception of AM-16 which was higher than the other sites (0.8 x 10^{-9} µCi/ml versus 0.3 x 10^{-9} to 0.5 x 10^{-9} µCi/ml for the other sites [Note AM-19 and AM-20 were excluded due to being bad detectors). The average values for the 7/12/2007 to 1/11/2008 sampling period ranged from 0.4 to 0.9 x 10^{-9} µCi/ml with AM-20 being the highest at 0.9 x 10^{-9} µCi/ml.

With the installation of the air particulate monitors as discussed above, CBR will locate and operate radon detectors at the same locations in **Figure 6.1-1**. The detectors will be operated on a six-month basis and replaced with a new detector at that time. Detectors will no longer be operated at the other sites mentioned above, i.e., A-15, AM-16, AM-17, AM-18, AM-19, AM-20 and AM-21.

The operational monitoring sites proposed for the satellite facility will be the same as those shown in **Figure 6.1-1**. Operational monitoring of radon concentrations will continue as long as uranium recovery and restoration activities are in progress.

6.1.2.3 Quality of Air Measurements

The accuracy of monitoring data is critical to ensure that the preoperational air monitoring program precisely reflects air quality. Reg. Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	1 x 10^{-16}	1 x 10^{-16}
Radium-226	1 x 10^{-16}	1 x 10^{-16}
Thorium-230	1 x 10^{-16}	1 x 10^{-16}
Radon-222	2 x 10^{-10}	2 x 10^{-10}
Lead-210	2 x 10^{-15}	2 x 10^{-15}

Note that Landauer does not provide the LLD on the analytical report. The LLD for Radtrak® detectors is a function of the exposure time and the area of the cup that is analyzed by Landauer.

6.1.3 Baseline Groundwater Monitoring

CBR will operate evaporation ponds at the proposed satellite facility to manage liquid wastewater streams generated during operations and restoration. A groundwater monitoring program will be carried out to monitor groundwater downgradient of the evaporation ponds that is consistent with the monitoring requirements of Reg. Guide 4.14. CBR will install two monitor wells hydrologically down gradient, and one well up gradient of the proposed evaporation ponds. These upgradient and downgradient monitor wells will be installed during the operational phase once the exact locations of the ponds and other assets have been finalized. In addition, other groundwater monitoring activities will supplement this proposed monitoring:

- The evaporation ponds will have a leak detection system to assure there is no migration beyond the liners.
- The evaporation ponds will be located within the monitor well ring for MUs 1-3 to detect migration of any process fluids from the production areas.

- CBR will also monitor selected wells within 0.5 mile of the license boundary (see discussions below).

This overall monitoring program is sufficient for monitoring groundwater conditions associated with the operation of the evaporation ponds.

6.1.3.1 Private Water Supply Wells

This section will discuss the results of the radiological and nonradiological analyses for private water supply wells within the TCEA and vicinity. Other information on the selected wells including formation, depth, and usage is shown in **Appendix F**.

Radiological Analyses

A summary of groundwater radiological quality data collected in 2007, 2008 and 2009 in the TCEA and vicinity for private water supply wells is presented in **Table 6.1-3**. All private wells in the vicinity of the AOR are completed in the Brule Formation. Additional summary data for radium-226 and natural uranium as compared to other CBR Brule Formation and Basal Chadron Sandstone Formation monitor wells are presented in **Table 6.1-4**. Four of the private wells that were monitored are located within the TCEA permit boundary (Wells 270, 272, 273, and 277) and the remaining wells (Wells 269, 274, 275, 313, and 314) are located less than 0.5 mile from the permit boundary (**Figure 6.1-3**). The wells were chosen based on proximity to the proposed mining operation, use, and distribution throughout the expansion area. For operational monitoring, wells 269, 274, 275, 312 and 314 will be monitored. Well 313 has been replaced with Well 312 since Well 313 and 314 are located close together, so additional data are only needed for one of these wells. Well 312 will allow for more representative sampling of the area north of the TCEA permit boundary.

Table 6.1-5 contains individual well results of the analyses for radionuclides for all private wells sampled for the TCEA during 2007, 2008, and 2009. Results are for concentrations of lead 210, polonium 210, radium-226, thorium 230 and natural uranium. As shown for all parameters in the data summary of **Table 6.1-3**, approximately 59% of the samples were less than the reporting limit, with approximately 41% at or greater than the reporting limit. Natural uranium was the only parameter with all values greater than the reporting limit. Lead-210 had the greater number of values at or less than the reporting limit (98%), followed by thorium-230 (89%) and ra-226 (87%) concentrations.

The results of the analyses indicate concentrations of the radionuclides are within the expected ranges for naturally occurring background in the area. The concentration of uranium in the wells completed in the Brule Formation within the NTEA ranged from <0.0003 to 0.05 mg/l, as compared to the private wells in the TCEA (0.008 – 0.0272 mg/l). The concentration of dissolved radium-226 in these same NTEA wells ranged from <0.2 to 1.3×10^{-9} µCi/ml, as compared to 0.006 to 0.5 pCi/L for the TCEA, with the majority of the wells below the detection level.

Nonradiological Analysis

The nonradiological analytical results for 2007 – 2008 for the private wells are presented in **Table 6.1-6, 6.1-7, 6.1-8,** and **6.1-9**. The analytical results for these tables are summarized in **Table 6.1-4.** Concentrations of the parameters for the private wells versus CBR monitor wells completed in the Brule Formation are comparable. The difference between the wells completed in the Brule Formation versus the CBR monitor wells completed in the Basal Chadron Sandstone is clearly shown in **Table 6.1-4**. Major differences are discussed below in Section 6.1.3.2. Similar trends in relative concentrations were observed in water quality sampling at the NTEA for these water-bearing units.

6.1.3.2 CBR Groundwater Monitor Wells

Locations of all groundwater monitoring wells in the vicinity of the TCEA are shown on **Figure 6.1-3.** There are seven active monitoring wells screened in the Brule Formation (BOW 2006-1, BOW 2006-2, BOW 2006-3, BOW 2006-4, BOW 2006-5, BOW 2006-6, and BOW 2006-7). The Miller Well (W-273) is also being utilized as a monitoring well for the Brule Formation. Ten active monitoring wells are screened in the Basal Chadron Sandstone (CPW 2006-1, COW 2006-1, COW 2006-2, COW 2006-3, COW 2006-4, COW 2006-5, COW 2006-6, COW 2006-7, UBCOW 2006-1, and UBCOW 2006-2) **(Figure 6.1-3)**. Well completion reports for these monitoring wells are included in **Appendix A**. No completion report is available for W-273. Individual well Laboratory Analytical Reports and QA/QC Summary Reports received from the contract analytical laboratory for radiological and nonradiological parameters are presented in **Appendix H.**

Water Level Measurements

Water-level measurement events for the Brule Formation were conducted at four monitoring wells (BOW 2006-1, BOW 2006-2, BOW 2006-3, and BOW 2006-4) during two water level measurement events in January 2009 and at seven monitoring wells and W-273 in January 2010 **(Table 6.1-10)**. The static water level for wells screened in the Brule Formation in the vicinity of the TCEA typically ranges from 30 to 80 feet bgs. Water levels measured during the January 2010 ranged from approximately 3,819 to 3,913 feet amsl **(Figure 6.1-4)**. Groundwater flow in the Brule Formation is directed to the north and northeast across the entire TCEA. Groundwater elevations for all events indicate groundwater flow is convergent with the White River. The average hydraulic gradient within the TCEA is 0.0168 ft/ft. Regional water level information for the Brule Formation is currently only available in the vicinity of the CPF.

Water-level measurement events for the Basal Chadron Sandstone were conducted at all ten monitoring wells (CPW 2006-2, COW 2006-1, COW 2006-2, COW 2006-3, COW 2006-4, COW 2006-5, COW 2006-6, COW 2006-7, UBCOW 2006-1, and UBCOW 2006-2) during three water level measurement events during the months of January 2009 and January 2010 **(Table 6.1-10)**. The static water level for wells screened in the Basal Chadron Sandstone in the vicinity of the TCEA typically ranges from 180 to 270 feet bgs. Groundwater elevations from the more recent January 2010 measurement event are shown on **Figure 6.1-5**. Water levels ranged from approximately 3,707 to 3,720 feet amsl. Groundwater flow is directed predominantly toward the east-northeast across the entire TCEA **(Figure 6.1-5)**. The average hydraulic gradient within the TCEA is 0.0012 ft/ft. Regional water level information for the Basal Chadron Sandstone is currently only available in the vicinity of the CPF.

Strong vertically downward gradients exist at all locations within the TCEA, indicating minimal, if any, risk for potential impacts to the Brule Formation from the underlying Basal Chadron Sandstone under natural conditions **(Figures 3.3-3a** through **3.3-3e)**. Observed head differences between the two water-bearing zones at three well pairs (BOW 2006-5 and COW 2006-1, BOW 2006-1 and CPW 2006-2, and BOW 2006-3 and COW 2006-4) ranged from approximately 86 to

196 feet during the January 2010 measurement event. Head differences between well pairs screened in the upper and lower Basal Chadron Sandstone (UBCOW 2006-1 and CPW 2006-2, UBCOW 2006-2 and COW 2006-4) were less than 1.0 feet for all water level measurement events, indicating favorable hydraulic communication between the two intervals.

Available groundwater data for both the Brule Formation and Basal Chadron Sandstone at the TCEA do not indicate any documented flow rate variations or recharge issues that would impact groundwater quality as a result of ISL mining operations in the Basal Chadron Sandstone. There are no surface-water ponds within the TCEA permit boundary and only limited stream flow. The Brule Formation, while considered an overlying aquifer, is not an extensive or exceptionally productive system. The available monitoring data do not indicate any seasonality or pumping effects by domestic wells within this zone.

6.1.3.3 Groundwater Quality Data

Groundwater quality within the White River drainage generally is poor (Engberg and Spalding 1978). Groundwater obtained from the Basal Chadron Sandstone aquifer has a strong sulfur odor as a result of localized reducing conditions associated with the ore body (**Figure 6.1-6**). A summary of groundwater quality data collected in 2007, 2008 and 2009 to establish background conditions in the vicinity of the TCEA is presented in **Table 6.1-4**. The data are presented for the two water-bearing zones at the TCEA: the Brule Formation and the Basal Chadron Sandstone. Four of the private wells that are monitored are located within the TCEA permit boundary (Wells 270, 272, 273, and 277) and the remaining wells (Wells 269, 274, 275, 313, and 314) are located less than 0.5 mile from the permit boundary (**Figure 6.1-3**). Well 313 will be replaced by Well 312 for future monitoring of private water supply wells. Well 313 and 314 are located close together, so additional data are only needed from one of these wells. Well 312 will allow for more representative sampling of the area north of the permit boundary.

Radiological

Tables 6.1-11 and **6.1-12** report the detailed radiological results of three bi-weekly sampling events for Brule Formation and Basal Chadron Sandstone monitoring wells within the TCEA. The bi-weekly sampling events were conducted for dissolved radiological parameters at all of the Brule Formation monitoring wells (BOW 2006-1, BOW 2006-2, BOW 2006-3, BOW 2006-4, BOW 2006-5, BOW 2006-6, and BOW 2006-7) in November 2008 through February 2009 and at ten Basal Chadron Sandstone monitoring wells (CPW 2006-2, COW 2006-1, COW 2006-2, COW 2006-3, COW 2006-4, COW 2006-5, COW 2006-6, COW 2006-7, UBCOW 2006-1, and UBCOW 2006-2) between December 2008 and February 2009. Analyses were also conducted for three bi-weekly samples for suspended radiological parameters (lead-210, polonium-210, radium-226, and thorium-230) for Brule wells BOW 2006-5, BOW 2006-7, BOW 2006 and Well 273 from November through December 2009.

A summary of the radiological analyses for uranium and radium-226 ranges for the individual well results for **Table 6.1-11** and **6.1-12** is presented in **Table 6.1-4**. Uranium concentrations in the Brule Formation for private wells and monitoring wells ranged from 0.008 to 0.0272 mg/L and from 0.0032 to 0.0264 mg/L, respectively. Uranium concentrations in the Basal Chadron Sandstone ranged from 0.0004 to 0.0385 mg/L. Dissolved radium-226 concentrations for private wells and monitor wells in the Brule Formation ranged from 0.006 to 0.500 mg/L and 0.065 to 0.41 pCi/L, respectively. Dissolved radium concentrations in the Basal Chadron Sandstone ranged from 0.23 to 181 pCi/L. Suspended radium-226 concentrations in the Brule formation for wells Bow 2006-5, BOW 2006-6, BOW-2007 and Well 273 ranged from 0.04 to 0.20 pCi/l.

Nonradiological

Tables 6.1-13 reports the detailed nonradiological results of three bi-weekly sampling events for the Brule Formation and Basal Chadron Sandstone monitoring wells within the TCEA, which were included in the range of concentrations reported on **Table 6.1-4**. The bi-weekly sampling events were conducted at four Brule Formation monitoring wells (BOW 2006-1, BOW 2006-2, BOW 2006-3, BOW 2006-4, BOW 2006-5, BOW 2006-6, and BOW 2006-7) in November 2008 through February 2009 and at ten Basal Chadron Sandstone monitoring wells (CPW 2006-2, COW 2006-1, COW 2006-2, COW 2006-3, COW 2006-4, COW 2006-5, COW 2006-6, COW 2006-7, UBCOW 2006-1, and UBCOW 2006-2) between December 2008 and February 2009. TDS concentrations for the Brule Formation ranged from 237 to 327 mg/L, whereas TDS for the Basal Chadron Sandstone ranged from 980 to 1,300 mg/L. Alkalinity for the Brule Formation was detected up to 172 mg/L, while alkalinity in the Basal Chadron Sandstone was consistently detected above 300 mg/L. Conductivity for the Brule Formation was detected up to 466 µmhos/cm, while conductivity for the Basal Chadron Sandstone was detected above 1,690 µmhos/L at all sampling locations. Major ion concentrations (i.e., alkalinity (total as $CaCO_3$), carbonate (as CO_3), bicarbonate (as HCO_3), calcium, chloride, fluoride, magnesium, ammonia nitrogen as N, nitrate plus nitrite as N, potassium, silicia, sodium and sulfate),for the Brule Formation ranged from 527 to 589 mg/L, while concentrations for the Basal Chadron Sandstone ranged from 1,547 to 1,967 mg/L. Similar trends in relative concentrations were observed in water quality sampling at the NTEA for these two water-bearing zones.

In general, concentrations of TDS, specific conductance and major ions in the Basal Chadron Sandstone appear to be an order of magnitude larger than observed in the Brule Formation at the TCEA. To date, water quality sampling indicates that the Brule Formation and the Basal Chadron Sandstone have unique geochemical signatures within the TCEA.

Quality of Groundwater Measurements

The accuracy of monitoring data is critical to ensure that the water monitoring program precisely reflects water quality.

In addition to recommending the use of approved analytical methods for water quality measurements (contained in 40 CFR 136), the NRC also specifies analytical quality requirements in Reg. Guide 4.14 for the following lower limits of detection (LLD) in water:

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	2×10^{-10}	2×10^{-10}
Thorium-230	2×10^{-10}	2×10^{-10}
Radium-226	2×10^{-10}	2×10^{-10}
Polonium-210	1×10^{-9}	1×10^{-9}
Lead-210	1×10^{-9}	1×10^{-9}

6.1.4 Baseline Surface Water Monitoring

Surface water sampling in Reg. Guide 4.14 calls for sampling of surface water passing through the project site or offsite surface waters that may be subject to drainage from potentially contaminated areas or that could be affected by a tailings impoundment failure. Grab samples are to be collected on a monthly basis with samples analyzed for suspended and dissolved natural uranium, radium-226 and thorium-230.

Surface water sampling in Reg. Guide 4.14 also requires samples from each large onsite body of water or offsite impoundments that may be subject to direct surface drainage from potentially contaminated areas that could be affected by a tails impoundment failure. Grab samples are to be collected on a quarterly basis with samples analyzed for suspended and dissolved natural uranium, radium-226 and thorium-230. Semiannually, samples should be analyzed for suspended and dissolved lead-210 and polonium-210.

There is one unnamed drainage and Cherry Creek that pass through the project site. Bozle Creek does not pass through the project site, but does pass in close proximity to the eastern license boundary (**Figure 6.1-7**). These ephemeral drainages enter the White River, with the later being subject to sampling. Sampling for the White River and ephemeral drainages are discussed in Section 6.1.4.2.

There are no current onsite surface impoundments. Since there will be no tailing impoundments, sampling for the TCEA is conducted at offsite downgradient surface impoundments that may be subject to direct surface drainage from surface contaminated areas associated with the satellite facilities, evaporation ponds and other wellfield activities. Surface impoundments are discussed in Section 6.1.4.2.

Available historical flow and water quality data collected by state and federal agencies on the White River in the vicinity of the TCEA was summarized. These data are discussed in Section 6.1.4.1.

6.1.4.1 State and Federal Agency Monitoring Programs

Table 6.1-14 shows the mean monthly discharge of the White River as compared to the mean monthly precipitation over several years. These extended data show that a general correlation can be made between the direct precipitation and discharge. Higher flows are recorded in spring and early summer with lowest flow rates in late summer to early fall, reflecting seasonal changes related to precipitation.

Table 6.1-15 provides mean monthly discharge information for the White River at Crawford for 1999 through September, 2007 (NDNR 2010). The average flows from 1999 through 2006 (complete 12 months each of measurements) ranged from 16.7 to 21.9 ft^3/sec with an average of 20.3 ft^3/sec. These data for the White River at Crawford are comparable to the stream flow data shown in **Table 6.1-14** (average flow of 20.2 ft^3/sec).

6.1.4.2 NDEQ White River Ambient Stream Monitoring Program

The NDEQ has collected flow and water quality data for a number of years from the White River at the following NDEQ sampling stations: Ft. Robinson (SW1WHITE325), Crawford (WH1WHITE208) and Chadron (WH1WHITE105). Descriptions of these sampling points are shown in **Table 6.1-16**. With the exception of the Chadron sampling station, sampling locations in the Three Crow area (White River at Crawford and White River at Fort Robinson) are shown in **Figure 6.1-7**. The Chadron sampling station is located 2.5 miles east of the City of Chadron on Hwy 20, then 10 miles north/northeast on Slim Buttes Road to the White River. The sampling program is a component of the NDEQ statewide ambient streams monitoring program. Flow and water quality data for three sampling points in these areas were provided to CBR on January 09, 2010 (Lund J. 2010).

Field Measurements

Data was provided for the years 2001 through 2009 for field measurements, including flow data. Field measurements (temperature, dissolved oxygen, pH, conductivity, and field turbidity) were collected using a Hydro-Lab Quanta with Turbidity & Eureka Multi-Parameter Meter. Lab turbidity measurements were made with a Hach turbidity meter.

Table 6.1-17 provides the annual summaries for the flow measurements at the three sampling stations. Detailed measurements are shown in **Appendix I**. Flow measurements for the White River at Crawford (20.6 ft3/sec) are similar to the measurements reported by the NDNR and USGS above. Average flows at the White River at Crawford were consistently higher than the White River at Chadron for the years 2003 through 2009. This can be associated with evaporation and water consumption for local use in this stretch of the river.

The results of additional field measurements (water temperature, dissolved oxygen, pH, conductivity and turbidity) are present in **Table 6.1-18**. In general, as the White River flows downstream, it becomes cooler, dissolved oxygen concentrations and pH decrease, and conductivity and turbidity increase. Likewise, dissolved oxygen may decrease due to increased amounts of nutrients and organic matter downstream and thus, increased biological activity, or as a result of decreased flow rates and relative water stagnation.

Laboratory Analyses

Water quality samples were collected at the locations listed in **Table 6.1-16.** The results of the laboratory nonradiological water quality analyses are presented in **Tables 6.1-19, 6.1-20** and **6.1-21.** More detailed results are shown in **Appendix I**.

Data presented for most analytes in these tables demonstrate strong increasing concentration trends from upstream to downstream, including calcium, chloride, magnesium, total suspended solids (TSS), sodium, total Kjeldahl nitrogen (TKN), and phosphorous. Although TKN increases downstream, concentrations of nitrate (nitrite + nitrate as nitrogen) tend to decrease downstream for unknown reasons. Ammonia concentrations do not show any notable year-to-year trends.

Downstream increases of TSS and ionic (calcium, chloride, magnesium, and sodium) concentrations are likely sources of the above-noted turbidity and conductivity trends, respectively. These trends are likely associated with increased amounts of agricultural runoff between the Cities of Crawford and Chadron.

6.1.4.3 Crow Butte White River, Tributary and Surface Impoundment Sampling Program

The baseline surface water monitoring planned requires water samples for water quality analyses from the White River and associated tributaries and surface impoundments in the area of the TCEA, including Cherry Creek, Bozle Creek, an unnamed drainage, Sulzbach Pond, Cherry Creek Pond, Ice House Pond and Grabel Ponds. However, Cherry Creek, Bozle Creek, and other drainages in the area of the TCEA are designated as ephemeral with intermittent flow. During the baseline sampling program, there has not been a sufficient amount of flow to allow for the collection of water samples. Therefore, water samples were only collected from the surface impoundments and the White River. In lieu of water samples for these ephemeral drainages, sediment samples were collected (see Section 6.1.7).

Sampling location numbers assigned to all of the creeks and ponds except for the Grabel Ponds include the Bozle Creek (B-1), Cherry Creek (C-1), Sulzbach Pond (I-9), and Ice House Pond (I-10) and Cherry Creek Pond (I-11). Sampling locations are shown in **Figure 6.1-7.** Monthly samples are currently being collected at two points on the White River (upstream and downstream of the TCEA).

Water samples have been collected from Cherry Creek, Bozle Creek, Sulzbach Pond, Cherry Creek Pond, Ice House Pond and Grabel Pond. Monthly samples are currently being collected at two points on the White River (upstream and downstream of the TCEA). Sampling location numbers assigned to all of the creeks and ponds except for the Grabel Ponds include the Bozle Creek (B-1), Cherry Creek (C-1), Sulzbach Pond (I-9), Ice House Pond (I-10), Cherry Creek Pond (I-11) and White River (w-4 and W-5). Sampling locations are shown in **Figure 6-1-7.**

CBR did not perform flow measurements on the White River, opting to use historical USGS and NDEQ flow data discussed above. No flow measurements were attempted on Cherry Creek, Dead Man's Creek, Bozle Creek or unnamed drainages in the TCEA area due to the seasonal nature of flows in these features.

The analytical results for radiological and nonradiological parameters for the Ice House Pond, Cherry Creek Pond, Grabel ponds and Sulzbach Pond are presented in **Tables 6.1-22** and **6.1-23**, respectively.

<u>Radiological Analyses</u>

The radiological laboratory analytical results for the Ice House Pond, Grabel Ponds, Cherry Creek Pond and the Sulzbach Pond are presented in **Table 6.1-22.** Water samples were collected the second through the fourth quarters of 2007, first through the fourth quarter of 2008 and first quarter of 2009. Radiological analytical results are for the dissolved fractions of lead-210, polonium-210, radium-226, and thorium-220 as activity (pCi/l). Uranium was analyzed as mass (mg/l).

The radiological analytical results were at levels that would be expected for background concentrations of the area. Uranium levels varied from 0.0029 to 0.0185 mg/l, radium--226 levels were primarily below the reporting limit with three samples of 0.2, 0.2 and 0.3 pCi/l in the second quarter of 2008. lead-210 and thorium-230 levels were below the reporting limit for each analysis, Po-210 results varied from below the reporting limit to a maximum of 0.8 pCi/l.

Nonradiological Analyses

The nonradiological analytical results presented in **Table 6.1-23** were for quarterly samples collected in the third quarter of 207 and quarters 2, 3 and 4 for 2008. Overall, the concentrations of the measured parameters were similar over the sampling period with some isolated variations. One noted exception was for the third quarter of 2007 when a number of parameters for the Cherry Creek Pond were substantially higher than for the other ponds, e.g., alkalinity, bicarbonate as HCO_3, ammonia nitrogen as N, sodium, conductivity, total dissolved solids, iron, and manganese.

The continuance of the preoperational baseline monitoring plan for surface water will include quarterly sampling of Cherry Creek Pond, Ice House Pond, Sulzbach Pond and Grabel Pond(s), which will be analyzed quarterly for suspended and dissolved natural uranium, radium-226 and thorium-230. Semiannually, samples will be analyzed for suspended and dissolved lead-210 and polonium-210. For the White River (sample points W-4 and W-5) and the ephemeral streams if sufficient flow is available (i.e., Cherry Creek, Bozle Creek and unnamed drainage), sampling will occur monthly. The samples will be analyzed for suspended and dissolved natural uranium, radium-226 and thorium-230. Semiannually, samples will be analyzed for suspended and dissolved lead-210 and polonium-210.

6.1.4.4 Quality of Surface Water Measurements

The accuracy of monitoring data is critical to ensure that the water monitoring program precisely reflects water quality.

In addition to recommending the use of approved analytical methods for water quality measurements (contained in 40 CFR 136), the NRC also specifies analytical quality requirements in Reg. Guide 4.14 for the following lower limits of detection (LLD) in water:

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	2×10^{-10}	2×10^{-10}
Thorium-230	2×10^{-10}	2×10^{-10}
Radium-226	2×10^{-10}	2×10^{-10}
Polonium-210	1×10^{-9}	1×10^{-9}
Lead-210	1×10^{-9}	1×10^{-9}

6.1.5 Baseline Vegetation, Food and Fish Monitoring

6.1.5.1 Vegetation

Reg. Guide 4.14 recommends sampling of grazing areas near the site in different sectors that will have the highest predicted air particulate concentrations during the milling operations. CBR selected three vegetation sampling locations located on the northern site boundary. These sampling sites were selected due to being located downwind of the satellite facility in the three predominant wind direction sectors (winds predominantly from south-southwest direction. The site boundary adjoins the Ft. Robinson State Park, so sampling was restricted to the area near the permit boundary.

CBR conducted vegetation sampling at three locations along the northern boundary of the TCEA in 2009. These composite vegetation samples were obtained three times during the grazing season and analyzed for natural uranium, thorium-230, radium-226, lead-210, and polonium-210.The sample locations were based on being downwind of the three predominant wind roses at the site boundary (**Figure 6.1-2**). The results of analyses for 2009 are presented in **Table 6.1-24.** The vegetation samples were composite samples of the vegetation present in proportion to occurrence. Concentrations for natural uranium ranged from 1.10 E^{-5} to 4.8 E^{-6} µCi/kg. Concentrations for radium-226 ranged from 8.4 E^{-6} to 2.2 E^{-5} µCi/kg. Concentrations for thorium-230 ranged from <2.7 E^{-6} to 3.6 E^{-5} µCi/kg. Concentrations for lead-210 ranged from 3.1 E^{-4} to 7.0 E^{-4} µCi/kg. Concentrations for polonium-210 ranged from 5.6 E^{-6} to 7.5 E^{-5} µCi/kg. In 2007. These results are similar to historical baseline vegetation monitoring performed in the current CBR project area.

As part of the continuing preoperational radiological monitoring program, additional vegetation samples will be collected during the grazing season at the designated sampling locations (**Figure 6.1-8**). A minimum of three samples will be collected three times during the grazing season. These samples will be analyzed for the concentrations of natural uranium, thorium-230, radium-226, lead-210 and polonium-210.

Grass samples will be collected in accordance with the SHEQMS Volume VI Environmental Manual (CBR 2010).

<u>Quality of Vegetation Measurements</u>

The accuracy of monitoring data is critical to ensure that the vegetation monitoring program precisely reflects radionuclide concentrations. Reg. Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/kg (wet)	Actual LLD µCi/kg (wet)
Natural Uranium	2×10^{-7}	6.9×10^{-8}
Thorium-230	2×10^{-7}	6.9×10^{-8}
Radium-226	5×10^{-8}	6.9×10^{-8}
Polonium-210	1×10^{-6}	3.5×10^{-7}
Lead-210	1×10^{-6}	3.5×10^{-7}

Note that all recommended LLDs were met with the exception of radium-226. The actual LLD of 6.9×10^{-8} was slightly above the recommended LLD of 5×10^{-8}. The recommended LLD was not met due to inadequate sample size. However, all measured radium-226 values were well above the recommended LLD and the error estimate was at or near the 10% of the reported value recommended by NRC.

6.1.6 Food

6.1.6.1 Crops

Reg. Guide 4.14 recommends that crops, livestock, etc. raised within three kilometers (km) (~1.86 miles) of the mill site be sampled at the time of harvest or slaughter. The NRC has indicated that other food sources should be explored for sampling, such as private gardens in the area (e.g., sampling a variety of available garden plants). Grab samples should be analyzed for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. Livestock should include a variety of animals present in the area, including cattle, sheep, pigs, fowl, etc.

The preoperational baseline plan will provide for a survey of a three km area around the centerpoint of the satellite facility as to the availability of crops, livestock, fowl and other applicable sources for sampling. This would determine the types of crops grown in the area, number and types of livestock, availability of gardens, etc.

As shown on **Figure 6.1-8**, the land to the north of the TCEA is downwind of the predominant wind directions from the TCEA. This land is part of the Ft. Robinson State Park and is for recreation and grazing. There are no croplands within three km of the TCEA to the north of the TCEA (downwind of predominant wind direction). As seen in **Figure 6.1-8**, crops do exist within the TCEA license boundary, but once construction commences, cultivation will cease. There are croplands just to the east, south and west of the license boundary. As part of the preoperational monitoring plan, CBR will survey these available croplands and seek landowner approval to sample crops during the harvest periods. At the current time, wheat seems to be the main crop being grown in the area of the TCEA.

A survey within the three km radius of the satellite facility will also be made for the presence of private gardens, with the priority on locating such gardens downwind from the TCEA in the predominant wind direction. CBR will seek approval from the garden owner to be able to collect samples from at least three garden items being grown. Sampling of available gardens would involve sampling of leafy tissues and fruits, etc.

Vegetation samples will be collected in accordance with the SHEQMS Volume VI Environmental Manual (CBR 2010).

6.1.6.2 Livestock

At the current time; the only livestock known to be raised within three km radius of the satellite facility are cattle and bison. CBR will survey the area for the presence of these and other livestock, and when found, will seek approval from the owner(s) to collect samples at the time of slaughter. Efforts will be made to collect samples prior to start of construction to be able to compare to samples collected during operations.

Sampling of livestock would involve sampling and analysis of tissues such as bone, muscle, liver and kidney for each species (e.g., cattle and bison). Sampling targets would be identified and an agreement made with the owner as to a sampling program acceptable to both parties.

Samples for crops and livestock will be obtained at the time of harvest or slaughter. Samples would be analyzed for natural uranium, radium-226, thorium-230, lead-210, and polonium-210.

6.1.6.3 Fish

Reg. Guide 4.14 requires that fish be collected, if available, from lakes, streams in the project site area that may be subject to seepage or direct surface runoff from potentially contaminated areas or that could be affected by a tailings impoundment failure. Fish should be collected and sampled and analyzed semiannually for natural uranium, radium-226, thorium-230, lead-210 and polonium-210.

The CBR preoperational monitor plan will provide for collection of fish samples from the White River (at or near sample points W-4 and W-5), Ice House Pond (I-10) and Cherry Creek Pond (I-11) (**Figure 6.1-7**). It is highly unlikely the ephemeral streams (i.e., Cherry Creek, unnamed drainage, and Bozle Creek) will have ever sufficient flow to sustain fish populations. Therefore sampling is not planned for these drainages.

If feasible, two target species will be collected at each collection point, one being a predator species and the other either a forage or bottom-feeder species. This of course will depend on the success of the collection efforts. Specimens from different families may include Catostomidae (suckers), Centrarchidae (sunfish, bass and crappie), Cyprinidae (minnows, shiners, chubs and daces) and Salmonidae (rainbow, brown and brook trout).

Where feasible (e.g., fish size and tissue quantity), separate tissues will be collected from specimens for radionuclide analysis. Tissues will consist of bone, liver and muscle. The levels of uranium-series radionuclides in fish tissue are generally highest in bone, followed by skin, liver, gonad and muscle (Swanson, S.M. 1985, Elsenbud, M. 1987). For smaller fish, such as minnows, whole body radionuclide analysis will be conducted. Radionuclide uptake has been reported to not vary with fish age, size or sex (Swanson, S.M. 1985). Analyses will be performed for natural uranium, radium-226, thorium-230, lead-210 and polonium-210.

Any sampling method used will be consistent with procedures of the U.S. Geological Survey (USGS 1993). Seining will be the preferred option.

6.1.7 Baseline Soil Monitoring

Reg. Guide 4.14 recommends soil samples be collected as follows:

- Up to 40 samples surface soil samples would be collected at 300-meter intervals to a distance of 1500 meters in each of eight directions from the center of the milling area. Surface soil samples would be collected to a depth of 5 cm using consistent sampling methods. Sampling would be conducted once prior to construction and repeated for locations disturbed by excavation, leveling or contouring. All samples would be analyzed for Ra-226, and 10% of the samples analyzed for natural uranium, thorium-230 and lead-210.
- Five or more surface soil samples (to a depth of 5 cm) would be collected at the same locations used for air particulate samples. Samples would be collected once prior to construction. Samples would be analyzed for natural uranium, radium-226, thorium-230 and lead-210.
- Five subsurface samples collected at the center point location and ar distances of 750 meters in each of four directions. Subsurface soil samples would be collected to a depth of one meter and divided into three equal sections for analysis. Samples would be collected once prior to construction and repeated for locations disturbed by construction. All samples would be analyzed for Ra-226 and one set of the samples analyzed for natural uranium, thorium-230, and lead-210.

In 2008, CBR collected surface soil samples once from designated sampling locations and analyzed for natural uranium, radium-226, lead-210, and thorium-230. Soil samples were collected from the top 5 centimeters of soil. Samples were collected at sampling points AM-15, AM-16, AM-17, AM-18, AM-19, AM-20 and AM-21 (**Figure 6.1-2**).

Vegetative roots, rocks and other debris were removed from the soil samples. The samples were sent to Energy Laboratories in Casper, Wyoming for analysis. The results of analysis of the soil samples are presented in **Table 6.1-25**. Radium-226 soil concentrations ranged from 0.5 to 0.7 pCi/g, natural uranium soil concentrations ranged from 0.4 to 0.6 pCi/g, lead-210 soil concentrations ranged from 0.3 to 0.6 pCi/g and thorium-230 soil concentrations ranged from 0.2 to 0.4 pCi/g.

As part of the preoperational radiological monitoring program, additional surface soil samples will also be collected at the five air monitoring locations.

In addition, to the extent feasible, soil samples will be collected at 300 meter intervals to a distance of 1500 meters in each of 8 directions from the centerpoint of the satellite facility. The location of the satellite facility and size and shape of the license boundary requires a modification to Reg. Guide 4.14 as for sampling points. In addition to the sampling points based on the centerpoint of the satellite facility, additional transects will be made across the TCEA area to collect samples in areas of proposed wellfields (**Figure 6.1-9**). Sampling distances for some sampling points on transects from centerpoint of satellite facility were modified to obtain a more representative sampling of the project area, e.g., proposed wellfield locations.

Surface soil samples to a depth of 5 cm will be collected at 300-meter intervals to a distance of 1500 meters (where feasible) along established transects. Any areas disturbed by excavation, leveling or contouring would be resampled. All surface samples (5 cm) will be analyzed for radium-226 and 10% of the samples for natural uranium, thorium-230, and lead-210. Surface soils samples at each air monitoring station will be analyzed for natural uranium, radium-226, thorium-230 and lead-210. All surface soil sampling will occur once prior to construction and repeated for any locations disturbed by excavation, leveling or contouring. For subsurface samples, once prior to construction and repeated for any locations disturbed by construction.

Subsurface samples will be collected at the satellite facility center reference location and at a distance of 750 meters (alternate distances in some cases as explained above) in each of 8 directions, as shown in **Figure 6.1-9**. Samples were collected in 8 directions as opposed to 4 to accommodate the shape and size of the license boundary to collect representative samples. Additional subsurface samples will be collected along the additional transects discussed above. Any areas disturbed by construction will be resampled. Subsurface soil profile samples would be collected to a depth of one meter. Samples would be divided into three equal sections for analysis. All subsurface samples would be analyzed for Ra-226 and ones set of samples for Natural Uranium, Th-230, and Pb-210.

Soil samples will be collected in accordance with the SHEQMS Volume VI Environmental Manual (CBR 2010).

6.1.7.1 Quality of Soil Measurements

The accuracy of monitoring data is critical to ensure that the soil monitoring program precisely reflects radionuclide concentrations. Reg. Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/g	Actual LLD µCi/g
Natural Uranium	2×10^{-7}	2×10^{-8}
Radium-226	2×10^{-7}	2×10^{-8}
Thorium-230	2×10^{-7}	2×10^{-8}
Pb-210 (dry)	2×10^{-7}	2×10^{-8}

6.1.8 Baseline Sediment Sampling

Sediments of lakes, reservoirs, and flowing bodies of surface water may become contaminated as a result of direct liquid discharges, wet surface deposition, or from runoffs associated with contaminated soils. Because of various chemically and physically binding interactions with radionuclides, sediments serve as integrating media that are important to environmental monitoring.

Reg. Guide 4.14 recommends that sediment samples be collected from sediments of surface water passing through the project site or offsite surface waters that may be subject to drainage from potentially contaminated areas or that could be affected by evaporation pond failure. Samples are to be collected once following spring runoff and late summer following a period of extended low flow. Samples are to be analyzed for natural uranium, radium-226, thorium-230, and lead-210.There were one unnamed drainage and Cherry Creek that flow though the project site. Bozle Creek does not flow through the project site, but does flow in close proximity to the eastern license boundary (**Figure 6.1-7**). These ephemeral drainages flow into the White River, with the later being subject to sampling. Sampling for the White River and ephemeral drainages are discussed in Section 6.1.4.2.

Sediment sampling in Reg. Guide 4.14 also requires samples from each large onsite body of water or offsite impoundments that may be subject to direct surface drainage from potentially contaminated areas that could be affected by a tailings impoundment failure. One sample is to be collected prior to construction and analyzed for natural uranium, radium-226, thorium-230 and lead-210. There are no onsite surface impoundments. Since there is no tailings impoundment, sampling was conducted on offsite downgradient surface impoundments that may be subject to direct surface drainage from surface contaminated areas associated with the satellite facilities, evaporation ponds and other wellfield activities. Surface impoundments are discussed in section 6.1.4.2.

Sediments in Cherry Creek Pond, Ice House Pond, Grabel Ponds and Sulzbach Pond have been sampled twice as part of the preoperational monitoring program. Sampling was done in the fourth and third quarters of 2007 and 2008, respectively. Samples were analyzed for dissolved lead-210, radium-226, polonium-210, thorium-230 and natural uranium. The analytical results are shown in **Table 6.1-26** and sampling locations in **Figure 6.1-7.** Radium-226 sediment concentrations ranged from 0.2 – 1.0 pCi/g, lead-210 from 0.6 – 4.1 pCi/g, polonium-210 0.6 to 1.3 pci/g, thorium-230 <0.09 – 0.7 pCi/g and natural uranium 1.4 – 22 pCi/g. Thorium-230 was not analyzed for in the 12/19/2007 sampling event.

The preoperational monitoring program will be expanded to include additional sampling and analysis for Cherry Creek Pond, Ice House Pond, Grabel Ponds and the Sulzbach Pond. These ponds will be sampled once prior to construction and analyzed for natural uranium, radium-226, thorium-230, and lead-210.

In, addition, an unnamed drainage and Cherry Creek will be sampled up and downstream of the drainages passing through the site. Bozle Creek does not flow through the project site, but the drainage is in close proximity to the license boundary so that it may be subject to direct runoff from potentially contaminated areas (i.e., wellfields). Bozle Creek will be sampled at a point upstream of the southern license boundary and downstream of the northern license boundary. The White River will be sampled at upstream and downstream locations (sample points W-4 and W-5) (**Figure 6.1-7**), so that the ephemeral streams crossing or in close proximity to the TCEA will flow into the river between these sampling points.

These drainages and the White River will be sampled twice, once following spring runoff and late summer following period of extended low flow. Samples will be analyzed for natural uranium, radium-226, thorium-230, and lead-210.

Sediment samples will be collected in accordance with the SHEQMS Volume VI Environmental Manual (CBR 2010).

6.1.8.1 Quality of Sediment Measurements

The accuracy of monitoring data is critical to ensure that the sediment monitoring program precisely reflects radionuclide concentrations. Reg. Guide 4.14 specifies the following lower limits of detection (LLD):

Radionuclide	Recommended LLD µCi/g	Actual LLD µCi/g
Natural Uranium	2 x 10^{-7}	2 x 10^{-8} (1996 samples) 1 x 10^{-8} (2004 samples) 2 x 10^{-7} (2006 samples)
Thorium-230	2 x 10^{-7}	2 x 10^{-8}
Radium-226	2 x 10^{-7}	2 x 10^{-8} (1996 samples) 2 x 10^{-7} (2004 and 2006 samples)
Lead-210	2 x 10^{-7}	1 x 10^{-7} (1996 samples) 1 x 10^{-6} (2004 samples) 2 x 10^{-7} (2006 samples)

6.1.9 Baseline Direct Radiation Monitoring

Reg. Guide4.14 recommends direct radiation measurements be collected at 150-meter intervals to a distance in each of 8 directions from the centerpoint of the milling area or at a point equidistant from the milling area and tailings disposal area. Since there is no milling or tailings disposal area, CBR used the satellite facility as the centerpoint. Samples are to be collected once prior to construction and repeated for areas disturbed by site preparation or construction. Gamma exposure rate is to be derived, using passive integrating device such as a thermoluminescent detector (TLD), pressurized ionization chamber, or a properly calibrated portable survey instrument.

The preoperational baseline radiation monitoring program includes routine monitoring of direct radiation levels at the air monitoring stations.

Gamma measures were made in 2007 and 2008 using two different types of detectors: environmental thermoluminescence detector and environmental optically stimulated luminescence detector.

6.1.9.1 Environmental Thermoluminescence Detector (TLD)

Gamma readings were taken at specific sampling locations at TCEA (i.e., AM-15, AM-16, AM-17, AM-18, AM-19, AM-20, and AM-21). In addition, background samples were reported for the background sampling location point AM-26 used for the CPF site (SW quarter of SW quarter of Section 2 T31N R52 W). This monitor site is located at the southeast corner of the City of Crawford. Quarterly measurements were made from January 2007 to Januay 2008. The results are presented in **Table 6.1-27**.

The TLDs were placed at sample locations depicted in **Figure 6.1-2**. The average gamma exposure rates were relative constant, ranging from 3 to 10 mrem/qtr (**Table 6.1-27**). Monitoring was conducted by placing the TLDs provided by Thermo Nutech on a quarterly basis at the monitoring locations. Lithium fluoride chips were used and housed in rugged containers to provide protection from the weather. The containers or monitors were placed at the predetermined monitoring locations approximately one meter above ground level. They were exchanged with new monitors on a quarterly basis and the exposed monitors were returned to the vendor for processing. These devices provide an integrated exposure for the period between annealing and processing. The results were reported in mrem per week.

6.1.9.2 Environmental Optically Stimulated Luminescence Detector (OSLD)

In 2008, OSLDs were placed the sampling locations shown in **Figure 6.1-2** for gamma measurements. The OSLDs are the most advanced technology available for measuring radiation exposure, including being accurate within ± Mrem, while in contrast, TLD and film badges require 10 Mrem to begin reporting (Landauer 2010). These detectors, unlike TLD or film badges, provide accurate dose readings, even when exposed to extreme temperatures, moisture, or when tampered with or dropped. The vendor no longer supplies TLDs, replacing these with the OSLDs. Therefore, OSLDs will be used for future gamma exposure measurements requiring continuous integrating devices.

The OSLDs were used for gamma measurements from January 2008 to July 2008 to compare to TLD measurements at the same locations in 2007. Monitoring was conducted by placing the OSLDs provided by Landauer on a quarterly basis at the monitoring locations. The monitors were placed at the predetermined monitoring locations approximately one meter above ground level. They were exchanged with new monitors on a quarterly basis and the exposed monitors were returned to the vendor for processing. These devices provide an integrated exposure for the period between annealing and processing.

The results are shown in **Table 6.1-27**. Gamma exposure rates ranged from 2.7 to 13.4 mrem/qtr. These measurements were consistent with the TLD background measurements of 3 to 10 mrem/qtr in 2007 and 2008. The average background gamma level in the Western Great Plains have been reported to be 0.014 mR/hr (NRC 1979), which corresponds well to the results obtained with the TLD and OSLD gamma monitors

Additional preoperational monitoring will be carried out and include the following:

1. Gamma readings will be made at 150 meter intervals in each of 8 directions from the center of the satellite facility and along additional established transects as discussed in Section 6.1.2 (air particulate monitoring). Sampling locations are shown in **Figure 6.1-9**. The gamma exposure rate will be determined using a properly calibrated portable survey instrument.
2. OSLDs will be placed at each of the air monitoring stations, with quarterly changes. Sample locations are shown in **Figure 6.1-9**.

The preoperational direct gamma radiation program was designed to meet the guidance provided in Reg. Guide 4.14. NRC guidance recommends a combination of direct gamma radiation measurements and exposure measurements made with integrating devices (i.e., thermoluminescent detectors or TLDs) during preoperational monitoring. Direct measurements are made in areas where process facilities will be located during site characterization.

In addition to the environmental gamma monitors, NRC recommends that the background gamma radiation in the area of the facility be measured with a scintillometer. As per Reg. Guide 4.14, CBR will perform preoperational gamma radiation measurements at 150-meter intervals as discussed above (**Figure 6.1-9**). Note that some alternate sampling locations will be utilized as discussed in Section 6.1.6. These measurements will be made once prior to construction, and repeated for area disturbed by site preparation or construction. The type of survey instrument and procedures would be as described below for measurements previously conducted at the proposed satellite facility.

6.1.10 Preoperational Baseline Monitoring Program Summary

The TCEA preoperational baseline monitoring program discussed in this section is summarized in **Table 6.1-28**.

6.2 Physiochemical Monitoring

The groundwater excursion monitoring program is designed to detect excursions of lixiviant into the ore zone aquifer outside of the wellfield being leached and into the overlying or adjacent water bearing strata. The Pierre Shale below the ore zone is over 1200 feet thick and contains no water bearing strata. Therefore, it is not necessary to monitor any water bearing strata below the ore zone.

6.2.1 Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed no further than 300 feet from the wellfield boundary and no further than 400 feet apart. After completion, wells are 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 are sampled to obtain baseline water quality. For baseline sampling, wells are purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying monitor wells are sampled three times at least fourteen (14) days apart. Samples are analyzed for chloride, conductivity, and total alkalinity as specified in License Condition 10.4. Results from the samples are averaged arithmetically to obtain an average baseline value as well as a maximum value for determination of upper control limits for excursion detection. Well development and sampling activities are performed in accordance with the instructions contained in the SHEQMS Program Volume VI, *Environmental Manual.*

6.2.2 Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which would be indicative of a migration of lixiviant from the wellfield. The constituents chosen for 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 IX process (uranium is exchanged for chloride on the IX resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits are set at 20% 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 consists of sampling the monitor wells on a biweekly basis and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. License

SUA-1534 Condition 11.2 currently requires that monitor wells be sampled no more than 14 days apart except in the event of certain situations. These situations include inclement weather, mechanical failure, holiday scheduling, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment. In these situations, CBR documents the cause and the duration of any delays. In no event is sampling delayed for more than five days.

Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, or if one UCL value is exceeded by 20 percent, the well is resampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the NRC Project Manager is notified by telephone or email within 48 hours and notified in writing within thirty (30) days.

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.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status is increased to weekly. An excursion is considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive one-week samples.

Evaporation Pond Leak Detection System

The evaporation pond will be lined and equipped with a leak detection system. During operations, the leak detection standpipes will be checked for evidence of leakage. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard will also be performed during normal operations. The current CBR Pond Inspection Program will be adapted for the North Trend Satellite Facility and will meet the guidance contained in Reg. Guide 3.11 and Reg. Guide 3.11.1.

A minimum freeboard of 5 feet is allowed for the current commercial ponds during normal operations. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, it will be analyzed for specific conductivity. Should the analyses indicate that the liner is leaking (by comparison to chemical analyses of pond water), the following actions will be taken:

- The NRC will be notified by telephone or email within 48 hours of leak verification;
- The level of the leaking pond will be lowered by transferring its contents into an adjacent pond. While lowering the water level in the pond, inspections of the liner will be made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid;
- Once the source of the leakage is found, the liner will be repaired and water will be reintroduced to the pond; and,
- A written report will be submitted to the NRC within 30 days of leak verification. The report will include analytical data and describe the cause of the leakage, corrective actions taken and the results of those actions.

6.3 Ecological Monitoring

CBR does not perform any ecological monitoring at the current licensed operation. CBR will follow a swift fox survey protocol during drilling of boreholes and "project development" activities at the TCEA. The swift fox is listed as endangered under the Nebraska Nongame and Endangered Species Conservation Act.

Satellite "project development" activities include construction of satellite facilities (process building and associated storage structures, evaporation ponds, wellfield development (surface preparation, monitor and injection/recovery wells, wellhouses, and trunklines/piping), well workover, boreholes outside of wellfields, and project roadways. Project development activities apply to initial construction/wellfield development, operations and decommissioning. Decommissioning includes decontaminating, dismantling, and removing satellite facilities and associated wellfield buildings/equipment/wells and, site reclamation and groundwater restoration. The swift fox protocol is presented in **Appendix K**.

Table 6.1-1 Airborne Particulate Concentrations for Three Crow Expansion Area

Location	Radionuclide	Date	Concentration uCi/ml	Error Estimate uCi/ml	LLD uCi/ml
First Quarter 2007					
AM-6 (Background)	Uranium	01/0207 – 04/02/07	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.22 E^{-14}	7.60 E^{-16}	2.00 E^{-15}
AM-15	Uranium	01/10/07 – 04/10/07	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.04 E^{-14}	6.99 E^{-16}	2.00 E^{-15}
Second Quarter 2007					
AM-6 (Background)	Uranium	04/02/07 – 07/02/07	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		8.29 E^{-15}	1.19 E^{-15}	2.00 E^{-15}
AM-15	Uranium	04/10/07 – 07/12/07	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		2.47 E^{-14}	2.56 E^{-15}	2.00 E^{-15}
Third Quarter 2007					
AM-6 (Background)	Uranium	07/02/07 – 10/01/07	<1.54 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.70 E^{-14}	1.18 E^{-15}	2.00 E^{-15}
AM-15	Uranium	07/12/07 – 10/01/07	1.08 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		1.71 E^{-14}	1.15 E^{-15}	2.00 E^{-15}
Fourth Quarter 2007					
AM-6 (Background)	Uranium	10/01/07 – 01/02/07	8.01 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		3.02 E^{-16}	2.31 E^{-16}	1.00 E^{-16}
	Lead 210		7.60 E^{-15}	9.61 E^{-16}	2.00 E^{-15}
AM-15	Uranium	10/01/07 – 01/11/08	<1.00 E^{-16}	N/A	1.00 E^{-16}
	Radium 226		<1.00 E^{-16}	N/A	1.00 E^{-16}
	Lead 210		3.71 E^{-14}	2.49 E^{-15}	2.00 E^{-15}

Table 6.1-2 Ambient Atmospheric Radon-222 Concentration for Three Crow Expansion Area

Location	Date	Gross Count	Average Radon Concentration (uCi/ml x 10^{-9})	Accuracy (x 10^{-9} uCi/ml)	Percent Effluent Concentration
AM-6 (Control)	1/10/2007 – 7/12/2007	71.3	0.4	0.05	4.0%
AM-15	1/10/2007 – 7/12/2007	82.4	0.5	0.06	5.0%
AM-16	1/10/2007 – 7/12/2007	66.6	0.4	0.05	4.0%
AM-17	1/10/2007 – 7/12/2007	77.5	0.4	0.05	4.0%
AM-18	1/10/2007 – 7/12/2007	152.0	0.8	0.06	8.0%
AM-19	1/10/2007 – 7/12/2007	Bad Detector			
AM-20	1/10/2007 – 7/12/2007	Bad Detector			
AM-21	1/10/2007 – 7/12/2007	59.7	0.3	0.04	3.0%
AM-6 (Control)	7/12/2007 – 1/11/2008	72.4	0.4	0.05	4.0%
AM-15	7/12/2007 – 1/11/2008	Detector fell out of cup – frozen in snow bank			
AM-16	7/12/2007 – 1/11/2008	83.5	0.5	0.05	5.0%
AM-17	7/12/2007 – 1/11/2008	127.2	0.7	0.06	7.0%
AM-18	7/12/2007 – 1/11/2008	134.1	0.7	0.06	7.0%
AM-19	7/12/2007 – 1/11/2008	126.4	0.7	0.06	7.0%
AM-20	7/12/2007 – 1/11/2008	165.0	0.9	0.07	9.0%
AM-21	7/12/2007 – 1/11/2008	91.4	0.5	0.05	5.0%

LLD (x 10^{-9} uCi/ml)

Effluent Concentration Limit, 10 CFR 20 Appendix B, Table 2, Column 1

Table 6.1-3 Summary of Three Crow Expansion Area Dissolved Radiological Analyses for Private Water Supply Wells in TCEA and AOR 2007 - 2009

Radiological Parameter	At or Less than Reporting Limit (RL) (<)				Greater than Reporting Limit (RL) (>)			
	Number [a]	Average	Minimum	Maximum	Number [a]	Average	Minimum	Maximum
		pCi/l Unless Noted Otherwise				pCi/l Unless Noted Otherwise		
DISSOLVED								
Lead – 210	50	6.11	1.0	29.3	1	1.1	1.1	1.1
Polonium - 210	53	0.61	0.1	1.0	11	2.35	0.4	3.6
Thorium – 230	46	0.154	0.06	0.21	5	0.2	0.1	0.3
Radium – 226	53	0.198	0.08	0.3	7	0.21	0.006	0.5
Uranium (mg/l)	--	--	--	--	58	0.0162	0.0078	0.0339

Note:
See **Table 6.1-5** for individual well analytical results.
Private Water Supply Wells Sampled: W-269, W-270. W-272, W-273, W-274, W-275, W-277, W-312, and W-314.
a Number of individual samples collected at each well from 2007 to 2009.

Table 6.1-4 Summary of Groundwater Quality for Three Crow Vicinity

Constituent	Private Wells in AOR[a] Brule Formation		Three Crow Expansion Area Wells[b] Brule Formation		Three Crow Expansion Area Wells[c] Basal Chadron Formation	
	Range	Mean	Range	Mean	Range	Mean
	mg/l (unless stated otherwise)					
Calcium	7 – 99	54	14 -101	50.25	8 - 24	13.0
Magnesium	1 – 9	4.2	1 - 14	4.96	2 - 7	3.7
Sodium	16 - 75	28.6	14 - 83	35	333 - 474	399
Potassium	6 - 20	11.7	6 - 12	9.1	6 - 9	9.6
Bicarbonate	170 - 313	227	194 - 478	246	353 - 418	396
Sulfate	4 - 75	19	9 -25	16.4	225 - 361	271.4
Chloride	1 - 42	10	4 - 23	8.54	166 - 274	186
Specific Conductance (µmhos/cm)	246 - 633	436	239 – 735	410	1690 - 2190	1867
Total Dissolved Solids (TDS)	215 - 448	313	221 - 499	302	980 - 1300	1098
pH (Std. units)	7.38 – 8.4	7.82	7.49 – 8.74	7.98	7.82 – 8.75	8.23
Anions (meq/l)	3.0 – 6.24	4.75	3.67 – 8.78	4.78	16.3 – 20.6	17.7
Cations (meq/l)	3.37 – 6.46	5.07	3.43 – 8.06	4.68	16 – 21.8	18.6
Uranium (mg/l)	0.008 – 0.0272	0.0161	0.0032– 0.0264	0.0134	0.0004 – 0.0385	0.0087
Dissolved Ra-226[d] (pCi/l)	0.006 – 0.5	0.28	0.065 – 0.41	0.126	0.23 - 181	18.1
Suspended Ra-226[d] (pCi/l)	--	--	0.04 – 0.20	0.087	--	--

[a] private water supply wells (2007 – 2009)
[b] CBR TCEA Brule monitor wells (includes Well 274 [Miller Well[) (2008 – 2009) [Note Suspended Ra-226 analyses were for 3 sampling events in 2009 for wells BOW 2006-5, BOW 2006-6 and BOW 2006-7]
[c] 10 CBR TCEA Basal Chadron monitor wells (2008 – 2009)
[d] Values less than detection limits reduced by one-half to provide a conservative estimate.
mg/l = milligrams/liter
meq/l = milliequivalents per liter
pCi/l = picocuries per liter
µmhos/cm = micromhos per centimeter

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Table 6.1-5 Three Crow Expansion Area and Area of Review Private Well Dissolved Radiological Analytical Results 2007 - 2009

MAJOR IONS	UNITS	W-269		W-269		W-269		W-270		W-270		W-270		W-272		W-272		W-272	
		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Lead 210	pCi/L	<1.0	1.0	--	--	<1.0	1.0	<1.0	1.0	--	--	<1.0	1.0	<1.0	1.0	--	--	<1.0	1.0
Lead 210 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead 210 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polonium 210	pCi/L	<1.0	1.0	--	--	<1.0	1.0	<1.0	1.0	--	--	3.4	1.0	<1.0	1.0	--	--	2.7	1.0
Polonium 210 Precision (±)	pCi/L	--	--	--	--	0.5	--	--	--	--	--	2.8	--	--	--	--	--	2.5	--
Polonium 210 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Radium 226	pCi/L	<0.2	0.2	<0.2	0.2	0.5	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
Radium 226 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Radium 226 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thorium 230	pCi/L	<0.2	0.2	--	--	<0.2	0.2	<0.2	0.2	--	--	<0.2	0.2	<0.2	0.2	--	--	<0.2	0.2
Thorium 230 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thorium MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.0 13	0.0003	0.0184	0.0003	0.0185	0.0003	0.027	0.0003	0.0272	0.0003	0.0236	0.0003	0.014	0.0003	0.0145	0.0003	0.0127	0.0003

MAJOR IONS	UNITS	W-273		W-273		W-273		W-274		W-274		W-274		W-275		W-275		W-275	
		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007		Second Quarter 2007		Third Quarter 2007		Fourth Quarter 2007	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Lead 210	pCi/L	<1.0	1.0	--	--	Well Off		<1.0	1.0	--	--	<1.0	1.0	<1.0	1.0	--	--	<1.0	1.0
Lead 210 Precision (±)	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Lead 210 MDC	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Polonium 210	pCi/L	<1.0	1.0	--	--			<1.0	1.0	--	--	3.6	1.0	2.4	1.0	--	--	3.0	1.0
Polonium 210 Precision (±)	pCi/L	--	--	--	--			2.4	--	--	--	2.8	--	2.4	--	--	--	2.6	--
Polonium 210 MDC	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Radium 226	pCi/L	<0.2	0.2	<0.2	0.2			<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
Radium 226 Precision (±)	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Radium 226 MDC	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Thorium 230	pCi/L	<0.2	0.2	--	--			<0.2	0.2	--	--	<0.2	0.2	<0.2	0.2	--	--	<0.2	0.2
Thorium 230 Precision (±)	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Thorium MDC	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	pCi/L	--	--	--	--			--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.016	0.0003	0.0159	0.003			0.013	0.0003	0.0126	0.0003	0.0134	0.0003	0.0084	0.0003	0.0085	0.0003	0.0078	0.0003

Not detected at Reporting Limit.

Table 6.1-5 Three Crow Expansion Area and Area of Review Private Well Dissolved Radiological Analytical Results 2007 - 2009

MAJOR IONS	UNITS	W-277 Second Quarter 2007		W-277 Third Quarter 2007		W-277 Fourth Quarter 2007		W-313 Second Quarter 2007		W-313 Third Quarter 2007		W-313 Fourth Quarter 2007		W-313 Second Quarter 2007		W-314 Third Quarter 2007		W-314 Fourth Quarter 2007	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Lead 210	pCi/L	<1.0	1.0	--	--	<1/0	1.0	<1.0	1.0	--	--	<1.0	1.0	<1.0	1.0	--	--	<1.0	1.0
Lead 210 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead 210 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polonium 210	pCi/L	<1.0	1.0	--	--	3.4	1.0	<1.0	1.0	--	--	3.0	1.0	<1.0	1.0	--	--	2.3	1.0
Polonium 210 Precision (±)	pCi/L	--	--	--	--	2.6	--	--	--	--	--	2.3	--	--	--	--	--	2.1	--
Polonium 210 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Radium 226	pCi/L	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
Radium 226 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Radium 226 MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thorium 230	pCi/L	<0.2	0.2	--	--	<0.2	0.2	<0.2	0.2	--	--	<0.2	0.2	<0.2	0.2	--	--	<0.2	0.2
Thorium 230 Precision (±)	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thorium MDC	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.017	0.0003	0.0191	0.0003	0.018	0.0003	0.012	0.0003	0.0118	0.0003	0.0107	0.0003	0.023	0.0003	0.023	0.0003	0.0339	0.0003

MAJOR IONS	UNITS	W-269 Second Quarter 2008		W-269 Third Quarter 2008		W-269 Fourth Quarter 2008		W-269 First Quarter 2009		W-270 Second Quarter 2008		W-270 Third Quarter 2008		W-270 Fourth Quarter 2008		W-270 First Quarter 2009		W-272 Second Quarter 2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Lead 210	pCi/L	<9.4	9.4	<7.4	7.4	<10.8	10.8	<3.2	3.2	<9.4	9.4	<12.5	12.5	<5.4	5.4	<3.8	3.8	<9.4	9.4
Lead 210 Precision (±)	pCi/L	5.6	--	4.5	--	6.6	--	1.9	--	5.6	--	7.4	--	3.3	--	2.3	--	5.6	--
Lead 210 MDC	pCi/L	9.4	--	7.4	--	10.8	--	3.2	--	9.4	--	12.5	--	5.4	--	3.8	--	9.4	--
Polonium 210	pCi/L	<0.1	0.1	<0.6	0.6	<0.3	0.3	<0.5	0.5	<0.4	0.4	<0.9	0.09	<0.2	0.2	<0.5	0.5	<0.4	0.4
Polonium 210 Precision (±)	pCi/L	0.1	--	0.6	--	0.3	--	0.3	--	0.4	--	0.9	--	0.2	--	0.3	--	0.4	--
Polonium 210 MDC	pCi/L	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	0.5	--	--	--
Radium 226	pCi/L	<0.2	0.2	<0.3	0.3	<0.18	0.18	<0.08	0.08	<0.2	0.2	<0.26	0.26	<0.18	0.18	0.14	0.08	<0.2	0.2
Radium 226 Precision (±)	pCi/L	0.09	--	0.1	--	0.09	--	0.05	--	0.08	--	0.15	--	0.09	--	0.07	--	0.1	--
Radium 226 MDC	pCi/L	0.2	--	0.3	--	0.18	--	0.08	--	0.2	--	0.26	--	0.18	--	0.08	--	0.2	--
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.13	0.13	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1
Thorium 230 Precision (±)	pCi/L	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.2	--	0.04	--	0.1	--
Thorium MDC	pCi/L	--	--	--	--	--	--	0.2	--	--	--	--	--	--	--	0.1	--	--	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.0185	0.0003	0.0136	0.0003	0.0185	0.0003	0.0107	0.0003	0.0242	0.0003	0.0258	0.0003	0.0252	0.0003	0.0232	0.0003	0.0145	0.0003

Not detected at Reporting Limit.

Table 6.1-5 Three Crow Expansion Area and Area of Review Private Well Radiological Analytical Results 2007 – 2009

MAJOR IONS	UNITS	W-272 Third Quarter 2008 RESULTS	W-272 Third Quarter 2008 RL	W-272 Fourth Quarter 2008 RESULTS	W-272 Fourth Quarter 2008 RL	W-272 First Quarter 2009 RESULTS	W-272 First Quarter 2009 RL	W-273 Second Quarter 2008 RESULTS	W-273 Second Quarter 2008 RL	W-273 Third Quarter 2008 RESULTS	W-273 Third Quarter 2008 RL	W-273 Fourth Quarter 2008 RESULTS	W-273 Fourth Quarter 2008 RL	W-273 First Quarter 2009 RESULTS	W-273 First Quarter 2009 RL	W-274 Second Quarter 2008 RESULTS	W-274 Second Quarter 2008 RL
Lead 210	pCi/L	<12.5	12.5	<5.4	5.4	<5.5	5.5	<9.4	9.4	<7.4	7.4	Well Off		Well Off		1.1	NA
Lead 210 Precision (+)	pCi/L	7.4	--	3.3	--	3.3	--	ND*	--	4.5	--	No Data	No Data	No Data	No Data	3.5	--
Lead 210 MDC	pCi/L	12.5	--	5.4	--	5.5	--	5.9	--	7.4	--	No Data	No Data	No Data	No Data	5.9	--
Polonium 210	pCi/L	<0.4	0.4	<0.2	0.2	0.8	0.8	<1.0	1.0	<0.5	0.5	No Data	No Data	No Data	No Data	0.4	1.0
Polonium 210 Precision (+)	pCi/L	0.5	--	0.2	--	0.8	--	ND*	--	0.5	--	No Data	No Data	No Data	No Data	0.8	--
Polonium 210 MDC	pCi/L	--	--	--	--	0.8	--	--	--	--	--	No Data	No Data	No Data	No Data	--	--
Radium 226	pCi/L	<0.20	0.2	<0.18	0.18	0.36	0.08	0.006	NA	<0.30	0.30	No Data	No Data	No Data	No Data	0.1	NA
Radium 226 Precision (+)	pCi/L	0.15	--	0.13	--	0.15	--	0.1	--	0.1	--	No Data	No Data	No Data	No Data	0.1	--
Radium 226 MDC	pCi/L	0.23	--	0.18	--	0.18	--	0.2	--	0.3	--	No Data	No Data	No Data	No Data	0.2	--
Thorium 230	pCi/L	<0.1	0.1	0.3	0.2	<0.2	0.2	0.1*	0.2	<0.1	0.1	No Data	No Data	No Data	No Data	0.1	0.2
Thorium 230 Precision (+)	pCi/L	0.1	--	0.2	--	0.2	--	0.08	--	0.1	--	No Data	No Data	No Data	No Data	0.1	--
Thorium MDC	pCi/L	--	--	--	--	0.2	--	--	--	--	--	No Data	No Data	No Data	No Data	--	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	No Data	No Data	No Data	No Data		
Uranium Activity	mg/l	0.0138	0.0003	0.014	0.0003	0.0139	0.0003	0.0152	0.0003	0.0164	0.0003	No Data	No Data	No Data	No Data	0.0125	0.0003

MAJOR IONS	UNITS	W-274 Third Quarter 2008 RESULTS	W-274 Third Quarter 2008 RL	W-274 Fourth Quarter 2008 RESULTS	W-274 Fourth Quarter 2008 RL	W-274 First Quarter 2009 RESULTS	W-274 First Quarter 2009 RL	W-275 Second Quarter 2008 RESULTS	W-275 Second Quarter 2008 RL	W-275 Third Quarter 2008 RESULTS	W-275 Third Quarter 2008 RL	W-275 Fourth Quarter 2008 RESULTS	W-275 Fourth Quarter 2008 RL	W-275 First Quarter 2009 RESULTS	W-275 First Quarter 2009 RL	W-277 Second Quarter 2008 RESULTS	W-277 Second Quarter 2008 RL
Lead 210	pCi/L	<12.5	12,.5	<5.4	5.4	<2.8	2.8	<9.4	9.4	<7.4	7.4	<5.4	5.4	<5.5	5.5	<9.4	9.4
Lead 210 Precision (+)	pCi/L	7.4	--	3.2	--	1.7	--	5.5	--	4.5	--	3.2	--	3.3	--	5.5	--
Lead 210 MDC	pCi/L		12.5	5.4	--	2.8	--	9.4	--	7.4	--	5.4	--	5.5	--	9.4	--
Polonium 210	pCi/L	<0,5	0.5	<0.24	0.2	<0.5	0.5	0.9	0.9	<0.7	0.7	<0.17	0.17	<0.4	0.04	<0.2	0.2
Polonium 210 Precision (+)	pCi/L	1.0	--	0.2	--	0.4	--	0.9	--	0.7	--	0.2	--	0.3	--	0.2	--
Polonium 210 MDC	pCi/L	--	--	--	--	0.5	--	--	--	--	--	--	--	0.4	--	--	--
Radium 226	pCi/L	<0.25	0.25	<0.20	0.20	<0.19	0.19	<0.2	--	<0.3	0.3	<0.18	0.18	<0.19	0.19	<0.2	--
Radium 226 Precision (+)	pCi/L	0.14	--	0.13	--	0.1	--	0.08	--	0.2	--	0.12	--	0.1	--	0.1	--
Radium 226 MDC	pCi/L	0.25	--	0.2	--	0.19	--	0.2	--	0.3	--	0.18	--	0.19	--	0.2	--
Thorium 230	pCi/L	<0.2	0.2	0.3	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	0.2	0.2	<0.1	0.1	<0.1	0.1
Thorium 230 Precision (+)	pCi/L	0.2	--	0.2	--	0.1	--	0.1	--	0.1	--	0.2	--	0.05	--	0.1	--
Thorium MDC	pCi/L	--	--	--	--	0.2	--	--	--	--	--	--	--	0.1	--	--	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.0122	0.0003	0.0123	0.0003	0.0118	0.0003	0.008	0.0003	0.0083	0.0003	0.0087	0.0003	0.008	0.0003	0.0181	0.0003

Not detected at Reporting Limit.

Table 6.1-5 Three Crow Expansion Area and Area of Review Private Well Radiological Analytical Results 2007 - 2009

MAJOR IONS	UNITS	W-277 Third Quarter 2008 RESULTS	W-277 Third Quarter 2008 RL	W-277 Fourth Quarter 2008 RESULTS	W-277 Fourth Quarter 2008 RL	W-277 First Quarter 2009 RESULTS	W-277 First Quarter 2009 RL	W-313 Second Quarter 2008 RESULTS	W-313 Second Quarter 2008 RL	W-313 Third Quarter 2008 RESULTS	W-313 Third Quarter 2008 RL	W-313 Fourth Quarter 2008 RESULTS	W-313 Fourth Quarter 2008 RL	W-313 First Quarter 2009 RESULTS	W-313 First Quarter 2009 RL
Lead 210	pCi/L	<12.5	12.5	<5.4	5.4	<3.8	3.8	<28.8	28.8	<12.5	12.5	<4.1	4.1	<3.2	3.2
Lead 210 Precision (±)	pCi/L	7.3	--	3.2	--	2.3	--	16.9	--	7.3	--	2.5	--	1.9	--
Lead 210 MDC	pCi/L	12.5	--	5.4	--	3.8	--	28.8	--	12.5	--	4.1	--	3.2	--
Polonium 210	pCi/L	<0.6	0.6	<0.2	0.2	<0.5	0.5	<1.0	1.0	<0.7	0.7	<0.3	0.3	<0.5	0.5
Polonium 210 Precision (±)	pCi/L	0.6	--	0.2	--	0.2	--	0.4	--	0.7	--	0.3	--	0.3	--
Polonium 210 MDC	pCi/L	--	--	--	--	0.5	--	--	--	--	--	--	--	0.5	--
Radium 226	pCi/L	<0.21	0.21	<0.19	0.19	<0.08	0.08	<0.1	0.1	<0.3	0.3	<0.17	0.17	0.17	0.11
Radium 226 Precision (±)	pCi/L	0.13	--	0.11	--	0.06	--	0.08	--	0.1	--	0.07	--	0.1	--
Radium 226 MDC	pCi/L	0.21	--	0.19	--	0.08	--	0.1	--	0.3	--	0.17	--	0.11	--
Thorium 230	pCi/L	<0.1	0.1	<0.21	0.21	<0.1	0.1	<0.1	0.1	<0.06	0.06	<0.1	0.1	<0.2	0.2
Thorium 230 Precision (±)	pCi/L	0.1	--	0.2	--	0.06	--	0.1	--	0.06	--	0.1	--	0.1	--
Thorium MDC	pCi/L	--	--	--	--	0.1	--	--	--	--	--	--	--	0.2	0.2
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.0181	0.0003	0.0161	0.0003	0.0156	0.0003	0.0116	0.0003	0.0114	0.0003	0.0103	0.0003	0.0114	0.0003

MAJOR IONS	UNITS	W-314 Second Quarter 2008 RESULTS	W-314 Second Quarter 2008 RL	W-314 Third Quarter 2008 RESULTS	W-314 Third Quarter 2008 RL	W-314 Fourth Quarter 2008 RESULTS	W-314 Fourth Quarter 2008 RL	W-314 First Quarter 2009 RESULTS	W-314 First Quarter 2009 RL
Lead 210	pCi/L	<29.3	29.3	<12.5	12.5	<4.1	4.1	<2.8	2.8
Lead 210 Precision (±)	pCi/L	17.5	--	7.3	--	2.4	--	1.6	--
Lead 210 MDC	pCi/L	29.3	--	12.5	--	4.1	--	2.8	--
Polonium 210	pCi/L	<1.0	1.0	<1.0	1.0	<0.2	0.2	<0.7	0.7
Polonium 210 Precision (±)	pCi/L	0.1	--	1.0	--	0.2	--	0.5	--
Polonium 210 MDC	pCi/L	--	--	--	--	--	--	0.7	--
Radium 226	pCi/L	0.2	0.1	<0.23	0.23	<0.17	0.17	<0.18	0.18
Radium 226 Precision (±)	pCi/L	0.1	--	0.14	--	0.07	--	0.1	--
Radium 226 MDC	pCi/L	0.1	--	0.23		0.17	--	0.18	--
Thorium 230	pCi/L	<0.1	0.1	<0.08	0.08	<0.1	0.1	<0.2	0.2
Thorium 230 Precision (±)	pCi/L	0.1	--	0.08	--	0.1	--	0.08	--
Thorium MDC	pCi/L	--	--	--	--	--	--	0.2	--
Uranium Activity	pCi/L	--	--	--	--	--	--	--	--
Uranium Activity	mg/l	0.0237	0.0003	0.0221	0.0003	0.0205	0.0003	0.0233	0.0003

Not detected at Reporting Limit.

Table 6.1-6 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results - Third Quarter 2007

MAJOR IONS	UNITS	WELL-269		WELL-270		WELL-272		WELL-273		WELL-274		WELL-275		WELL-277		WELL-282	
		9/17/2007		9/14/2007		9/14/2007		9/14/2007		9/14/2007		9/14/2007		9/14/2007		9/14/2007	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	206	1.0	162	1.0	238	1.0	239	1.0	247	1.0	145	1.0	168	1.0	169	1
CARBONATE AS CO3	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1
BICARBONATE AS HCO3	mg/L	251	1.0	198	1.0	290	1.0	292	1.0	301	1.0	177	1.0	205	1.0	206	1
CALCIUM	mg/L	58	1.0	89	1.0	83	1.0	83	1.0	83	1.0	43	1.0	67	1.0	49	1
CHLORIDE	mg/L	5	1.0	40	1.0	7	1.0	6	1.0	4	1.0	1	1.0	8	1.0	2	1
FLUORIDE	mg/L	0.7	0.1	0.4	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.4	0.1	0.5	0.1
MAGNESIUM	mg/L	3	1.0	3	1.0	7	1.0	7	1.0	9	1.0	3	1.0	4	1.0	6	1
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	1.1	0.1	14.3	0.1	3.3	0.1	2.3	0.1	2.6	0.1	0.6	0.1	3.9	0.1	1	0.1
NITROGEN, NITRITE AS N	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
POTASSIUM	mg/L	18	1.0	19	1.0	9	1.0	9	1.0	6	1.0	6	1.0	11	1.0	6	1
SILICA	mg/L	45.7	0.1	46.1	0.1	60.3	0.1	60.3	0.1	60.1	0.1	66.8	0.1	54.8	0.1	66.5	0.1
SODIUM	mg/L	33	1.0	25	1.0	19	1.0	22	1.0	23	1.0	18	1.0	18	1.0	19	1
SULFATE	mg/L	11	1.0	36	1.0	15	1.0	13	1.0	12	1.0	5	1.0	20	1.0	5	1
PHYSICAL PROPERTIES																	
CONDUCTIVITY	umhos/cm	405	1.0	633	1.0	501	1.0	474	1.0	482	1.0	249	1.0	383	1.0	294	1
pH	s.u.	7.78	0.01	7.78	0.01	7.72	0.01	7.7	0.01	7.83	0.01	7.99	0.01	7.83	0.01	7.93	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	276	10	448	10	354	10	334	10	336	10	234	10	290	10	256	10
METALS, DISSOLVED																	
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.003	0.001	0.002	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.003	0.001	0.003	0.001
BARIUM	mg/L	<0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	<0.1	0.1	0.2	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0,005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0,01	0.01	<0.01	0.01	0.06	0.01	<0.-01	0.01	<0.01	0.01
IRON	mg/L	0.1	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.002	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.01	0.1	<01	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.002	0.001	0.012	0.001	0.003	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.005	0.001	<0.005	0.001
URANIUM	mg/L	0.0184	0.0003	0.0272	0.0003	0.0145	0.0003	0.0159	0.0003	0.0126	0.0003	0.0085	0.0003	0.0191	0.0003	0.012	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.02	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.017	0.01	0.06	0.01	0.08	0.01	0.04	0.01
DATA QUALITY																	
A/C BALANCE (± 5)	%	4.43		1.06		2		4.02		4.72		4.3		4.56			
ANIONS	meq/L	4.59		6.15		5.54		5.43		5.53		3.11		4.31			
CATIONS	meq/L	5.02		6.28		5.77		5.88		6.07		3.39		4.72			
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	302		419		359		355		359		234		302			
TDS BALANCE (0.80-1.20)	dec. %	0.91		1.07		0.99		0.94		0.94		1		0.96			

Table 6.1-6 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results - Third Quarter 2007

MAJOR IONS	UNITS	WELL-313		WELL-314	
		9/19/2007		9/17/2007	
		RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	168	1.0	168	1.0
CARBONATE AS CO3	mg/L	3	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	199	1.0	205	1.0
CALCIUM	mg/L	7	1.0	54	1.0
CHLORIDE	mg/L	4	1.0	17	1.0
FLUORIDE	mg/L	0.4	0.1	0.4	0.1
MAGNESIUM	mg/L	<1.0	1.0	2.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	1	0.1	1.0	0.1
NITROGEN, NITRITE AS N	mg/L	<0.1	0.1	<0.1	0.1
POTASSIUM	mg/L	12	1.0	20	1.0
SILICA	mg/L	61.9	0.1	54.1	0.1
SODIUM	mg/L	75	1.0	40	1.0
SULFATE	mg/L	10	1.0	40	1.0
PHYSICAL PROPERTIES					
CONDUCTIVITY	umhos/cm	331	1.0	437	1.0
pH	s.u.	8.32	0.01	7.95	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	270	10	306	10
METALS, DISSOLVED					
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.01	0.001	0.003	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01
IRON	mg/L	0.04	0.03	0.1	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.003	0.001	0.009	0.001
URANIUM	mg/L	0.0118	0.0003	0.023	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.01	0.01	0.03	0.01
DATA QUALITY					
A/C BALANCE (± 5)	%	2.45		3.59	
ANIONS	meq/L	3.77		4.77	
CATIONS	meq/L	3.96		5.13	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	276		333	
TDS BALANCE (0.80-1.20)	dec. %	0.98		0.92	

Table 6.1-7 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Second Quarter 2008

MAJOR IONS	UNITS	WELL-269(SULZBACH)		WELL-270		WELL-272		WELL-273		WELL-274		WELL-275	
		5/23/2008		5/23/2008		5/23/2008		5/30/2008		5/30/2008		5/23/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	195	1.0	158	1.0	225	1.0	221	1.0	231	1.0	140	1.0
CARBONATE AS CO3	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	238	1.0	192	1.0	275	1.0	270	1.0	282	1.0	170	1.0
CALCIUM	mg/L	58	1.0	96	1.0	99	1.0	82	1.0	85	1.0	44	1.0
CHLORIDE	mg/L	2.0	1.0	34	1.0	7.0	1.0	6.0	1.0	3.0	1.0	<1.0	1.0
FLUORIDE	mg/L	0.7	0.1	0.4	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.4	0.1
MAGNESIUM	mg/L	3.0	1.0	3.0	1.0	7.0	1.0	6.0	1.0	9.0	1.0	4.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	1.09	0.05	16.8	0.05	9.17	0.05	2.45	0.05	2.83	0.05	0.65	0.05
NITROGEN, NITRITE AS N	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
POTASSIUM	mg/L	18	1.0	18	1.0	10	1.0	9.0	1.0	6.0	1.0	6.0	1.0
SILICA	mg/L	25.5	0.1	25.7	0.1	32.7	0.1	35	0.1	34.8	0.1	35.9	0.1
SODIUM	mg/L	32	1.0	22	1.0	16	1.0	20	1.0	21	1.0	18	1.0
SULFATE	mg/L	11	1.0	32	1.0	18	1.0	14	1.0	13	1.0	5.0	1.0
PHYSICAL PROPERTIES													
CONDUCTIVITY	umhos/cm	416	1.p	584	1.0	545	1.0	486	1.0	498	1.0	286	1.0
pH	s.u.	7.61	0.01	7.74	0.01	7.72	0.01	7.72	0.01	7.61	0.01	8.03	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	266	10	414	10	365	10	336	10	336	10	215	10
METALS, DISSOLVED													
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.003	0.001	0.002	0.001	0.004	0.001	0.003	0.001	0.003	0.001	0.003	0.001
BARIUM	mg/L	<0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1
BORON	mg/L	<0.1	0.1	<0.,1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0,005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0,05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0,01	0.01	0.01	0.01	<0.01	0.01	<0..01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	0.12	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.002	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.002	0.001	0.01	0.001	0.002	0.001	0.002	0.001	0.002	0.001	<0.001	0.001
URANIUM	mg/L	0.0185	0.0003	0.0242	0.0003	0.0145	0.0003	0.0152	0.0003	0.0125	0.0003	0.008	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.03	0.01	0.02	0.01	0.1	0.01	0.03	0.01	0.19	0.01	0.04	0.01
THORIUM 230 precision(±)	pCi/L	0.1		0.1		0.1		0.08		0.1		0.1	
DATA QUALITY													
A/C BALANCE (± 5)	%	7.7		3.78		5.71		6.01		7.64		6.87	
ANIONS	meq/L	4.29		5.99		5.74		5.09		5.2		3	
CATIONS	meq/L	5		6.46		6.44		5.74		6.06		3.44	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	279		407		373		326		333		211	
TDS BALANCE (0.80-1.20)	dec. %	0.95		1.02		0.98		1.03		1.01		1.02	

Table 6.1-7 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Second Quarter 2008

MAJOR IONS	UNITS	WELL-277		WELL-313		WELL-314	
		5/23/2008		5/16/2008		5/16/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	156	1,0	159	1.0	156	1.0
CARBONATE AS CO3	mg/L	<1.0	1,0	<1.0	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	190	1,0	194	1.0	190	1.0
CALCIUM	mg/L	62	1.0	7.0	1.0	54	1.0
CHLORIDE	mg/L	6	1.0	3.0	1.0	18	1.0
FLUORIDE	mg/L	0.4	0.1	0.4	0.1	0.4	0.1
MAGNESIUM	mg/L	4	1.0	<1.0	1.0	2.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	3.8	0.05	0.9	0.05	1.0	0.05
NITROGEN, NITRITE AS N	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1
POTASSIUM	mg/L	10	1.0	11	1.0	19	1.0
SILICA	mg/L	28.8	0.1	36.2	0.1	30.5	0.1
SODIUM	mg/L	19	1.0	74	1.0	38	1.0
SULFATE	mg/L	20	1.0	11	1.0	38	1.0
PHYSICAL PROPERTIES							
CONDUCTIVITY	umhos/cm	391	1.0	349	1.0	454	1.0
pH	s.u.	7.72	0.01	8.11	0.01	7.94	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	276	10	268	10	315	10
METALS, DISSOLVED							
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.003	0.001	0.009	0.001	0.003	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1
BORON	mg/L	0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	0.01	0.01	<0,01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	0.06	0.03	0.06	0.03
LEAD	mg/L	<0.001	0.001	0.002	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.004	0.001	0.003	0.001	0.009	0.001
URANIUM	mg/L	0.0181	0.0003	0.0116	0.0003	0.0237	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.21	0.01	0.03	0.01	0.03	0.01
DATA QUALITY							
A/C BALANCE (± 5)	%	5.66		3.93		5.21	
ANIONS	meq/L	3.99		3.58		4.49	
CATIONS	meq/L	4.47		3.87		4.98	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	268		252		306	
TDS BALANCE (0.80-1.20)	dec. %	1.03		1.06		1.03	

Table 6.1-8 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Third Quarter 2008

MAJOR IONS	UNITS	WELL-269		WELL-270		WELL-272		WELL-273		WELL-274		WELL-275		WELL-277	
		7/21/2008		7/29/2008		7/29/2008		7/21/2008		7/25/2008		7/21/2008		7/29/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	203	1.0	161	1.0	257	1.0	230	1.0	237	1.0	144	1.0	162	1.0
CARBONATE AS CO3	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	248	1.0	196	1.0	313	1.0	281	1.0	289	1.0	175	1.0	197	1.0
CALCIUM	mg/L	66	1.0	84	1.0	83	1.0	85	1.0	67	1.0	44	1.0	55	1.0
CHLORIDE	mg/L	5.0	1.0	42	1.0	9.0	1.0	7.0	1.0	4.0	1.0	1.0	1.0	8.0	1.0
FLUORIDE	mg/L	0.8	0.1	0.4	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.4	0.1
MAGNESIUM	mg/L	5.0	1.0	3.0	1.0	6.0	1.0	7.0	1.0	8	1.0	4.0	1.0	3.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.5	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	1.3	0.1	16	0.05	5.45	0.05	2.4	0.1	2.43	0.05	0.6	0.1	4.61	0.05
NITROGEN, NITRITE AS N	mg/L														
POTASSIUM	mg/L	12	1.0	19	1.0	9.0	1.0	8.0	1.0	7.0	1.0	6.0	1.0	11	1.0
SILICA	mg/L	68.4	0.2	11.1	0.1	14.9	0.1	77.5	0.2	15.2	0.1	83.6	0.2	13.3	0.1
SODIUM	mg/L	24	1.0	24	1.0	18	1.0	20	1.0	25	1.0	17	1.0	19	1.0
SULFATE	mg/L	12	1.0	33	1.0	15	1.0	12	1.0	9.0	1.0	4.0	1.0	18	1.0
PHYSICAL PROPERTIES															
CONDUCTIVITY	umhos/cm	442	1.0	632	1.0	539	1.0	499	1.0	488	1.0	296	1.0	404	1.0
pH	s.u.	7.38	0.01	7.63	0.01	7.49	0.01	7.4	0.01	7.67	0.01	7.73	0.01	7.67	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	300	10	425	10	362	10	336	10	325	10	216	10	271	10
METALS, DISSOLVED															
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.004	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
BARIUM	mg/L	<0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	<0.1	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1	<.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0,05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	0.11	0.03	<0.03	0.03
LEAD	mg/L	<0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	0.002	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.003	0.001	0.011	0.001	0.003	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.005	0.001
URANIUM	mg/L	0.0136	0.0003	0.0258	0.0003	0.0138	0.0003	0.0164	0.0003	0.0122	0.0003	0.0083	0.0003	0.0181	0.0003
VANADIUM	mg/L	<01	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.03	0.01	0.02	0.01	0.07	0.01	0.03	0.01	0.1	0.01	0.04	0.01	0.09	0.01
DATA QUALITY															
A/C BALANCE (± 5)	%	4.94		-2.36		-4.06		5.72		-0.363		4.73		-0.906	
ANIONS	meq/L	4.58		6.24		6.12		5.23		5.26		3.07		4.2	
CATIONS	meq/L	5.06		5.95		5.64		5.87		5.22		3.37		4.12	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	339		386		337		386		293		271		250	
TDS BALANCE (0.80-1.20)	dec. %	0.88		1.1		1.07		0.87		1.11		0.8		1.08	

Table 6.1-8 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Third Quarter 2008

MAJOR IONS	UNITS	WELL-313 7/29/2008		WELL-314 7/25/2008	
		RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	166	1.0	173	1.0
CARBONATE AS CO3	mg/L	5.0	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	194	1.0	211	1.0
CALCIUM	mg/L	7.0	1.0	60	1.0
CHLORIDE	mg/L	5.0	1.0	21	1.0
FLUORIDE	mg/L	0.4	0.1	0.4	0.1
MAGNESIUM	mg/L	<1.0	1.0	2.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	0.92	0.05	1.19	0.05
NITROGEN, NITRITE AS N	mg/L				
POTASSIUM	mg/L	12	1.0	20	1.0
SILICA	mg/L	14.6	0.1	13.1	0.1
SODIUM	mg/L	72	1.0	33	1.0
SULFATE	mg/L	9.0	1.0	49	1.0
PHYSICAL PROPERTIES					
CONDUCTIVITY	umhos/cm	351	1.0	503	1.0
pH	s.u.	8.31	0.01	7.81	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	259	10	337	10
METALS, DISSOLVED					
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.007	0.001	0.002	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	0.04	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	>0.05	0.05
SELENIUM	mg/L	0.002	0.001	0.009	0.001
URANIUM	mg/L	0.0114	0.0003	0.0221	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.02	0.01	0.08	0.01
DATA QUALITY					
A/C BALANCE (± 5)	%	0.909		-0.529	
ANIONS	meq/L	3.72		5.17	
CATIONS	meq/L	3.79		5.11	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	227		311	
TDS BALANCE (0.80-1.20)	dec. %	1.14		1.08	

Table 6.1-9 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Fourth Quarter 2008

MAJOR IONS	UNITS	WELL-269		WELL-270		WELL-272		WELL-273	
		11/14/2008		11/14/2008		11/14/2008			
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	199	1	156	1	232	1	WELL OFF UNTIL SPRING	
CARBONATE AS CO3	mg/L	ND	1	ND	1	ND	1		
BICARBONATE AS HCO3	mg/L	243	1	190	1	283	1		
CALCIUM	mg/L	49	1	92	1	88	1		
CHLORIDE	mg/L	4	1	38	1	8	1		
FLUORIDE	mg/L	0.7	0.1	0.4	0.1	0.5	0.1		
MAGNESIUM	mg/L	2	1	3	1	6	1		
NITROGEN, AMMONIA AS N	mg/L	ND	0.05	ND	0.05	ND	0.05		
NITROGEN, NITRATE+NITRITE AS N	mg/L	1.17	0.05	16.1	0.05	5.29	0.05		
POTASSIUM	mg/L	16	1	17	1	9	1		
SILICA	mg/L	50.2	0.2	52.3	0.2	67	0.2		
SODIUM	mg/L	29	2	22	2	16	2		
SULFATE	mg/L	9	1	30	1	13	1		
PHYSICAL PROPERTIES									
CONDUCTIVITY	umhos/cm	381	1	592	1	493	1		
pH	s.u.	7.74	0.01	7.82	0.01	7.69	0.01		
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	284	10	440	10	374	10		
METALS, DISSOLVED									
ALUMINUM	mg/L	ND	0.1	ND	0.1	ND	0.1		
ARSENIC	mg/L	0.003	0.001	ND	0.001	0.003	0.001		
BARIUM	mg/L	ND	0.1	0.1	0.1	0.2	0.1		
BORON	mg/L	ND	0.1	ND	0.1	ND	0.1		
CADMIUM	mg/L	ND	0.005	ND	0.005	ND	0.005		
CHROMIUM	mg/L	ND	0.05	ND	0.05	ND	0.05		
COPPER	mg/L	ND	0.01	ND	0.01	ND	0.01		
IRON	mg/L	ND	0.03	ND	0.03	ND	0.03		
LEAD	mg/L	ND	0.001	ND	0.001	ND	0.001		
MANGANESE	mg/L	ND	0.01	ND	0.01	ND	0.01		
MERCURY	mg/L	ND	0.001	ND	0.001	ND	0.001		
MOLYBDENUM	mg/L	ND	0.1	ND	0.1	ND	0.1		
NICKEL	mg/L	ND	0.05	ND	0.05	ND	0.05		
SELENIUM	mg/L	0.002	0.001	0.012	0.001	0.002	0.001		
URANIUM	mg/L	0.0185	0.0003	0.0252	0.0003	0.014	0.0003		
VANADIUM	mg/L	ND	0.1	ND	0.1	ND	0.1		
ZINC	mg/L	0.02	0.01	0.03	0.01	0.12	0.01		
DATA QUALITY									
A/C BALANCE (± 5)	%	-0.938		2.05		2.59			
ANIONS	meq/L	4.38		5.99		5.54			
CATIONS	meq/L	4.3		6.24		5.84			
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	297		434		388			
TDS BALANCE (0.80-1.20)	dec. %	0.96		1.01		0.96			

MAJOR IONS	UNITS	WELL-274		WELL-275		WELL-277	
		11/14/2008		11/14/2008		11/14/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	243	1	145	1	142	1
CARBONATE AS CO3	mg/L	ND	1	ND	1	ND	1
BICARBONATE AS HCO3	mg/L	296	1	177	1	174	1
CALCIUM	mg/L	80	1	41	1	56	1
CHLORIDE	mg/L	4	1	1	1	7	1
FLUORIDE	mg/L	0.6	0.1	0.5	0.1	0.5	0.1
MAGNESIUM	mg/L	9	1	3	1	3	1
NITROGEN, AMMONIA AS N	mg/L	ND	0.05	ND	0.05	ND	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	2.82	0.05	0.67	0.05	2.84	0.05
POTASSIUM	mg/L	6	1	6	1	9	1
SILICA	mg/L	64.2	0.2	73.9	0.2	53.8	0.2
SODIUM	mg/L	20	2	17	2	16	2
SULFATE	mg/L	10	1	4	1	13	1
PHYSICAL PROPERTIES							
CONDUCTIVITY	umhos/cm	468	1	246	1	345	1
pH	s.u.	7.88	0.01	8.15	0.01	7.94	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	337	10	227	10	285	10
METALS, DISSOLVED							
ALUMINUM	mg/L	ND	0.1	ND	0.1	ND	0.1
ARSENIC	mg/L	0.003	0.001	0.003	0.001	0.002	0.001
BARIUM	mg/L	0.1	0.1	0.2	0.1	ND	0.1
BORON	mg/L	ND	0.1	ND	0.1	ND	0.1
CADMIUM	mg/L	ND	0.005	ND	0.005	ND	0.005
CHROMIUM	mg/L	ND	0.05	ND	0.05	ND	0.05
COPPER	mg/L	ND	0.01	ND	0.01	ND	0.01
IRON	mg/L	ND	0.03	0.08	0.03	ND	0.03
LEAD	mg/L	0.003	0.001	ND	0.001	ND	0.001
MANGANESE	mg/L	ND	0.01	ND	0.01	ND	0.01
MERCURY	mg/L	ND	0.001	ND	0.001	ND	0.001
MOLYBDENUM	mg/L	ND	0.1	ND	0.1	ND	0.1
NICKEL	mg/L	ND	0.05	ND	0.05	ND	0.05
SELENIUM	mg/L	ND	0.001	ND	0.001	0.004	0.001
URANIUM	mg/L	0.0123	0.0003	0.0087	0.0003	0.0161	0.0003
VANADIUM	mg/L	ND	0.1	ND	0.1	ND	0.1
ZINC	mg/L	1.24	0.01	0.03	0.01	0.16	0.01
DATA QUALITY							
A/C BALANCE (± 5)	%	3.28		1.95		5.94	
ANIONS	meq/L	5.39		3.09		3.56	
CATIONS	meq/L	5.75		3.21		4.01	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	368		256		272	
TDS BALANCE (0.80-1.20)	dec. %	0.92		0.89		1.05	

Table 6.1-9 Three Crow Expansion Area and Area of Review Private Water Well Non-Radiological Analytical Results – Fourth Quarter 2008

MAJOR IONS	UNITS	WELL-313		WELL-314	
		11/12/2008		11/12/2008	
		RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	165	1	165	1
CARBONATE AS CO3	mg/L	5	1	ND	1
BICARBONATE AS HCO3	mg/L	191	1	201	1
CALCIUM	mg/L	7	1	58	1
CHLORIDE	mg/L	4	1	18	1
FLUORIDE	mg/L	0.4	0.1	0.4	0.1
MAGNESIUM	mg/L	ND	1	2	1
NITROGEN, AMMONIA AS N	mg/L	ND	0.05	ND	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	0.95	0.05	1.05	0.05
POTASSIUM	mg/L	12	1	20	1
SILICA	mg/L	81.2	0.2	67.8	0.2
SODIUM	mg/L	74	2	32	2
SULFATE	mg/L	9	1	42	1
PHYSICAL PROPERTIES					
CONDUCTIVITY	umhos/cm	341	1	470	1
pH	s.u.	8.4	0.01	7.95	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	264	10	327	10
METALS, DISSOLVED					
ALUMINUM	mg/L	ND	0.1	NED	0.1
ARSENIC	mg/L	0.01	0.001	0.003	0.001
BARIUM	mg/L	ND	0.1	ND	0.1
BORON	mg/L	ND	0.1	ND	0.1
CADMIUM	mg/L	ND	0.005	ND	0.005
CHROMIUM	mg/L	ND	0.05	ND	0.05
COPPER	mg/L	ND	0.01	ND	0.01
IRON	mg/L	0.07	0.03	ND	0.03
LEAD	mg/L	ND	0.001	ND	0.001
MANGANESE	mg/L	ND	0.01	ND	0.01
MERCURY	mg/L	ND	0.001	ND	0.001
MOLYBDENUM	mg/L	ND	0.1	ND	0.1
NICKEL	mg/L	ND	0.05	ND	0.05
SELENIUM	mg/L	0.003	0.001	0.01	0.001
URANIUM	mg/L	0.0103	0.0003	0.0205	0.0003
VANADIUM	mg/L	ND	0.1	ND	0.1
ZINC	mg/L	0.02	0.01	0.15	0.01
DATA QUALITY					
A/C BALANCE (± 5)	%	2.25		1.84	
ANIONS	meq/L	3.68		4.76	
CATIONS	meq/L	3.85		4.94	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	311		361	
TDS BALANCE (0.80-1.20)	dec. %	0.85		0.91	

Table 6.1-10 Water Levels – Brule Formation and Basal Chadron Sandstone (January 2009 and 2010)

Well	1/9/2009	1/30/2009	1/22/2010 & 2/8/2010
BRULE FORMATION			
BOW 2006-1	3862.90	3863.34	3863.83
BOW 2006-2	3879.01	3879.07	3878.50
BOW 2006-3	3878.25	3878.05	3877.20
BOW 2006-4	3857.78	3857.50	3861.58
BOW 2006-5	NM	NM	3842.83
BOW 2006-6	NM	NM	3904.43
BOW 2006-7	NM	NM	3913.02
Well 273 (Miller Well)	NM	NM	3819.13
BASAL CHADRON SANDSTONE			
CPW2006-2	3,721.22	3,721.01	3,717.26
COW2006-1	3,723.94	3,723.64	3,720.36
COW2006-2	3,721.11	3,720.85	3,717.13
COW2006-3	3,720.43	3,720.22	3,716.73
COW2006-4	3,720.81	3,720.46	3,717.02
COW2006-5	3,720.26	3,720.03	3,716.46
COW2006-6	3,713.43	3,712.89	3,708.23
COW2006-7	3,711.76	3,712.20	3,707.55
UBCOW2006-1	3,720.51	3,720.36	3,716.73
UBCOW2006-2	3,720.84	3,720.61	3,716.96

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Table 6.1-11 Three Crow Expansion Area Monitor Well Radiological (Dissolved) Results 2008-2009

MAJOR IONS	UNITS	COW 2006-1		COW 2006-1		COW 2006-1		COW 2006-2		COW 2006-2		COW 2006-2		COW 2006-3		COW 2006-3		COW 2006-3	
		12/2/2008		12/16/2008		1/5/2009		12/2/2008		12/16/2008		1/5/2009		12/3/2008		1/5/2009		12/17/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
URANIUM	mg/L	0.0014	0.0003	0.0016	0.0003	0.0014	0.0003	0.0294	0.0003	0.0339	0.0003	0.0294	0.0003	0.0042	0.0003	0.004	0.0003	0.0046	0.0003
RADIONUCLIDES-DISSOLVED																			
LEAD 210	pCi/L	<4.1	4.1	<4.4	4.4	<4.9	4.9	583	8.3	295	4.4	140	4.9	<4.1	4.1	<4.9	4.9	<8.8	8.8
LEAD 210 precision(±)	pCi/L	2.5		2.6		6.1		11		5.6		4.6		2.5		2.9		5.3	
LEAD 210 MDC	pCi/L	4.1		4.4		4.9		8.3		4.4		4.9		4.1		4.9		8.8	
POLONIUM 210	pCi/L	<0.20	0.2	<0.5	0.5	<0.3	0.3	8.8	2.1	24	5.3	12	2.8	<.48	0.48	<0.3	0.3	<0.2	0.2
POLONIUM 210 precision(±)	pCi/L	0.2		0.5		0.3		2.1		5.3		2.8		0.48		0.3		0.2	
POLONIUM MDC	pCi/L																		
RADIUM 226	pCi/L	1.6	0.16	2.1	0.19	2.6	0.23	181	0.16	157	0.17	150	0.21	5.4	0.17	5.2	0.22	4.8	0.17
RADIUM 226 precision(±)	pCi/L	0.24		0.29		0.36		2.4		2.2		2.4		0.43		0.48		0.4	
RADIUM 226 MDC	pCi/L	0.16		0.19		0.23		0.16		0.17		0.21		0.17		0.22		0.17	
THORIUM 230	pCi/L	<.17	0.17	<0.2	0.2	<0.09	0.09	1.6	0.52	0.8	0.4	0.9	0.3	<.15	0.15	<0.07	0.07	<0.1	0.1
THORIUM 230 precision(±)	pCi/L	0.2		0.2		0.09		0.5		0.4		0.3		0.1		0.07		0.1	
THORIUM 230 MDC	pCi/L																		

MAJOR IONS	UNITS	COW 2006-4		COW 2006-4		COW 2006-4		COW 2006-5		COW 2006-5		COW 2006-5		COW 2006-6		COW 2006-6		COW 2006-6	
		12/1/2008		12/15/2008		1/6/2009		1/16/2009		1/30/2009		2/13/2009		1/16/2009		1/30/2009		2/13/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
URANIUM	mg/L	0.0013	0.0003	0.0012	0.0003	0.0012	0.0003	0.0013	0.0003	0.0012	0.0003	0.0011	0.0003	0.001	0.0003	0.0006	0.0003	0.0004	0.0003
RADIONUCLIDES-DISSOLVED																			
LEAD 210	pCi/L	<4.1	4.1	<4.4	4.4	<3.2	3.2	<4.00	4	<3.2	3.2	<2.80	2.8	<4.00	4	<4.4	4.4	<2.80	2.8
LEAD 210 precision(±)	pCi/L	2.4		2.6		1.9		2.3		1.9		1.7		2.4		2.7		1.7	
LEAD 210 MDC	pCi/L	4.1		4.4		3.2		4		3.2		2.8		4		4.4		2.8	
POLONIUM 210	pCi/L	<.26	0.26	<0.4	0.4	<0.5	0.5	<.29	0.3	<0.7	0.7	<0.69	0.7	<.23	0.2	<0.5	0.5	15.2	1.8
POLONIUM 210 precision(±)	pCi/L	0.26		0.4		0.5		0.3		0.3		0.3		0.2		0.2		7.6	
POLONIUM MDC	pCi/L									0.7		0.7				0.5		1.8	
RADIUM 226	pCi/L	0.78	0.18	1.4	0.17	0.85	0.22	0.86	0.19	0.94	0.2	0.33	0.2	2.5	0.2	2.2	0.2	0.85	0.2
RADIUM 226 precision(±)	pCi/L	0.18		0.23		0.23		0.2		0.23		0.16		0.32		0.33		0.21	
RADIUM 226 MDC	pCi/L	0.18		0.17		0.22		0.19		0.2		0.2		0.2		0.2		0.2	
THORIUM 230	pCi/L	<0.31	0.31	<0.09	0.09	<0.09	0.09	<0.08	0.08	<0.1	0.1	<0.20	0.2	<0.11	0.1	<0.1	0.1	<0.20	0.2
THORIUM 230 precision(±)	pCi/L	0.31		0.1		0.09		0.1		0.1		0.1		0.1		0.1		0.09	
THORIUM 230 MDC	pCi/L											0.2						0.2	

Table 6.1-11 Three Crow Expansion Area Monitor Well Radiological (Dissolved) Results 2008-2009

MAJOR IONS	UNITS	COW 2006-7		COW 2006-7		COW 2006-7		CPW 2006-2		CPW 2006-2		CPW 2006-2		UBCOW 2006-1		UBCOW 2006-1		UBCOW 2006-1	
		1/16/2009		1/30/2009		2/13/2009		11/24/2008		12/8/2008		12/22/2008		11/24/2008		12/8/2008		12/22/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
URANIUM	mg/L	0.0053	0.0003	0.0056	0.0003	0.0052	0.0003	0.0385	0.0003	0.038	0.0003	0.0335	0.0003	0.0026	0.0003	0.0025	0.0003	0.0021	0.0003
RADIONUCLIDES-DISSOLVED																			
LEAD 210	pCi/L	<4.00	8.8	<3.2	3.2	<2.80	2.8	<4.4	4.4	<4.6	4.6	<4.0	4	<4.4	4.4	<9.2	9.2	<4.0	4
LEAD 210 precision(±)	pCi/L	2.4		1.9		1.7		2.6		2.8		2.4		2.6		5.4		2.4	
LEAD 210 MDC	pCi/L	4		3.2		2.8		4.4		4.6		4		4.4		9.2		4	
POLONIUM 210	pCi/L	<0.24	0.2	<0.4	0.4	<0.41	0.4	<1.2	0.2	<.31	0.31	<0.21	0.21	<0.3	0.3	<.21	0.21	<0.28	0.28
POLONIUM 210 precision(±)	pCi/L	0.2		0.2		0.2		0.2		0.31		0.21		0.3		0.21		0.28	
POLONIUM MDC	pCi/L			0.4		0.4													
RADIUM 226	pCi/L	2.7	0.17	0.26	0.25	1.7	0.21	5.3	0.23	5.5	0.22	4.5	0.11	0.71	0.18	0.32	0.19	0.57	0.17
RADIUM 226 precision(±)	pCi/L	0.32		0.18		0.28		0.49		0.48		0.41		0.19		0.15		0.16	
RADIUM 226 MDC	pCi/L	0.19		0.25		0.21		0.23		0.22		0.11		0.18		0.19		0.17	
THORIUM 230	pCi/L	<0.08	0.1	<0.2	0.2	<0.22	0.2	0.6	0.4	<0.09	0.09	<0.36	0.36	0.5	0.3	<0.12	0.12	<0.22	0.22
THORIUM 230 precision(±)	pCi/L	0.08		0.2		0.1		0.4				0.36		0.3		0.12		0.22	
THORIUM 230 MDC	pCi/L					0.2													

MAJOR IONS	UNITS	UBCOW 2006-2		UBCOW 2006-2		UBCOW 2006-2		BOW 2006-1		BOW 2006-1		BOW 2006-1		BOW 2006-2		BOW 2006-2		BOW 2006-2	
		12/1/2008		12/15/2008		1/6/2009		11/24/2008		12/8/2008		12/22/2008		12/1/2008		12/15/2008		1/13/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
URANIUM	mg/L	0.0034	0.0003	0.0032	0.0003	0.0033	0.0003	0.0176	0.0003	0.0172	0.0003	0.0146	0.0003	0.0136	0.0003	0.0128	0.0003	0.014	0.0003
RADIONUCLIDES-DISSOLVED																			
LEAD 210	pCi/L	<8.3	8.3	<4.4	4.4	<4.7	4.7	<4.4	4.4	<4.6	4.6	<4.0	4	<4.1	4.1	<4.4	4.4	<4.00	4
LEAD 210 precision(±)	pCi/L	4.9		2.7		2.8		2.6		2.7		2.4		2.4		2.7		2.4	
LEAD 210 MDC	pCi/L	8.3		4.4		4.7		4.4		4.6		4		4.1		4.4		4	
POLONIUM 210	pCi/L	<0.15	0.15	<0.3	0.3	<0.3	0.3	<.3	0.3	<0.26	0.26	<0.37	0.37	<0.17	0.17	<.4	0.4	<0.60	0.6
POLONIUM 210 precision(±)	pCi/L	0.15		0.3		0.3		0.3		0.26		0.37		0.17		0.4		0.6	
POLONIUM MDC	pCi/L																		
RADIUM 226	pCi/L	0.23	0.18	0.45	0.17	0.6	0.23	0.41	0.18	<0.20	0.2	0.41	0.1	<0.21	0.21	0.19	0.18	<0.19	0.19
RADIUM 226 precision(±)	pCi/L	0.13		0.15		0.21		0.15		0.13		0.13		0.11		0.13		0.14	
RADIUM 226 MDC	pCi/L	0.17		0.17		0.23		0.18		0.2		0.1		0.21		0.18		0.19	
THORIUM 230	pCi/L	<0.31	0.31	<0.2	0.2	<0.09	0.09	<0.1	0.1	<0.07	0.07	<0.09	0.09	<0.12	0.12	<0.1	0.1	<0.10	0.1
THORIUM 230 precision(±)	pCi/L	0.31		0.2		0.09		0.1		0.07		0.09		0.12		0.1		0.1	
THORIUM 230 MDC	pCi/L																		

Table 6.1-11 Three Crow Expansion Area Monitor Well Radiological (Dissolved) Results 2008-2009

MAJOR IONS	UNITS	BOW 2006-3 12/1/2008 RESULTS	BOW 2006-3 12/1/2008 RL	BOW 2006-3 12/17/2008 RESULTS	BOW 2006-3 12/17/2008 RL	BOW 2006-3 1/13/2009 RESULTS	BOW 2006-3 1/13/2009 RL	BOW 2006-4 1/16/2009 RESULTS	BOW 2006-4 1/16/2009 RL	BOW 2006-4 1/30/2009 RESULTS	BOW 2006-4 1/30/2009 RL	BOW 2006-4 2/13/2009 RESULTS	BOW 2006-4 2/13/2009 RL
URANIUM	mg/L	0.0111	0.0003	0.0103	0.0003	0.0032	0.0003	0.0098	0.0003	0.0102	0.0003	0.0099	0.0003
RADIONUCLIDES-DISSOLVED													
LEAD 210	pCi/L	<4.1	4.1	<8.8	8.8	<4.00	4	<4.00	4	<4.4	4.4	<2.80	2.8
LEAD 210 precision(±)	pCi/L	2.4		5.2		2.4		2.4		2.7		1.7	
LEAD 210 MDC	pCi/L	4.1		8.8		4		4		4.4		2.8	
POLONIUM 210	pCi/L	<0.31	0.31	<0.3	0.3	<.43	0.4	<.25	0.3	<0.5	0.5	0.8	0.6
POLONIUM 210 precision(±)	pCi/L	0.31		0.3		0.4		0.3		0.3		0.6	
POLONIUM MDC	pCi/L									0.5		0.6	
RADIUM 226	pCi/L	<0.16	0.16	<.17	0.17	<0.19	0.19	<.19	0.19	<0.19	0.19	<0.21	0.21
RADIUM 226 precision(±)	pCi/L	0.07	0.15	0.11		0.12		0.13		0.12		0.13	
RADIUM 226 MDC	pCi/L	0.16		0.17		0.19		0.19		0.19		0.21	
THORIUM 230	pCi/L	<0.15	0.15	0.4	0.2	<0.12	0.1	<0.11	0.1	<0.09	0.09	<0.16	0.2
THORIUM 230 precision(±)	pCi/L	0.15		0.2		0.1		0.1		0.09		0.07	
THORIUM 230 MDC	pCi/L											0.2	

Table 6.1-12 Three Crow Expansion Area Monitor Well Radiological (Dissolved and Suspended) Results 2008-2009

MAJOR IONS	UNITS	BOW 2006-5		BOW 2006-5		BOW 2006-5		BOW 2006-6		BOW 2006-6		BOW 2006-6		BOW 2006-7		BOW 2006-7		BOW 2006-7	
		11/24/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		121/18/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
<u>RADIONUCLIDES-DISSOLVED</u>																			
LEAD 210	pCi/L	<0.7	0.7	<0.7	0.7	<1.2	1.2	<0.7	0.7	<0.7	0.7	1.3	1.2	<0.7	0.07	<0.7	0.7	<1.2	1.2
LEAD 210 precision(±)	pCi/L	0.4		0.4		0.7		0.4		0.4		0.8		0.4		0.4		0.7	
LEAD 210 MDC	pCi/L	0.7		0.7		1.2		0.7		0.7		1.2		0.7		0.7		1.2	
POLONIUM 210	pCi/L	<1.0	1.0	<0.7	0.07	<0.5	0.5	<0.6	0.6	<0.6	0.6	<0.4	0.4	<0.4	0.4	<0.6	0.6	<0.6	0.6
POLONIUM 210 precision(±)	pCi/L	0.4		0.4		0.3		0.3		0.2		0.2		0.2		0.4		0.2	
POLONIUM MDC	pCi/L	1.0		0.7		0.5		0.6		0.6		0.4		0.4		0.6		0.6	
RADIUM 226	pCi/L	<0.17	0.17	<0.13	0.13	<0.18	0.18	<0.17	0.17	<0.14	0.14	<0.20	0.20	<0.16	0.16	<0.13	0.13	<0.18	0.18
RADIUM 226 precision(±)	pCi/L	0.1		0.08		0.12		0.11		0.07		0.12		0.11		0.08		0.11	
RADIUM 226 MDC	pCi/L	0.17		0.13		0.18		0.17		0.14		0.20		0.16		0.13		0.18	
THORIUM 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2
THORIUM 230 precision(±)	pCi/L	0.09		0.1		0.09		0.08		0.07		0.06		0.05		0.06		0.09	
THORIUM 230 MDC	pCi/L	0.2		0.1		0.2		0.1		0.1		0.1		0.1		0.1		0.2	

MAJOR IONS	UNITS	BOW 2006-5		BOW 2006-5		BOW 2006-5		BOW 2006-6		BOW 2006-6		BOW 2006-6		BOW 2006-7		BOW 2006-7		BOW 2006-7	
		11/20/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		121/18/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
URANIUM	mg/L	<0.0003	0.0003	0.0005	0.0003	0.0005	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0011	0.0003	<0.0003	0.0003	0.0004	0.0003	0.0009	0.0003
<u>RADIONUCLIDES-SUSPENDED</u>																			
LEAD 210	pCi/L	<2.7	2.7	<1.6	1.6	<0.5	0.5	<2.7	2.7	<1.6	1.6	<0/5	0.5	<2.7	2.7	<1.6	1.6	<0.5	0.5
LEAD 210 precision(±)	pCi/L	1.6		0.9		0.3		1.6		0.9		0.3		1.6		0.9		0.3	
LEAD 210 MDC	pCi/L	2.7		1.6		0.5		2.7		1.6		0.5		2.8		1.6		0.5	
POLONIUM 210	pCi/L	<0.5	0.05	<0.3	0.3	<0.3	0.3	<0.4	0.4	<0.4	0.4	<0.3	0.3	<0.4	0.4	<0.4	0.4	<0.3	0.3
POLONIUM 210 precision(±)	pCi/L	0.2		0.2		0.2		0.3		0.2		0.1		0.2		0.2		0.2	
POLONIUM MDC	pCi/L	0.5		0.3		0.3		0.4		0.4		0.3		0.4		0.4		0.3	
RADIUM 226	pCi/L	<0.2	0.2	<0.08	0.08	<0.1	0.1	<0.2	0.2	0.1	0.08	0.2	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1
RADIUM 226 precision(±)	pCi/L	0.08		0.04		0.08		0.07		0.07		0.1		0.09		0.09		0.08	
RADIUM 226 MDC	pCi/L	0.2		0.08		0.1		0.2		0.08		0.1		0.2		0.1		0.1	
THORIUM 230	pCi/L	<0.03	0.03	0.1	0.03	<0.06	0.06	0.04	0.03	0.06	0.03	0.2	0.05	<0.06	0.06	0.06	0.05	<0.08	0.08
THORIUM 230 precision(±)	pCi/L	0.02		0.04		0.04		0.03		0.03		0.06		0.03		0.04		0.04	
THORIUM 230 MDC	pCi/L	0.03		0.03		0.06		0.03		0.03		0.05		0.06		0.05		0.08	

Table 6.1-12 Three Crow Expansion Area Monitor Well Radiological (Dissolved and Suspended) Results 2008-2009

MAJOR IONS	UNITS	MILLER (273) 11/20/2009		MILLER (273) 12/04/2009		MILLER (27S 12/18/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED							
LEAD 210	pCi/L	<0.7	0.7	<0.7	0.7	<1.2	1.2
LEAD 210 precision(±)	pCi/L	0.4		0.4		0.7	
LEAD 210 MDC	pCi/L	0.7		0.7		1.2	
POLONIUM 210	pCi/L	<0.6	0.6	<0.5	0.5	<0.7	0.7
POLONIUM 210 precision(±)	pCi/L	0.4		0.5		0.5	
POLONIUM MDC	pCi/L	0.6		0.5		0,7	
RADIUM 226	pCi/L	<0.19	0.19	<0.14	0.14	<0.19	0.19
RADIUM 226 precision(±)	pCi/L	0.13		0.08		0.08	
RADIUM 226 MDC	pCi/L	0.19		0.14		0.19	
THORIUM 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.2	0.2
THORIUM 230 precision(±)	pCi/L	0.08		0.07		0.07	
THORIUM 230 MDC	pCi/L	0.2		0.1		0.2	
URANIUM	mg/L	<0.0003	0.0003	0.0142	0.0003	0.0009	0.0003
RADIONUCLIDES-SUSPENDED							
LEAD 210	pCi/L	<2.8	2.8	<1.6	1.6	<0.5	0.5
LEAD 210 precision(±)	pCi/L	1.6		0.9		0.3	
LEAD 210 MDC	pCi/L	2.8		1.6		0.5	
POLONIUM 210	pCi/L	<0.4	0.4	<0.3	0.3	<0.2	0.2
POLONIUM 210 precision(±)	pCi/L	0.2		0.2		0.09	
POLONIUM MDC	pCi/L	0.4		0.3		0.2	
RADIUM 226	pCi/L	<0.2	0.2	0.1	0.09	<0.1	0.1
RADIUM 226 precision(±)	pCi/L	0.07		0.07		0.09	
RADIUM 226 MDC	pCi/L	0.2		0.09		0.1	
THORIUM 230	pCi/L	<0.04	0.04	8.1	0.05	<0.07	0.07
THORIUM 230 precision(±)	pCi/L	0.03		0.9		0.05	
THORIUM 230 MDC	pCi/L	0.04		0.05		0.07	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	COW 2006-1		COW 2006-1		COW 2006-1		COW 2006-2		COW 2006-2		COW 2006-2		COW 2006-3		COW 2006-3		COW 2006-3	
		12/2/2008		12/16/2008		1/5/2009		12/2/2008		12/16/2008		1/5/2009		12/3/2008		12/17/2008		1/5/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	343	1.0	346	1.0	349	1.0	310	1.0	311	1.0	317	1.0	328	1.0	333	1.0	334	1.0
CARBONATE AS CO3	mg/L	13	1.0	10	1.0	12	1.0	12	1.0	10	1.0	11	1.0	<1.0	1.0	9	1.0	11	1.0
BICARBONATE AS HCO3	mg/L	392	1.0	403	1.0	402	1.0	353	1.0	358	1.0	363	1.0	401	1.0	389	1.0	386	1.0
CALCIUM	mg/L	9	1.0	10	1.0	9	1.0	12	1.0	11	1.0	10	1.0	12	1.0	12	1.0	12	1.
CHLORIDE	mg/L	182	1.0	176	1.0	169	1.0	274	1.0	264	1.0	237	1.0	172	1.0	168	1.0	166	1.0
FLUORIDE	mg/L	1.2	0.1	1.1	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.3	0.1	1.3	0.1
MAGNESIUM	mg/L	3	1.0	3	1.0	3	1.0	3	1.0	3	1.0	3	1.0	3	1.0	3	1.0	3	1.0
NITROGEN, AMMONIA AS N	mg/L	0.44	0.05	0.45	0.05	0.46	0.05	0.49	0.05	0.52	0.05	0.52	0.05	0.46	0.05	0.48	0.05	0.48	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
POTASSIUM	mg/L	8	1.0	7	1.0	7	1.0	11	1.0	12	1.0	10	1.0	8	1.0	8	1.0	8	1.0
SILICA	mg/L	16.2	0.2	15.4	0.2	14.5	0.2	16.5	0.2	14.7	0.2	14.3	0.2	14.7	0.2	14	0.2	14.2	0.2
SODIUM	mg/L	414	2.0	423	2.0	403	2.0	474	2.0	474	2.0	448	2.0	413	2.0	423	2.0	405	2.0
SULFATE	mg/L	242	1.0	244	1.0	242	1.0	289	1.0	289	1.0	291	1.0	286	1.0	285	1.0	283	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	1800	1.0	1810	1.0	1800	1.0	2130	1.0	2140	1.0	2000	1.0	1840	1.0	1870	1.0	1800	1.0
pH	s.u.	8.38	0.01	8.24	0.01	8.3	0.01	8.52	0.01	8.35	0.01	8.4	0.01	8.26	0.01	8.16	0.01	8.2	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	1040	10	1040	10	1060	10	1220	10	1230	10	1200	10	1080	10	1110	10	1100	10
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
BORON	mg/L	1.0	0.1	1.1	0.1	1.1	0.1	1.0	0.1	1.1	0.1	1.1	0.1	1.0	0.1	1.2	0.1	1.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	0.04	0.03	0.04	0.03	0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	0.01	0.01	0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.003	0.001	0.002	0.001	<0.001	0.001	0.002	0.001	0.002	0.001	<0.001	0.001	0.003	0.001	0.002	0.001	<0.001	0.001
URANIUM	mg/L	0.0014	0.0003	0.0016	0.0003	0.0014	0.0003	0.0294	0.0003	0.0339	0.0003	0.0294	0.0003	0.0042	0.0003	0.0046	0.0003	0.004	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.01	0.1	<0.01	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	4.94		6.38		4.38		4.13		4.76		3.44		4.49		5.69		3.85	
ANIONS	meq/L	17.1		17		16.9		20		19.7		19.2		17.5		17.4		17.3	
CATIONS	meq/L	18.9		19.3		18.4		21.8		21.7		20.5		19.1		19.5		18.7	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	1090		1090		1040		1270		1260		1210		1110		1120		1100	
TDS BALANCE (0.80-1.20)	dec. %	0.95		0.95		1.02		0.96		0.98		0.99		0.97		0.99		1	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	COW 2006-4		COW 2006-4		COW 2006-4		COW 2006-5		COW 2006-5		COW 2006-5		COW 2006-6		COW 2006-6		COW 2006-6	
		12/1/2008		12/15/2008		1/6/2009		1/16/2009		1/30/2009		2/13/2009		1/16/2009		1/30/2009		2/13/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	348	1.0	350	1.0	350	1.0	337	1.0	339	1.0	339	1.0	348	1.0	350	1.0	354	1.0
CARBONATE AS CO3	mg/L	10	1.0	9	1.0	10	1.0	<1.0	1.0	3	1.0	<1.0	1.0	13	1.0	12	1.0	9	1.0
BICARBONATE AS HCO3	mg/L	405	1.0	409	1.0	406	1.0	411	1.0	408	1.0	414	1.0	398	1.0	402	1.0	413	1.0
CALCIUM	mg/L	10	1.0	10	1.0	9	1.0	8	1.0	8	1.0	9	1.0	11	1.0	11	1.0	12	1.0
CHLORIDE	mg/L	172	1.0	173	1.0	174	1.0	181	1.0	179	1.0	181	1.0	215	1.0	213	1.0	202	1.0
FLUORIDE	mg/L	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.3	0.1	1.2	0.1
MAGNESIUM	mg/L	3.0	1.0	3.0	1.0	3.0	1.0	2.0	1.0	2.0	1.0	2.0	1.0	3.0	1.0	3.0	1.0	4.0	1.0
NITROGEN, AMMONIA AS N	mg/L	0.45	0.05	0.5	0.05	0.48	0.05	0.52	0.05	0.52	0.05	0.48	0.05	0.57	0.05	0.57	0.05	0.51	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
POTASSIUM	mg/L	7	1.0	6	1.0	7.0	1.0	7.0	1.0	7.0	1.0	6. 0	1.0	13	1.0	10	1.0	9.0	1.0
SILICA	mg/L	14.5	0.2	14.3	0.2	14.2		12	0.2	11.5	0.2	12	0.2	11.4	0.2	11	0.2	11.8	0.2
SODIUM	mg/L	394	2.0	398	2.0	390	2.0	372	2	383	2.0	373	1.0	428	2.0	417	2.0	432	1.0
SULFATE	mg/L	227	1.0	225	1.0	228	1.0	276	1.0	274	1.0	274	1.0	354	1.0	361	1.0	348	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	1750	1.0	1780	1.0	1700	1.0	1830	1.0	1890	1.0	1900	1.0	2130	1.0	2180	1.0	2190	1.0
pH	s.u.	8.29	0.01	8.13	0.01	8.2	0.01	8.25	0.01	8.42	0.01	8.22	0.01	8.75	0.01	8.73	0.01	8.5	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	1040	10	1050	10	1040	10	1080	10	1100	10	1100	10	1280	10	1300	10	1240	10
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1
ARSENIC	mg/L	<0.001	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
BORON	mg/L	1.1	0.1	1.1	0.1	1.0	0.1	1.0	0.1	0.9	0.1	1.0	0.1	1.1	0.1	1.0	0.1	1.2	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	0.08	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	0.11	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.002	0.001	<0.001	0.001	<0.001	0.001	0.003	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
URANIUM	mg/L	0.0013	0.0003	0.0012	0.0003	0.0012	0.0003	0.0013	0.0003	0.0012	0.0003	0.0011	0.0003	0.001	0.0003	0.0006	0.0003	0.0004	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.01	0.1
ZINC	mg/L	0.07	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.13	0.01	0.04	0.01	0.01	0.01	0.01	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	4.15		4.65		3.26		-1.76		-0.33		-1.74		-1.62		-3.51		-0.35	
ANIONS	meq/L	16.6		16.6		16.7		17.6		17.6		17.7		20.4		20.6		20.1	
CATIONS	meq/L	18.1		18.3		17.9		17		17.5		17.1		19.8		19.2		20	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	1040		1040		1040		1070		1070		1070		1250		1240		1240	
TDS BALANCE (0.80-1.20)	dec. %	1		1.01		1		1.01		1.03		1.03		1.02		1.05		1	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	COW 2006-7		COW 2006-7		COW 2006-7		CPW 2006-2		CPW 2006-2		CPW 2006-2		UBCOW 2006-1		UBCOW 2006-1		UBCOW 2006-1	
		1/16/2009		1/30/2009		2/13/2009		11/24/2008		12/8/2008		12/22/2008		11/24/2008		12/8/2008		12/22/2008	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	329	1.0	334	1.0	330	1.0	343	1.0	350	1.0	348	1.0	332	1.0	340	1.0	339	1.0
CARBONATE AS CO3	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	19	1.0	7	1.0	<1.0	1.0	13	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	401	1.0	408	1.0	403	1.0	418	1.0	389	1.0	410	1.0	405	1.0	387	1.0	413	1.0
CALCIUM	mg/L	18	1.0	16	1.0	17	1.0	9.0	1.0	9.0	1.0	10	1.0	19	1.0	19	1.0	19	1.0
CHLORIDE	mg/L	179	1.0	183	1.0	176	1.0	170	1.0	169	1.0	166	1.0	174	1.0	169	1.0	168	1.0
FLUORIDE	mg/L	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1	1.2	0.1.0	1.1	0.1	1.2	0.1
MAGNESIUM	mg/L	5.0	1.0	4.0	1.0	5.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	5.0	1.0	6	1.0	5	1.0
NITROGEN, AMMONIA AS N	mg/L	0.36	0.05	0.36	0.05	0.32	0.05	0.5	0.05	0.5	0.05	0.48	0.05	0.3	0.05	0.31	0.05	0.29	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	ND	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
POTASSIUM	mg/L	15	1.0	11	1.0	11	1.0	7.0	1.0	7.0	1.0	7.0	1.0	14	1.0	13	1.0	13	1.0
SILICA	mg/L	12.4	0.2	11.2	0.2	12.5	0.2	13.7	0.2	14.7	0.2	13.9	0.2	14.8	0.2	15.5	0.2	14.9	0.2
SODIUM	mg/L	357	2.0	335	2.0	333	1.0	415	2.0	408	2.0	410	2.0	379	2.0	367	2.0	372	2.0
SULFATE	mg/L	263	1.0	262	1.0	258	1.0	263	1.0	259	1.0	256	1.0	236	1.0	227	1.0	227	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	1780	1.0	1840	1.0	1840	1.0	1780	1.0	1820	1.0	1770	1.0	1690	1.0	1720	1.0	1740	1.0
pH	s.u.	8	0.01	8.17	0.01	8.01	0.01	8.17	0.01	8.3	0.01	8.25	0.01	7.82	0.01	8.02	0.01	8.02	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	1050	10	1090	10	1070	10	1040	10	1040	10	1070	10	988	10	980	10	1010	10
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	ND	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.002	0.001	0.002	0.001	0.003	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.007	0.001	0.007	0.001	0.007	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
BORON	mg/L	0.9	0.1	0.9	0.1	0.9	0.1	1.1	0.1	1.2	0.1	1.1	0.1	1.0	0.1	1.1	0.1	1.0	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	0.06	0.03	0.12	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	ND	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.002	0.001	0.002	0.001	0.002	0.001	0.003	0.001	0.002	0.001	<0.001	0.001	0.003	0.001	0.002	0.001	<0.001	0.001
URANIUM	mg/L	0.0053	0.0003	0.0056	0.0003	0.0052	0.0003	0.0385	0.0003	0.038	0.0003	0.0335	0.0003	0.0026	0.0003	0.0025	0.0003	0.0021	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.02	0.01	0.03	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.01	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	0.153		-4		-3.05		4.71		3.86		4.67		5.0		3.94		4.66	
ANIONS	meq/L	17.2		17.4		17		17.2		17.2		17		16.5		16.4		16.3	
CATIONS	meq/L	17.2		16		16		18.9		18.6		18.7		18.3		17.7		17.9	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	1050		1030		1020		1090		1080		1080		1050		1020		1030	
TDS BALANCE (0.80-1.20)	dec. %	1		1.06		1.05		0.95		0.96		0.99		0.94		0.96		0.98	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	UBCOW 2006-2 12/1/2008		UBCOW 2006-2 12/15/2008		UBCOW 2006-2 1/6/2009		BOW 2006-1 11/24/2008		BOW 2006-1 12/8/2008		BOW 2006-1 12/22/2008		BOW 2006-2 12/1/2008		BOW 2006-2 12/15/2008		BOW 2006-2 1/13/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	314	1.0	315	1.0	314	1.0	159	1.0	162	1.0	160	1.0	162	1.0	162	1.0	159	1.0
CARBONATE AS CO3	mg/L	8	1.0	<1.0	1.0	5	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0
BICARBONATE AS HCO3	mg/L	367	1.0	383	1.0	374	1.0	194	1.0	197	1.0	196	1.0	197	1.0	197	1.0	194	1.0
CALCIUM	mg/L	23	1.0	24	1.0	23	1.0	62	1.0	65	1.0	63	1.0	48	1.0	53	1.0	51	1.0
CHLORIDE	mg/L	175	1.0	175	1.0	174	1.0	8.0	1.0	8.0	1.0	8.0	1.0	8.0	1.0	8.0	1.0	8.0	1.0
FLUORIDE	mg/L	1.1	0.1	1.1	0.1	1.1	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1
MAGNESIUM	mg/L	7.0	1.0	7.0	1.0	7.0	1.0	4.0	1.0	4.0	1.0	4.0	1.0	4.0	1.0	4.0	1.0	4.0	1.0
NITROGEN, AMMONIA AS N	mg/L	0.28	0.05	0.3	0.05	0.3	0.05	<0.05	0.05	<0.05	0.05	ND	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	3.84	0.05	4.14	0.05	3.9	0.05	2.43	0.05	2.4	0.05	2.33	0.05
POTASSIUM	mg/L	13	1.0	13	1.0	13	1.0	10	1.0	10	1.0	10	1.0	8.0	1.0	9.0	1.0	8.0	1.0
SILICA	mg/L	15.9	0.2	15.3	0.2	15.4		73.2	0.2	69	0.2	65.4	0.2	78.1	0.2	69.4	0.2	56.3	0.2
SODIUM	mg/L	382	2.0	384	2.0	380	2.0	17	2.0	17	2.0	16	2.0	23	2.0	27	2.0	26	2
SULFATE	mg/L	292	1.0	291	1.0	290	1.0	19	1.0	18	1.0	18	1.0	17	1.0	17	1.0	18	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	1820	1.0	1870	1.0	1800	1.0	348	1.0	294	1.0	400	1.0	308	1.0	258	1.0	391	1.0
pH	s.u.	8.09	0.01	7.89	0.01	8.0	0.01	7.49	0.01	7.82	0.01	7.71	0.01	7.81	0.01	7.66	0.01	7.81	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	1110	10	1110	10	1100	10	279	10	237	10	284	10	286	10	288	10	264	10
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.007	0.001	0.008	0.001	0.007	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.006	0.001	0.007	0.001	0.007	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
BORON	mg/L	1.0	0.1	1.0	0.1	0.9	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	>0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.04	0.01	0.05	0.01	0.03	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.01	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.005	0.05	<0.5	0.05	<0.05	0.05
SELENIUM	mg/L	0.001	0.001	<0.001	0.001	<0.001	0.001	0.005	0.001	0.004	0.001	0.005	0.001	0.005	0.001	0.006	0.001	0.007	0.001
URANIUM	mg/L	0.0034	0.0003	0.0032	0.0003	0.0033	0.0003	0.0176	0.0003	0.0172	0.0003	0.0146	0.0003	0.0136	0.0003	0.0128	0.0003	0.014	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.10	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.01	0.01	0.01	0.01	<0.01	0.01	0.02	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	3.75		3.84		3.4		3.93		4.96		4.47		-0.702		4.8		3.6	
ANIONS	meq/L	17.4		17.4		17.3		4.09		4.14		4.1		3.98		4.01		3.95	
CATIONS	meq/L	18.7		18.8		18.5		4.42		4.57		4.49		3.93		4.41		4.25	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	1100		1100		1100		325		325		317		314		314		292	
TDS BALANCE (0.80-1.20)	dec. %	1.01		1.01		1		0.86		0.73		0.9		0.91		0.92		0.9	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	BOW 2006-3		BOW 2006-3		BOW 2006-3		BOW 2006-4		BOW 2006-4		BOW 2006-4		BOW 2006-5		BOW 2006-5		BOW 2006-5	
		12/1/2008		12/17/2008		1/13/2009		1/16/2009		1/30/2009		2/13/2009		11/20/2009		12/04/2009		12/18/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	159	1.0	159	1.0	160	1.0	162	1.0	170	1.0	172	1.0	392	5.0	381	5.0	383	5.0
CARBONATE AS CO3	mg/L	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<1.0	1.0	<5.0	5.0	<5.0	5.0	<5.0	5.0
BICARBONATE AS HCO3	mg/L	194	1.0	194	1.0	195	1.0	198	1.0	207	1.0	210	1.0	478	5.0	464	5.0	467	5.0
CALCIUM	mg/L	26	1.0	27	1.0	25	1.0	14	1.0	14	1.0	17	1.0	100	1.0	101	1.0	97	1.0
CHLORIDE	mg/L	4	1.0	5	1.0	4	1.0	23	1.0	11	1.0	11	1.0	14	1.0	13	1.0	13	1.0
FLUORIDE	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.1	0.1	1.2	0.1	1.3	0.1
MAGNESIUM	mg/L	2.0	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	14.0	1.0	14	1.0	14	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	2.57	0.05	2.59	0.05	2.49	0.05	2.16	0.05	2.18	0.05	2.23	0.05	<0.1	0.1	2.1	0.1	0.1	0.1
POTASSIUM	mg/L	10	1.0	11	1.0	10	1.0	10	1.0	8.0	1.0	9.0	1.0	12.0	1.0	12	1.0	12	1.0
SILICA	mg/L	81	0.2	73.2	0.2	59.9	0.2	69.9	0.2	62.7	0.2	64.5	0.2	53.1	0.2	52.5	0.2	55.6	0.2
SODIUM	mg/L	56	2.0	56	2.0	59	2.0	83	2.0	68	2.0	67	1.0	34	1.0	35	1.0	31	1.0
SULFATE	mg/L	16	1.0	16	1.0	17	1.0	25	1.0	20	1.0	23	1.0	24	1.0	25	1.0	23	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	286	1.0	239	1.0	375	1.0	466	1.0	445	1.0	311	1.0	730	1.0	735	1.0	728	1.0
pH	s.u.	8.18	0.01	7.95	0.01	8.04	0.01	8.7	0.01	8.74	0.01	8.35	0.01	8.14	0.01	7.78	0.01	7.86	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	280	10	282	10	254	10	312	10	327	10	304	10	499	10.0	470	10.0	442	10.0
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.014	0.001	0.013	0.001	0.015	0.001	0.009	0.001	0.009	0.001	0.01	0.001	0.006	0.001	0.005	0.001	0.006	0.001
BARIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.1	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	N<0.001	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	<0.001	0.001	0.003	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.07	0.01	0.06	0.01	0.08	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.003	0.001	0.003	0.001	<0.001	0.001	0.005	0.001	0.003	0.001	0.003	0.001	<0.001	0.001	<0.001	0.001	0.001	0.001
URANIUM	mg/L	0.0111	0.0003	0.0103	0.0003	0.0032	0.0003	0.0098	0.0003	0.0102	0.0003	0.0099	0.0003	0.0227	0.0003	0.0242	0.0003	0.0264	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	0.004	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	0.23	0.01	0.28	0.01	0.44	0.01	1.14	0.01	1.07	0.01	1.22	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	3.75		4.27		3.71		0.918		-3.71		-3.34		-4.89		-3.86		-5.62	
ANIONS	meq/L	3.83		3.86		3.88		4.59		4.32		4.4		8.78		8.71		8.58	
CATIONS	meq/L	4.13		4.21		4.18		4.68		4.01		4.12		7.96		8.06		7.67	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	323		316		300		352		236		323		5.02		506		493	
TDS BALANCE (0.80-1.20)	dec. %	0.87		0.89		0.85		0.89		1.39		0.94		0.990		0.930		0.900	

Table 6.1-13 Three Crow Expansion Area Monitor Well Non-Radiological Analytical Results – 2008 and 2009

MAJOR IONS	UNITS	BOW 2006-6		BOW 2006-6		BOW 2006-6		BOW 2006-7		BOW 2006-7		BOW 2006-7		MILLER WELL (273)		MILLER WELL (273)		MILLER WELL (273)	
		11/20/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		12/18/2009		11/20/2009		12/04/2009		12/18/2009	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
ALKALINITY, TOTAL AS CaCO3	mg/L	172	5.0	171	5.0	173	5.0	162	5.0	163	5.0	168	5.0	246	5.0	241	5.0	243	5.0
CARBONATE AS CO3	mg/L	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0	<5.0	5.0
BICARBONATE AS HCO3	mg/L	210	5.0	209	5.0	211	5.0	197	5.0	199	5.0	205	5.0	301	5.0	294	5.0	296	5.0
CALCIUM	mg/L	46	1.0	40	1.0	46	1.0	30	1.0	33	1.0	33	1.0	71	1.0	72	1.0	72	1.0
CHLORIDE	mg/L	4.0	1.0	4.0	1.0	4.0	1.0	4.0	1.0	16	1.0	9.0	1.0	6.0	1.0	6.0	1.0	6.0	1.0
FLUORIDE	mg/L	0.4	0.1	0.4	0.1	0.4	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1
MAGNESIUM	mg/L	7.0	1.0	5.0	1.0	6.0	1.0	3.0	1.0	3.0	1.0	3.0	1.0	6.0	1.0	5.0	1.0	6.0	1.0
NITROGEN, AMMONIA AS N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
NITROGEN, NITRATE+NITRITE AS N	mg/L	1.8	0.1	2.5	0.1	1.8	0.1	1.2	0.1	1.2	0.1	1.2	0.1	2.2	0.1	1.1	0.1	2.5	0.1
POTASSIUM	mg/L	6.0	1.0	7.0	1.0	6.0	1.0	8.0	1.0	8.0	1.0	8.0	1.0	8.0	1.0	9.0	1.0	9.0	1.0
SILICA	mg/L	2.8	0.2	61.6	0.2	64.7	0.2	68.4	0.2	66.5	0.2	72.7	0.2	64.1	0.2	61.7	0.2	65.4	0.2
SODIUM	mg/L	14	1.0	25	1.0	16	1.0	35	1.0	42	1.0	33	1.0	19	1.0	21	1.0	19	1.0
SULFATE	mg/L	10	1.0	11	1.0	9.0	1.0	15	1.0	11	1.0	11	1.0	10	1.0	10	1.0	10	1.0
PHYSICAL PROPERTIES																			
CONDUCTIVITY	umhos/cm	348	1.0	347	1.0	345	1.0	338	1.0	375	1.0	351	1.0	471	1.0	477	1.0	475	1.0
pH	s.u.	8.12	0.01	7.94	0.01	7.96	0.01	8.13	0.01	8.00	0.01	7.96	0.01	8.12	0.01	7.75	0.01	7.68	0.01
SOLIDS,TOTAL DISSOLVED TDS@180C	mg/L	242	10.0	253	10.0	221	10.0	266	10.0	276	10.0	229	10.0	320	10.0	319	10.0	312	10.0
METALS, DISSOLVED																			
ALUMINUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ARSENIC	mg/L	0.004	0.001	0.006	0.001	0.005	0.001	0.007	0.001	0.004	0.001	0.005	0.001	0.003	0.001	0.003	0.001	0.003	0.001
BARIUM	mg/L	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	<0.1	0.1	0.1	0.1
BORON	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
CADMIUM	mg/L	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005	<0.005	0.005
CHROMIUM	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
COPPER	mg/L	<0.01	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
IRON	mg/L	<0.03	0.03	<0.03	0.03	0.04	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
LEAD	mg/L	0.001	0.001	0.002	0.001	0.003	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MANGANESE	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
MERCURY	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001
MOLYBDENUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
NICKEL	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
SELENIUM	mg/L	0.003	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.002	0.001	0.003	0.001
URANIUM	mg/L	0.0083	0.0003	0.0086	0.0003	0.0097	0.0003	0.0100	0.0003	0.0103	0.0003	0.0122	0.0003	0.0137	0.0003	0.0150	0.0003	0.0168	0.0003
VANADIUM	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
ZINC	mg/L	0.62	0.01	0.70	0.01	0.64	0.01	0.29	0.01	0.36	0.01	0.30	0.01	<0.01	0.01	0.01	0.01	<0.01	0.01
DATA QUALITY																			
A/C BALANCE (± 5)	%	-1.91		-2.88		-3.84		-3.34		-1.35		-5.53		-4.48		-1.18		-3.32	
ANIONS	meq/L	3.76		3.95		3.92		3.67		4.05		3.96		5.50		5.30		5.43	
CATIONS	meq/L	3.62		3.73		3.63		3.43		3.94		3.55		5.02		5.17		5.08	
SOLIDS, TOTAL DISSOLVED CALC.	mg/L	1.90		285		281		192		301		295		359		351		360	
TDS BALANCE (0.80-1.20)	dec. %	1.27		0.890		0.790		1.39		0.920		0.780		0.890		0.910		0.870	

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Table 6.1-14 Comparison of Mean Monthly Precipitation With Normal Mean Monthly Discharge of the White River at Crawford, Nebraska

Month	Mean Precipitation [1]		Mean Discharge [2]	
	inches	centimeters	ft^3/sec	$meters^3$/sec
January	0.61	1.55	21	0.59
February	0.76	1.93	23	0.65
March	1.74	4.42	27	0.76
April	2.65	6.73	25	0.71
May	3.11	7.9	27	0.76
June	2.42	6.15	22	0.62
July	2.77	7.04	16	0.45
August	1.21	3.07	13	0.37
September	1.38	3.51	14	0.4
October	1.66	4.22	17	0.48
November	0.82	2.08	19	0.54
December	0.79	2.01	20	0.57

1 – NOAA 1981.

2 – USGS 2004. (Period of Record 1931-2004)

Table 6.1-15 Normal Mean Monthly Discharge of the White River at Crawford, Nebraska 1999 through September 2007

Month	1999 (ft^3/sec)	2000 (ft^3/sec)	2001 (ft^3/sec)	2002 (ft^3/sec)	2003 (ft^3/sec)	2004 (ft^3/sec)	2005 (ft^3/sec)	2006 (ft^3/sec)	2007 (ft^3/sec)
January	22.6	21.7	21.0	22.9	22.6	23.0	23.9	24.1	18.9
February	22.4	24.1	24.3	23.6	24.0	24.8	23.3	24.5	20.2
March	23.1	25.5	27.0	26.8	26.4	25.9	24.5	26.4	22.6
April	26.1	29.1	26.4	25.3	26.5	22.7	25.3	25.9	23.4
May	23.7	10.0	24.7	23.9	25.9	21.1	26.5	23.2	20.3
June	27.1	20.5	18.6	16.6	23.2	17.1	26.5	17.8	15.9
July	21.4	15.4	14.4	10.3	13.2	17.4	17.6	11.0	10.0
August	15.0	11.5	12.5	10.1	11.7	11.3	18.1	10.0	4.1
September	17.0	12.1	12.9	13.7	23.3	17.8	14.8	14.8	8.7
October	19.4	17.4	17.2	18.1	17.5	20.8	18.5	18.6	*
November	20.8	20.1	22.0	22.3	22.6	21.3	21.0	21.1	*
December	21.4	20.7	22.2	22.2	23.1	22.1	23.1	21.3	*
Average	**21.7**	**16.7**	**20.3**	**19.7**	**21.6**	**20.4**	**21.9**	**19.9**	**16.0***

Source: NDNR 2010. Available period of record ended 2007.
*Data not available for fourth quarter of 2007.

Table 6.1-16 Description of NDEQ Sampling Sites on the White River in Dawes and Sioux Counties, Nebraska

Station No.	Segment No.	HUC Code	Latitude & Longitude	Legal Description	Sample Type	Status of Gauge
WHITE RIVER AT FORT ROBINSON						
SWH1WHITE325	WH1-30000	101402010108	42.62777 -103.51752	SE ¼, SW¼ , Sec. 26, T31N, R53W, Sioux County	Monthly water quality and quarterly metals (reduced list)	No existing flow gauge
WHITE RIVER AT CRAWFORD						
SWH1WHITE208	WH1-20000	101402010203	42.68663 -103.41772	SE ¼, SW ¼, Sec. 3, T31N, R52W, Dawes County	Monthly water quality and quarterly metals (reduced list)	Permanent flow Gauge
WHITE RIVER NORTHEAST OF CHADRON, NE						
SW1WHITE105	WH1-10000	101402010806	42.94828 -102.90054	SW ¼, SE ¼, Sec. 6, T34N R47W, Dawes County	Monthly water quality, all quarterly metals	No existing glow gauge

Source: Lund, J. 2010

Table 6.1-17 White River Flow Measurements at Fort Robinson, Crawford and Chadron 2001 – 2009

Location	Year								
	2009	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**		**Average**
	ft^3/sec (Average flow)								
White River at Ft. Robinson (SWH1WHITE325)	29.68	17.06	10.4	11.0	--	11.2	14.5		15.6
White River at Crawford (SWH1WHITE208)	35.2	15.5	12.6	15.1	--	18.9	26.4		20.6
White River at Chadron (SWH1WHITE105)	25.5	7.41	7.0	12.5	--	13.4	10.0		12.6

Source: Lund J. 2010

Table 6.1-18 NDEQ Field Measurements of White River 2001 - 2009

Sampling Location	Date	Reporting Values	Discharge	Gage Height	Water Temperature	Dissolved Oxygen	pH	Conductivity	Turbidity
			ft^3/sec	Feet	°C	mg/l	Std. Units	umhos/cm	NTU
White River at Ft. Robinson	2009	Average	29.68	NA	10.38	9.16	8.39	314	48.6
		Minimum	11.4	NA	2.02	7.12	7.99	258	3.2
		Maximum	127.2	NA	16.40	12.52	8.82	332	386.0
	2008	Average	17.06	NA	13.90	10.21	8.41	343	8.4
		Minimum	11.2	NA	1.7	7.17	7.92	289	0.0
		Maximum	21.90	NA	21.5	11.94	8.68	444	23.6
	2007	Average	10.4	NA	12.7	9.8	8.06	316	15.1
		Minimum	4.5	NA	0.2	8.0	7.32	298	1.8
		Maximum	18.9	NA	22.9	11.2	8.66	333	84.8
	2006	Average	11.0	NA	12.24	9.12	8.34	322	6.5
		Minimum	4.7	NA	3.82	5.30	7.70	295	1.5
		Maximum	15.2	NA	22.42	11.44	8.85	342	15.9
	2005	Average	No Data	NA	12.53	9.59	8.41	336	5.08
		Minimum	No Data	NA	-0.16	7.21	7.82	282	5.5
		Maximum	No Data	NA	22.06	12.47	9.09	359	17.50
	2004	Average	11.2	NA	12.3	9.6	8.2	327	4.4
		Minimum	2.3	NA	2.4	6.3	7.3	308	0.9
		Maximum	20.0	NA	21.8	11.7	8.9	351	8.4
	2003	Average	14.47	NA	10.80	10.62	8.38	344	5.1
		Minimum	8.85	NA	1.66	8.91	8.05	321	0.0
		Maximum	16.94	NA	21.55	11.75	8.62	356	15.9

Table 6.1-18 NDEQ Field Measurements of White River 2001 - 2009

Sampling Location	Date	Reporting Values	Discharge	Gage Height	Water Temperature	Dissolved Oxygen	pH	Conductivity	Turbidity
			ft³/sec	Feet	°C	mg/l	Std. Units	umhos/cm	NTU
White River at Ft. Robinson	2002	Average	No Data	NA	15.62	11.33	8.67	344	3.8
		Minimum	No Data	NA	4.39	9.85	8.5	320	0.0[a]
		Maximum	No Data	NA	27.1	12.72	9.16	354	8.2[a]
	2001	Average	No Data	NA	No Data	No Data	No Data	No Data	No Data
		Minimum	No Data	NA	No Data	No Data	No Data	No Data	No Data
		Maximum	No Data	NA	No Data	No Data	No Data	No Data	No Data
White River at Crawford	2009	Average	35.2	2.5	9.28	8.51	8.27	347.2	39.5
		Minimum	10.3	2.00	-0.25	6.45	7.66	317	4.1
		Maximum	121.0	3.86	17.71	11.7	8.71	389	319.0
	2008	Average	15.5	2.10	13.5	8.88	8.22	367.4	34.0
		Minimum	4.0	1.84	0.5	6.45	7.90	313	5.4
		Maximum	28.0	2.38	21.0	12.32	8.77	467	78.1
	2007	Average	12.6	2.03	12.4	8.8	7.82	341.8	43.4
		Minimum	5.0	1.70	0.6	7.1	7.42	325	4.2
		Maximum	20.0	2.30	22.5	10.8	8.21	366	233.0
	2006	Average	15.1	2.20	11.9	8.6	8.04	364.4	18.7
		Minimum	<3.0	1.85	1.10	4.17	7.52	329	4.2
		Maximum	26.0	2.36	21.27	11.87	8.47	607	47.6
	2005	Average	--	--	12.23	8.27	8.01	360	22.6
		Minimum	No Data	No data	0.75	7.47	7.12	294	2.40
		Maximum	No Data	No data	21.90	11.15	8.39	389	113.0
	2004	Average	18.9	2.25	12.0	9.0	8.0	352	12.1
		Minimum	14.7	2.12	1.2	5.9	7.0	335	2.6
		Maximum	27.4	2.49	21.7	10.8	8.5	374	21.8

Table 6.1-18 NDEQ Field Measurements of White River 2001 - 2009

Sampling Location	Date	Reporting Values	Discharge	Gage Height	Water Temperature	Dissolved Oxygen	pH	Conductivity	Turbidity
			ft³/sec	Feet	°C	mg/l	Std. Units	umhos/cm	NTU
White River at Crawford	2003	Average	26.4	2.38	10.63	10.35	8.20	374	8.9
		Minimum	13.6	2.08	0.81	7.85	7.95	349	0.9
		Maximum	121.2	4.1	21.16	11.51	8.48	386	23.6
	2002	Average	--	2.21	11.38	11.52	8.03	382	6.3
		Minimum	No Data	1.87	0.2	8.43	6.11	355	0
		Maximum	No Data	2.47	25.7	16.75	8.46	403	16.1
	2001	Average	No Data	2.29	10.58	11.36	8.13	368	10.0
		Minimum	No Data	1.85	2.20	7.82	7.00	323	1.0
		Maximum	No Data	2.48	26.10	15.63	9.33	412	38.5
White River at Chadron	2009	Average	25.5	NA	9.46	7.97	8.18	511	760
		Minimum	6.0[a]	NA	-0.22	5.85	7.20	267	5.2
		Maximum	48.3[a]	NA	21.52	11.35	8.72	663	5999
	2008	Average	7.41	NA	10.82	7.60	8.13	576	398
		Minimum	0.7	NA	-0.2	4.21	7.68	514	11.8
		Maximum	14.3	NA	23.1	12.99	8.62	631	2000
	2007	Average	7.0	NA	8.35	8.6	7.76	669	75.3
		Minimum	Dry[a]	NA	-0.2	6.0	7.29	561[a]	22.1
		Maximum	17.3[a]	NA	19.5	12.5	8.18	798[a]	136.0
	2006	Average	12.5	NA	10.80	7.76	7.94	698	110
		Minimum	Dry	NA	-0.26	3.01	7.32	485	7.0
		Maximum	34.8	NA	22.0	12.18	8.55	1038	305.0

Table 6.1-18 NDEQ Field Measurements of White River 2001 - 2009

Sampling Location	Date	Reporting Values	Discharge	Gage Height	Water Temperature	Dissolved Oxygen	pH	Conductivity	Turbidity
			ft³/sec	Feet	°C	mg/l	Std. Units	umhos/cm	NTU
White River at Chadron	2005	Average	No Data	NA	11.90	7.96	55.26	653	138
		Minimum	No Data	NA	-0.24	4.82	7.44	527	22.9
		Maximum	No Data	NA	24.22	10.94	8.95	1074	520.0
	2004	Average	13.4	NA	12.42	7.6	8.0	590	622
		Minimum	1.4	NA	-0.2	5.2	7.1	257	7.2
		Maximum	37.0	NA	24.2	11.1	8.9	930	5999
	2003	Average	10.01	NA	8.45	9.91	8.05	683	243
		Minimum	0.972[a]	NA	-0.15	5.4	7.7	495	15.0
		Maximum	27.08[a]	NA	22.44	14.95	8.43	972	2000
	2002	Average	No Data	NA	8.76	10.48	8.10	730	61
		Minimum	No Data	NA	-0.18	3.8	7.86	505	19[a]
		Maximum	No Data	NA	24.0	15.9	8.33	898	115[a]
	2001	Average	19.92	NA	9.59	11.08	7.82	624	181
		Minimum	5.9[a]	NA	0.20	7.76	6.00	297	8.47[a]
		Maximum	51.2[a]	NA	26.60	15.30	8.86	826	631[a]

Source: Lund, J. 2010
[a] Missing data: see **Appendix I** for full set of field measurement data.
Sampling locations shown on **Figure 6.1-7**
Complete set of sampling data shown in **Appendix I.**
ft³/sec = feet cubed per second
NTU = Nephelometric Turbidity Unit
umhos/cm = micromhos/cm

Table 6.1-19 Station Number SWH1WHITE325, White River, Fort Robinson, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
01/07/08	0.07		48.78	2.38	7.422	0.93	20.5		12.32		
02/04/08	0.21			2.62		0.97	22				
03/03/08	0.08			2.13		0.89	36.5				0.04
04/07/08			48.83	2.24	7.011	0.86	39		11.42		0.06
05/05/08				2.18		0.59	37.5				0.05
05/12/08				2.47		0.61	32				
05/19/08	0.06					0.47	46.5			0.55	0.18
05/27/08				2.21		0.61	29.5				
06/02/08				1.96		0.47	44.5				0.05
06/09/08				2.11		0.58	13				0.05
06/16/08				1.65		0.48	9.5				
06/23/08				1.48		0.38	23				
06/30/08				2.29		0.3					
07/07/08				2.41		0.21					
07/14/08						0.21	14				
08/11/08				1.8							
08/18/08				1.48		0.34	26.5				
08/25/08				2.38		0.34	17				
09/01/08				2.68		0.4	22				
09/15/08				2.3		0.58	13				
09/29/08				3.28		0.49					
10/06/08			48.93	2.7	7.252	0.51			11.94		0.1
11/03/08	0.09			2.73		0.63	10.5				0.05
12/01/08				2.55		0.95	22.5				0.04
2008 Average	**0.102**		**48.85**	**2.27**	**7.228**	**0.56**	**25.2**		**11.89**	**0.55**	**0.069**

Table 6.1-19 Station Number SWH1WHITE325, White River, Fort Robinson, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
01/08/07	0.13		54.31	2.42	7.254	1.01	16.5		12.09		0.049869
02/05/07	0.14			2.69		1.09	125			0.553075	0.14495
03/05/07				2.76		1.03	37.5				0.064634
04/02/07			53.54	2.84	7.762	0.72	44		12.91		0.061275
04/16/07	0.06			2.41		0.72	23.5				
05/07/07				2.32		0.70	18.5				0.047956
05/21/07				2.36		0.53	17.5				0.057145
06/04/07	0.06			2.50		0.59	14.5				0.106792
06/11/07				2.07		0.48	7				
07/09/07				2.20		0.18	15				
07/23/07	0.16		46.9	1.93	7.817	0.15			11.89		
08/06/07				2.28		0.12	5				
08/20/07				2.05		0.15	6.5				0.072892
09/10/07				2.15		0.48	5.5				
09/24/07				1.95		0.43	7.5				0.049328
10/01/07			50.53	2.19	7.782	0.45			11.67		
11/05/07	0.41			2.05		0.63	21				0.049024
12/03/07				2.34		0.97	10.5				
2007 Average	**0.16**		**51.32**	**2.31**	**7.654**	**0.58**	**23.44**		**12.14**	**0.553075**	**0.070387**
01/09/06	< 0.05	< 1.0	50.7	2.4	7.12	0.92	9.5	< 5.0	12.4	< 0.5	0.56
02/06/06	0.05			2.1		1.00	10			< 0.5	< 0.04
03/08/06	0.12			2.4		0.86	31.5			< 0.5	0.05
04/03/06	0.07	< 1.0	55.0	2.6	7.26	0.82	28.5	< 5.0	12.68	< 0.5	< 0.04
04/17/06	< 0.05			2.6		0.67	24.5			< 0.5	0.04
05/01/06	0.07			2.1		0.59	15			0.59	< 0.04

Table 6.1-19 Station Number SWH1WHITE325, White River, Fort Robinson, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
05/15/06	0.05			2.3		0.52	19.5			< 0.5	< 0.04
06/05/06	0.06			2.4		0.41	13.5			< 0.5	< 0.04
06/20/06	0.07			2.2		0.31	9.5			< 0.5	< 0.04
07/10/06	< 0.05	< 1.0	48.7	2.3	7.51	0.33	< 5.0	< 5.0	11.05	< 0.5	< 0.04
08/08/06	< 0.05			2.8		0.22	< 5.0			< 0.5	< 0.04
08/21/06	< 0.05			2.5		0.39	7			< 0.5	< 0.04
09/11/06	< 0.05			2.5		0.46	< 5.0			< 0.5	< 0.04
09/25/06	< 0.05			2.3		0.58	< 5.0			< 0.5	< 0.04
2006 Average	**0.07**		**51.5**	**2.4**	**7.30**	**0.58**	**16.85**		**12.04**	**0.59**	**0.22**
01/10/05	< 0.05	< 10.0	49.50	2.70	7.23	0.93	6.50	< 5.0	11.70	< 0.5	< 0.04
02/07/05	0.10			2.51		0.94	14.00			< 0.5	< 0.04
03/07/05	< 0.05			2.69		0.74	10.50			< 0.5	< 0.04
04/04/05	< 0.05	< 10.0	52.00	2.27	7.63	0.59	6.00	< 5.0	12.40	< 0.5	< 0.04
04/18/05	< 0.05			2.23		0.48	< 5.0			< 0.5	0.06
05/01/05	< 0.05			2.49		0.56	< 5.0			< 0.5	< 0.04
05/16/05	< 0.05			2.45		0.34	5.50			< 0.5	< 0.04
06/06/05	< 0.05			2.38		0.34	5.00			< 0.5	< 0.04
06/20/05	< 0.05			2.64		0.18	< 5.0			< 0.5	0.60
07/11/05	0.09	< 10.0	49.20	3.10	7.80	0.23	< 5.0	< 5.0	11.10	< 0.5	< 0.04
07/25/05	< 0.05			3.10		0.38	31.00			0.57	0.05
08/08/05	< 0.05			2.58		0.21	16.00			< 0.5	< 0.04
08/22/05	< 0.05			2.64		0.27	10.00			< 0.5	0.10
09/11/05	< 0.05			2.76		0.44	13.50			< 0.5	< 0.04
09/26/05	< 0.05			2.98		0.67	5.00			< 0.5	< 0.04
10/11/05	0.08	< 10.0	51.40	3.57	7.81	0.71	< 5.0	< 5.0	13.30	< 0.5	< 0.04

Table 6.1-19 Station Number SWH1WHITE325, White River, Fort Robinson, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
11/07/05	< 0.05			2.62		0.72	5.50			< 0.5	0.06
12/05/05	< 0.05			2.88		1.06	17.00			< 0.5	0.10
2005 Average	**0.09**		**50.53**	**2.70**	**7.62**	**0.54**	**11.19**		**12.13**	**0.57**	**0.16**
01/12/04	< 0.05		51.5	3.22	7.47	0.99	8		12.3	< 0.5	0.04
02/02/04	< 0.05			2.46		1.08	6			< 0.5	< 0.04
02/29/04	< 0.05			2.68		0.92	10			< 0.5	0.06
04/05/04	< 0.05		52.4	3.19	7.62	0.70	6.5			< 0.5	0.05
04/19/04	0.06			3.04		0.65	9.5			< 0.5	0.05
05/02/04	0.08			2.92		0.63	11.5			< 0.5	0.07
05/17/04	0.05			4.49		0.54	7.5			< 0.5	< 0.04
06/07/04	0.08			2.65		0.37	7			< 0.5	< 0.04
06/21/04	< 0.05			2.48		0.40	< 5			< 0.5	< 0.04
07/06/04	< 0.05		51.2	2.36	7.73	0.25	< 5		12.1	< 0.5	< 0.04
07/19/04	< 0.05			2.54		0.20	11.5			< 0.5	< 0.04
08/02/04	0.05			3.06		0.24	7.5			< 0.5	< 0.04
08/16/04	< 0.05			2.67		0.28	6			< 0.5	< 0.04
09/06/04	< 0.05			3.50		0.51	7			< 0.5	0.05
09/20/04	< 0.05			2.61		0.40	< 5			< 0.5	< 0.04
10/04/04	< 0.05		54.9	2.57	7.67	0.45	< 5		12.8	< 0.5	0.09
11/02/04	< 0.05			2.74		0.62	< 5			0.74	< 0.04
12/06/04	0.11			2.53		0.84	< 5			< 0.5	< 0.04
2004 Average	**0.07**		**52.5**	**2.87**	**7.62**	**0.56**	**8.17**		**12.40**	**0.74**	**0.059**
01/13/03	< .05	< 10	59.4	2.8	7.6	1.00	13		12.5	< .5	0.04
02/01/03	< .05			2.6		0.85	13.5			< .5	0.05
03/03/03	0.05			2.9		0.87	17			< .5	0.05

Table 6.1-19 Station Number SWH1WHITE325, White River, Fort Robinson, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
04/08/03	< .05	< 10	51.2	3.0	7.54	0.65	12		12.3	< .5	< .04
05/05/03	0.05			2.9		0.49	12.5			< .5	< .04
06/09/03	< .05			2.8		0.35	6			< .5	0.05
07/07/03	< .05	< 10	51.8	2.6	7.71	0.13	< 5		12.8	< .5	0.06
08/05/03	< .05			2.8		0.23	< 5			< .5	0.05
09/08/03	< .05			2.8		0.27	< 5			< .5	< .04
10/06/03	< .05	< 10	54.2	2.7	7.81	0.46	9		12.5	< .5	0.04
2003 Average	**0.05**		**54.2**	**2.8**	**7.67**	**0.53**	**11.9**		**12.5**		**0.05**
06/17/02	< 0.05			2.56		0.23	< 5			< 0.5	0.04
07/08/02	< 0.05	< 10	47.8	2.62	7.44	0.05	9.5	< 5	12.30	< 0.5	< 0.04
08/06/02	< 0.05			3.07		0.14	11			< 0.5	< 0.04
09/03/02	< 0.05			2.69		0.33	8			< 0.5	< 0.04
10/07/02	< 0.05	< 10	54	3.24	7.74	0.44	< 5	< 5	12.10	< 0.5	< 0.04
11/04/02	< 0.05			2.90		0.67	7.0			< 0.5	< 0.04
12/02/02	< 0.05			2.91		0.75	13.0			< 0.5	< 0.04
2002 Average			**50.9**	**2.85**	**7.59**	**0.37**	**9.7**		**12.20**		**0.04**
Total Average	**0.095**		**51.5**	**2.55**	**7.54**	**0.55**	**17.04**		**12.20**	**0.602**	**0.087**

Source: Lund, J. 2010
Blank spaces in column indicate no data presented.

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
01/07/08	0.06		51.18	2.9	7.394	0.7	13.5		13.5		
02/04/08	0.11			2.9		0.76	16.5				
03/03/08	0.12			2.65		0.52	11.5				
04/07/08			52.6	2.66	7.217	0.54	27.5		13.36		0.05
05/05/08				2.81		0.39	40.5				0.06
05/05/08				3.12		0.42	50.5				0.11
05/05/08				2.66		0.27	44			0.56	0.1
05/05/08				3.01		0.44	166			0.8	0.14
06/02/08				2.92		0.36	137			0.69	0.14
06/02/08				2.51		0.41	112				0.12
06/02/08				1.92		0.35	61			0.53	0.1
06/23/08				2.42		0.29	47.5				0.05
06/23/08				2.64		0.25	85				0.07
07/07/08				3.09		0.21	91				0.08
07/07/08						0.22	162				0.1
08/11/08				2.01		0.32	60				0.06
08/11/08				1.98		0.3	39.5				0.05
08/18/08				2.8							
09/01/08	0.07			3		0.34	39.5				0.05
09/01/08				3.37		0.46	101				0.08
09/01/08				2.8		0.48	31				0.05
09/01/08				3.02		0.33	16.5				
10/06/08			51.08	4.99	7.188	0.38	17.5		13.38		0.04
11/03/08				3.23		0.5	18.5				
12/01/08	0.1			3.15		0.69	7.5				

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
2008 Average	**0.092**		**51.62**	**2.86**	**7.266**	**0.41**	**58.19**		**13.41**	**0.65**	**0.081**
01/08/07			58.39	2.74	7.602	0.86	13.5		13.71		0.068365
02/05/07	0.07			3.15		0.98	109				0.100387
03/05/07				3.11		0.78	23				0.075251
04/02/07	0.12		57.92	3.42	7.96	0.46	33		14.43		0.060069
04/16/07	0.18			2.96		0.37	9.5				
05/07/07				2.93		0.43	43				0.09735
05/21/07				2.90		0.39	103			0.519621	0.119432
06/04/07	0.11			2.99		0.39	265				0.166529
06/11/07	0.07			2.46		0.34	28				
07/09/07	0.07			2.70		0.15	167			0.530721	0.119264
07/23/07	0.57		50.47	2.35	7.553	0.15	47.5		14.01		0.04811
08/06/07				2.65		0.19	62.5				
08/20/07				2.49		0.23	53.5				0.133743
09/10/07				2.45		0.38	38.5				0.089017
09/24/07	0.08			2.10		0.30	32.5				0.078473
10/01/07	0.11		53.15	2.72	7.892	0.33	18		12.97		0.084083
11/05/07	0.18			2.94		0.54					
12/03/07	0.06			2.90		0.80	5				
2007 Average	**0.15**		**54.98**	**2.78**	**7.752**	**0.45**	**61.85**		**13.78**	**0.525171**	**0.095390**
01/09/06	< 0.05	< 1.0	56.1	3.0	7.54	0.73	39	< 5.0	14.7	< 0.5	0.05
02/06/06	< 0.05			3.2		0.76	27			< 0.5	0.06
03/08/06	< 0.05			3.2		0.62	67.5			< 0.5	0.08
04/03/06	0.17	< 1.0	59.5	3.3	7.50	0.58	50.5	< 5.0	14.6	< 0.5	0.07
04/17/06	0.26			2.9		0.37	50			< 0.5	0.04

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
05/01/06	0.12			2.8		0.33	40			0.96	< 0.04
05/15/06	0.06			2.4		0.38	93			< 0.5	0.06
06/05/06	< 0.05			2.6		0.33	79.5			0.60	0.14
06/20/06	< 0.05			2.7		0.25	32			< 0.5	< 0.04
07/10/06	< 0.05	< 1.0	49.3	4.2	7.46	0.21	32.5	< 5.0	13.47	< 0.5	0.06
08/08/06	0.06			3.2		0.19	16			< 0.5	0.04
08/21/06	< 0.05			3.1		0.33	34.5			< 0.5	0.05
09/11/06	0.07			3.0		0.40	13.5			< 0.5	0.29
09/25/06	0.06			2.8		0.46	5			< 0.5	0.05
2006 Average	**0.11**		**54.94**	**3.02**	**7.50**	**0.42**	**41.43**		**14.26**	**0.78**	**0.08**
01/10/05	< 0.05	< 10.0	55.10	3.27	7.54	0.80	14.00	< 5.0	13.80	< 0.5	< 0.04
02/07/05	0.09			3.31		0.75	19.00			< 0.5	0.04
03/07/05	0.08			3.40		0.56	7.50			< 0.5	< 0.04
04/04/05	< 0.05	< 10.0	56.80	3.26	7.98	0.39	7.00	< 5.0	14.80	< 0.5	< 0.04
04/18/05	< 0.05			3.01		0.30	< 5.0			< 0.5	0.05
05/01/05	< 0.05			3.09		0.41	27.50			< 0.5	0.05
05/16/05	< 0.05			3.19		0.24	50.00			< 0.5	0.10
06/06/05	< 0.05			3.10		0.32	52.00			< 0.5	0.08
06/20/05	0.06			3.43		0.22	30.50			< 0.5	0.09
07/11/05	< 0.05	< 10.0	52.60	3.86	7.85	0.22	24.00	< 5.0	13.60	< 0.5	0.04
07/25/05	0.20			4.08		0.38	138.00			1.48	0.26
08/08/05	< 0.05			3.03		0.28	32.50			< 0.5	< 0.04
08/22/05	< 0.05			2.78		0.27	38.50			< 0.5	0.04
09/11/05	< 0.05			3.33		0.46	18.50			< 0.5	0.05
09/26/05	< 0.05			3.27		0.56	26.00			< 0.5	0.05

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
10/11/05	< 0.05	< 10.0	53.50	4.17	7.82	0.52	37.50	< 5.0	14.70	< 0.5	0.06
11/07/05	< 0.05			3.28		0.56	12.00			< 0.5	0.06
12/05/05	< 0.05			3.35		0.82	10.00			< 0.5	< 0.04
2005 Average	**0.11**		**54.50**	**3.35**	**7.80**	**0.45**	**32.03**		**14.23**	**1.48**	**0.08**
01/12/04	< 0.05		55	3.62	7.62	0.83	8.5		14.3	< 0.5	0.05
02/02/04	< 0.05			3.10		0.89	9			< 0.5	0.05
02/29/04	< 0.05			3.34		0.73	24			< 0.5	0.06
04/05/04	< 0.05		56.3	3.98	7.79	0.49	9			< 0.5	0.06
04/19/04	0.09			3.68		0.35	9			< 0.5	0.05
05/02/04	< 0.05			3.50		0.41	15			< 0.5	0.07
05/17/04	< 0.05			3.44		0.41	32.5			< 0.5	0.06
06/07/04	0.09			3.16		0.24	12			< 0.5	< 0.04
06/21/04	< 0.05			3.04		0.32	14.5			< 0.5	0.05
07/06/04	< 0.05		52.2	3.04	7.81	0.24	15		14.3	< 0.5	0.05
07/19/04	< 0.05			3.20		0.17	9.5			< 0.5	0.05
08/02/04	< 0.05			3.44		0.18	25			< 0.5	0.07
08/16/04	< 0.05			3.34		0.21	11.5			< 0.5	< 0.04
09/06/04	0.10			4.39		0.42	89			0.74	0.14
09/20/04	< 0.05			3.19		0.31	< 5			< 0.5	< 0.04
10/04/04	< 0.05		58.4	3.08	7.73	0.36	7		14.6	< 0.5	0.11
11/02/04	< 0.05			3.33		0.45	< 5			< 0.5	< 0.04
12/06/04	0.19			3.12		0.68	9.5			< 0.5	< 0.04
2004 Average	**0.12**		**55.48**	**3.39**	**7.74**	**0.43**	**18.75**		**14.40**	**0.74**	**0.07**
01/13/03	< .05	< 10	7	3.2	7.97	0.82	7		14.2	< .5	< .04
02/01/03	< .05		11	3.4		0.69	11			< .5	0.05

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
03/03/03	0.06		12.5	3.5		0.69	12.5			< .5	0.05
04/08/03	< .05	< 10	7.5	3.8	7.87	0.48	7.5		14.8	< .5	< .04
05/12/03	< .05		67	4.0		0.36	67			0.61	0.08
06/03/03	< .05		49	3.6		0.28	49			0.58	0.08
07/09/03	< .05	< 10	22	3.0	8.02	0.18	22		15.3	< .5	0.07
08/04/03	< .05		14	3.6		0.20	14			< .5	0.06
09/09/03	0.23		2900	4.7		0.61	2900			8.35	2.44
10/06/03	< .05	< 10	< 5	3.3	7.84	0.26	< 5		14.6	< .5	0.06
2003 Average	**0.14**		**343.28**	**3.61**	**7.93**	**0.46**	**343.28**		**14.73**	**3.18**	**0.36**
01/02/02	0.05	< 10	61.3	3.51	8.33	0.99	7.5	< 5	14.40	< 0.5	< 0.04
02/05/02	< 0.05		56.6	3.45	7.83	0.91	14.5		14.10	< 0.5	0.04
03/05/02	0.07		52.9	3.18	7.4	0.89	21.5		13.50	< 0.5	0.04
04/02/02	< 0.05	< 10	60.2	3.85	7.48	0.57	18.5	< 5	14.00	< 0.5	0.05
05/07/02	< 0.05		61.6	3.67	8.22	0.33	20		15.60	< 0.5	0.04
06/17/02	< 0.05			3.26		0.17	15			< 0.5	0.06
07/08/02	< 0.05	< 10	51.4	3.29	7.77	0.13	37	< 5	15.20	< 0.5	0.08
08/06/02	< 0.05			3.45		0.20	25			< 0.5	0.06
09/03/02	0.08			3.31		0.27	12			< 0.5	0.05
10/07/02	< 0.05	< 10	56.9	3.13	7.8	0.35	< 5	< 5	13.80	< 0.5	< 0.04
11/04/02	< 0.05			3.50		0.53	< 5			< 0.5	< 0.04
12/02/02	< 0.05			3.37		0.59	< 5			< 0.5	< 0.04
2002 Average	**0.07**		**57.27**	**3.41**	**7.83**	**0.49**	**19.00**		**14.37**		**0.05**
01/08/01			62.2	3.9377	8.19	0.7459815	16.5		13.2	0.511973	
02/05/01	0.0884185		46.9	3.353942	7.8	0.704935	11.5		12.5		
03/05/01			63	3.664556	7.61	0.813278	59		14.6		0.0812095

Table 6.1-20 Station Number SWH1WHITE208, White River, Crawford, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
04/02/01	0.113277		51.4	4.1118325	7.48	0.4889085	50		15.4		0.047041
05/07/01	0.064044		56.9	4.7335835	8.01	0.510237	194		17.6	0.658743	0.129153
06/04/01	0.068394		55.3	3.6949865	7.66	0.6602805	110		13.8	0.53056	0.1104615
07/09/01	0.083103		54.6	3.415668	7.57	0.3272945	59		14.9		0.114432
08/05/01	0.064998		46.4	3.745386	7.42	0.1843555			14.9		0.0477565
09/10/01			56.3	3.858378	7.8	0.31297	7		14.7		
10/01/01	0.0723245		50.5	3.2945705	7.74	0.352411	6		13.7		
11/06/01			58.2	3.4458865	7.58	0.560057			15		
12/03/01	0.0639755		58	3.2552535	7.74	0.783853	8		14.6		
2001 Average	**0.077317**		**54.98**	**3.709312**	**7.72**	**0.537047**	**52.10**		**14.58**	**0.56709**	**0.088342**
Total Average	**0.110560**		**111.51**	**3.202731**	**7.72**	**0.449386**	**65.98**		**14.32**	**1.165730**	**0.102817**

Source: Lund, J. 2010
Blank spaces in column indicate no data presented.

Table 6.1-21 Station Number SWH1WHITE105, White River Northeast, Chadron, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
01/07/08	0.07		74.5	7.22	11.97	0.53			41.52		
03/03/08	0.13			8.84		0.31	52			0.99	0.2
04/07/08			65.65	9.39	11.72		41.5		60.41		0.09
05/05/08				9.58			181			0.98	0.23
06/03/08	0.07			5.31		0.07	177			2.65	1.87
09/02/08				9.12			166			1.35	0.3
10/06/08		7.02955	62.15	5.87	10.73		77.3		37.14		0.19
11/03/08				7.85		0.06	47.5				0.14
12/01/08	0.06			8.94		0.06					0.05
2008 Average	**0.08**	**7.0296**	**67.43**	**8.01**	**11.47**	**0.21**	**106.04**		**46.36**	**1.49**	**0.38**
01/08/07			88.55	10.50	16.26	0.49			81.78		
02/05/07	0.05			11.82		0.55					
03/05/07	0.09			8.83		0.12					
04/02/07			71.51	11.10	13.57		16		68.97	0.551777	0.080949
04/16/07	0.06			10.33			79				0.077924
05/07/07	0.08			9.26			211			1.02442	0.277555
05/21/07				10.79			128			0.801414	0.229324
06/04/07	0.09			7.34		0.09	122			0.663214	0.195443
06/11/07	0.08			9.00			155			0.936286	0.219709
10/01/07	0.14		79.94	14.61	17.65		37		107.3	0.803101	0.113263
11/05/07	0.15			9.32			14.5			0.50846	0.081109
12/03/07				8.76		0.10	5.5				
2007 Average	**0.09**		**80.00**	**10.14**	**15.83**	**0.27**	**85.33**		**86.02**	**0.75552**	**0.159410**
01/09/06	0.08	< 1.0	68.3	8.9	12.40	0.37	16.5	< 5.0	60.6	< 0.5	< 0.04
02/06/06	< 0.05			9.5		0.34	10.5			< 0.5	< 0.04

Table 6.1-21 Station Number SWH1WHITE105, White River Northeast, Chadron, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
03/08/06	< 0.05			9.8		0.18	17.5			< 0.5	0.04
04/03/06	0.32	< 1.0	62.2	13.6	9.06	0.29	452	< 5.0	50.99	1.29	0.53
04/17/06	0.09			8.9		0.18	324			1.15	0.33
05/01/06	0.19			11.8		0.22	1060			2.54	1.02
05/15/06	0.16			8.9		< 0.05	111			0.77	0.14
06/05/06	0.11			8.9		< 0.05	105			0.86	0.17
06/20/06	0.08			11.7		< 0.05	119			1.31	0.19
07/10/06	< 0.05	< 1.0	61.3	11.3	11.98	< 0.05	138	< 5.0	81.17	1.59	0.29
08/08/06	0.08			11.5		< 0.05	139			1.45	0.27
08/21/06	0.12			9.6		< 0.05	129			1.44	0.27
09/25/06	0.13			9.9		< 0.05	79			1.52	0.26
2006 Average	**0.14**		**63.9**	**10.33**	**11.15**	**0.26**	**207.73**		**64.25**	**1.39**	**0.32**
01/10/05	< 0.05	< 10.0	86.40	13.51	17.50	0.53	7.50	< 5.0	89.90	< 0.5	< 0.04
02/07/05	0.05			10.43		0.32	14.00			< 0.5	0.04
03/07/05	< 0.05			10.46		0.08	31.00			< 0.5	0.05
04/04/05	< 0.05	< 10.0	72.40	12.08	14.10	0.20	184.00	< 5.0	110.00	0.63	0.18
04/18/05	< 0.05			21.96		< 0.05	158.00			1.04	0.23
05/01/05	0.15			12.11		0.31	110.00			0.68	0.20
05/16/05	0.21			11.01		0.41	2210.00			2.61	2.21
06/06/05	0.09			9.03		0.32	1090.00			2.01	1.04
06/20/05	0.16			14.36		0.28	488.00			1.77	0.69
07/11/05	< 0.05	< 10.0	65.70	9.75	10.50	0.29	204.00	< 5.0	41.10	1.00	0.25
07/25/05	0.07			11.16		0.16	330.00			1.30	0.40
08/08/05	0.21			8.56		< 0.05	110.00			0.74	0.17
08/22/05	< 0.05			7.28		0.22	406.00			1.17	0.43

Table 6.1-21 Station Number SWH1WHITE105, White River Northeast, Chadron, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
09/11/05	< 0.05			9.57		< 0.05	93.00			0.64	0.14
09/26/05	0.07			12.25		< 0.05	43.00			< 0.5	0.09
10/11/05	0.15	< 10.0	65.60	10.16	12.80	< 0.05	38.00	< 5.0	59.00	0.51	0.15
11/07/05	0.21			10.33		< 0.05	15.00			< 0.5	0.09
12/05/05	< 0.05			16.42		0.28	< 5.0			< 0.5	< 0.04
2005 Average	**0.14**		**72.53**	**11.69**	**13.73**	**0.28**	**325.38**		**75.00**	**1.18**	**0.40**
01/12/04	< 0.05		87.7	15.26	17.8	0.56	< 5		105	< 0.5	< 0.04
02/02/04	< 0.05			12.71		0.43	< 5			0.67	0.08
02/29/04	< 0.05			9.37		0.20	11			0.53	0.08
04/05/04	< 0.05		62.9	9.24	11	< 0.05	89			0.57	0.12
04/19/04	0.05			10.06		< 0.05	94			0.55	0.14
05/02/04	0.05			8.64		< 0.05	57.5			< 0.5	0.11
05/17/04	< 0.05			9.77		< 0.05	55.5			0.55	0.10
06/07/04	0.10			13.86		< 0.05	70			0.55	0.12
06/21/04	< 0.05			10.82		< 0.05	79			0.77	0.13
07/06/04	0.11		43.2	12.73	7.51	0.29	370		48.7	1.62	0.45
07/19/04	0.08			11.18		0.17	241			1.22	0.34
08/02/04	0.11			15.01		< 0.05	196			1.29	0.28
08/16/04	0.08			10.25		< 0.05	183			1.07	0.26
09/06/04	0.23			1.97		0.38	2910			6.53	3.21
09/20/04	0.05			9.82		0.06	448			1.52	0.50
10/04/04	0.09		26.4	4.20	3.86	0.39	2040		31.2	2.81	1.25
11/02/04	< 0.05			7.04		< 0.05	134			0.61	0.19
12/06/04	0.11			11.94		0.51	17.5			< 0.5	< 0.04
2004 Average	**0.10**		**55.05**	**10.22**	**10.04**	**0.33**	**437.22**		**61.63**	**1.39**	**0.46**

Table 6.1-21 Station Number SWH1WHITE105, White River Northeast, Chadron, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
01/13/03	0.05	< 10	107	13.8	19.9	0.25	15		106	< .5	< .04
02/01/03	< .05			11.2		0.58	5			< .5	0.05
03/03/03	0.05			12.7		0.45	< 5			< .5	< .04
04/08/03	0.05	< 10	69.9	13.0	12.1	<.05	75		74.5	< .5	0.10
05/05/03	0.13			8.5		0.50	3580			2.49	2.91
06/09/03	< .05			10.4		0.18	209			0.97	0.28
07/07/03	< .05	11.25	64.9	8.8	10.2	<.05	180		45.8	1.00	0.28
08/05/03	< .05			16.5		<.05	81			0.91	0.17
09/08/03	< .05			8.4		<.05	67			0.69	0.13
10/06/03	< .05	< 10	59.8	7.6	10.1	<.05	87		45	0.54	0.12
2003 Average	**0.07**		**75.40**	**11.09**	**13.08**	**0.39**	**477.67**		**67.83**	**1.10**	**0.51**
01/02/02	< 0.05	< 10	96.7	14.83	18.3	0.73	5	< 5	103.00	< 0.5	< 0.04
02/05/02	0.05		81.1	10.83	15.9	0.69	6		69.20	< 0.5	< 0.04
03/05/02	0.06		75.9	10.12	13.9	0.67	8		57.90	< 0.5	< 0.04
04/02/02	0.08	< 10	36.7	6.05	6.16	0.53	1248	< 5	63.20	2.06	1.20
05/07/02	< 0.05		58.7	16.31	10.9	0.11	1520		75.70	2.52	1.36
06/17/02	< 0.05			10.15		< 0.05	83			0.61	0.16
07/08/02	< 0.05	11.55	74.4	10.85	13.5	< 0.05	131	< 5	75.40	1.36	0.30
08/06/02	0.10			11.26		< 0.05	97			1.35	0.27
09/03/02	0.09			9.65		< 0.05	79			0.75	0.19
10/07/02	< 0.05	< 10	63	8.39	10.2	< 0.05	46	< 5	59.20	0.54	0.09
11/04/02	0.05			13.36		< 0.05	11.5			0.58	0.06
12/02/02	< 0.05			12.95		0.30	19.0			< 0.5	< 0.04
2002 Average	**0.07**		**69.50**	**11.23**	**12.69**	**0.50**	**271.13**		**71.94**	**1.22**	**0.46**
01/08/01	0.0799215		93.6	13.88383	18.1	0.9216275	28		104	0.8248095	0.081833

Table 6.1-21 Station Number SWH1WHITE105, White River Northeast, Chadron, NE

Sampling Date	Ammonia, mg/l	Arsenic, Dissolved, ug/l	Calcium, Dissolved, mg/l	Chloride, mg/l	Magnesium, Dissolved, mg/l	Nitrite + Nitrate (as N), mg/l	Residue, Nonfilterable (TSS), mg/l	Selenium, Total, ug/l	Sodium, Dissolved, mg/l	Total Kjeldahl Nitrogen, mg/l	Total Phosphorus, mg/l
02/05/01	0.063545		70.1	12.013683	15.5	0.8222615	18.5		91.7	0.5187015	0.0746595
03/05/01	0.1877735		43.3	6.227005	10.1	0.514814	306		74.7	1.8659715	0.479757
04/02/01	0.063917		61	11.293366	10.9	0.269359	110		56	0.6884615	0.134018
05/07/01	0.089157		62.8	14.9983155	15.7	0.2021355	510		105	1.5102885	0.4679395
06/04/01	0.0551175		65.9	11.4562915	12	0.463248	194		63.8	0.9829295	0.258926
07/09/01	0.1043685		48.5	8.7321115	9.63	0.4237985	878		77.4	1.6997155	0.7003655
08/05/01	0.062077		69.7	11.8997445	14.3		88		79.7	0.799391	0.1692175
09/10/01			59.1	9.6251515	10.7		96		60.4	0.9433605	0.167058
10/01/01	0.087271		60.4	9.828956	13.1		58		64	0.529504	0.104046
11/06/01			77.6	10.7712315	15.1		10.5		77.1		0.0654255
12/03/01	0.050924		78.1	11.910215	15.3	0.5643575			78.6		
2001 Average	**0.08441**		**65.84**	**11.05333**	**13.37**	**0.522700**	**208.82**		**77.70**	**1.036313**	**0.24575**
Total Average	**0.10230**		**68.06**	**10.58347**	**12.80**	**0.348082**	**282.84**		**71.34**	**1.206751**	**0.371745**

Source: Lund, J. 2010
Blank spaces in column indicate no data presented.

Table 6.1-22 Three Crow Surface Water Dissolved Radiological Baseline Data 2007 - 2009

Radionuclide	Sampling Locations							
	Icehouse Pond		Grabel Pond		Cherry Creek Pond		Sulzbach Pond	
	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/l							
First Quarter 2009								
Lead 210	<2.8	2.8	<2.8	2.8	<2.8	2.8	<0.38	3.8
Lead 210 Precision (+)	1.6	--	1.7	--	1.6	--	2.3	--
Lead 210 MDC	2.8	--	2.8	--	2.8	--	3.8	--
Polonium 210	<0.5	0.5	0.4	0.4	<0.4	0.4	<0.6	0.6
Polonium 21o Precision (+)	0.3	--	0.4	--	0.3	--	0.3	--
Polonium 210 MDC	0.5	--	0.4	--	0.4	--	0.6	--
Radium 226	<0.21	0.21	<.20	.20	<0.19	0.19	<0.08	0.08
Radium 226 Precision (+)	0.14	--	0.14	--	0.12	--	0.05	--
Radium 226 MDC	0.21	--	0.2	--	0.19	--	0.08	--
Thorium 230	<0.2	0.2	<0.4	0.4	<0.1	0.1	<0.3	0.3
Thorium 230 Precision (+)	0.2	--	0.2	--	0.05	--	0.1	--
Thorium 230 MDC	0.2	--	0.4	--	0.1	--	0.3	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0087	0.0003	0.0127	0.003	0.0154	0.0003	0.0077	0.0003
Fourth Quarter 2008								
Lead 210	<4.1	4.1	<5.4	5.4	<10.8	10.8	<5.4	5.4
Lead 210 Precision (+)	2.4	--	3.3	--	6.6	3.2	--	--
Lead 210 MDC	4.1	--	5.4	--	10.8	--	5.4	--
Polonium 210	<0.2	0.2	<0.3	0.3	<0.29	.3	<.31	0.3
Polonium 21o Precision (+)	0.2	--	0.3	--	0.3	--	0.3	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<0.18	0.18	<0.17	0.17	<0.2	0.2	<0.2	0.2
Radium 226 Precision (+)	0.07	--	0.11	--	0.1	--	0.08	--
Radium 226 MDC	0.18	--	0.17	--	0.2	--	0.2	--
Thorium 230	<0.2	0.2	<0.11	0.10	<0.07	0.07	<0.2	0.2
Thorium 230 Precision (+)	0.2	--	0.1	--	0.07	--	0.2	--
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0159	0.0003	0.0134	0.0003	0.0167	0.0003	0.013	0.0003

Table 6.1-22 Three Crow Surface Water Dissolved Radiological Baseline Data 2007 - 2009

Radionuclide	Sampling Locations							
	Icehouse Pond		Grabel Pond		Cherry Creek Pond		Sulzbach Pond	
	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/l							
Third Quarter 2008								
Lead 210	<2.1	2.1	<2.1	2.1	<2.1	2.1	<12.5	12.5
Lead 210 Precision (±)	1.3	--	1.3	--	1.3	--	7.4	--
Lead 210 MDC	2.1	--	2.1	--	2.1	--	12.5	--
Polonium 210	<0.4	0.4	0.8	<0.8	0.6	<0.6	<0.8	0.8
Polonium 21o Precision (±)	0.4	--	0.8	--	0.6	--	0.8	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<0.26	0.26	<0.22	0.22	<0.2	0.2	<0.2	0.2
Radium 226 Precision (±)	0.12	--	0.13	--	<0.1	0.2	<0.09	0.09
Radium 226 MDC	0.26	--	0.22	--	0.2	--	0.2	--
Thorium 230	<0.2	0.2	<0.1	0.1	<0.07	0.07	<0.1	0.1
Thorium 230 Precision (±)	0.2	--	0.1	--	0.07	--	0.1	--
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0063	0.0003	0.0125	0.0003	0.0147	0.0003	0.0029	0.0003
Second Quarter 2008								
Lead 210	<30.2	30.2	<29.3	29.3	<29.7	29.7	<9.4	9.4
Lead 210 Precision (±)	18.0	--	17.4	--	17.9	--	5.6	--
Lead 210 MDC	30.2	--	29.3	--	29.7	--	9.4	--
Polonium 210	<1.0	1.0	<0.8	0.8	<1.0	1.0	<0.5	0.5
Polonium 21o Precision (±)	0.9	--	0.8	--	0.1	--	0.5	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	0.2	0.2	0.2	0.1	0.3	0.1	<0.2	0.2
Radium 226 Precision (±)	0.1	--	0.1	--	0.1	--	0.1	--
Radium 226 MDC	0.1	--	0.1	--	0.1	--	0.2	--
Thorium 230	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Thorium 230 Precision (±)	0.1	--	0.1	--	0.1	--	0.1	--
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--

Table 6.1-22 Three Crow Surface Water Dissolved Radiological Baseline Data 2007 - 2009

Radionuclide	Sampling Locations							
	Icehouse Pond		Grabel Pond		Cherry Creek Pond		Sulzbach Pond	
	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/l							
Uranium, mg/l	0.013	0.0003	0.0137	0.0003	0.013	0.0003	0.0154	0.0003
First Quarter 2008								
Lead 210	--	--	--	--	--	--	--	--
Lead 210 Precision (±)	--	--	--	--	--	--	--	--
Lead 210 MDC	--	--	--	--	--	--	--	--
Polonium 210	--	--	--	--	--	--	--	--
Polonium 210 Precision (±)	--	--	--	--	--	--	--	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<0.17	0.17	<0.18	0.18	<0.17	0.17	--	--
Radium 226 Precision (±)	0.083	--	0.1	--	0.099	--	--	--
Radium 226 MDC	0.17	--	0.18	--	0.17	--	--	--
Thorium 230								
Thorium 230 Precision (±)								
Thorium 230 MDC								
Uranium Activity	9.0	0.2	9.3	0.2	11.3	0.2	--	--
Uranium, mg/l	0.0133	0.0003	0.0137	0.0003	0.0166	0.0003	--	--
Fourth Quarter 2007								
Lead 210	<1.0	1.0	<1.0	1.0	<1.0	1.0	--	--
Lead 210 Precision (±)	--	--	--	--	--	--	--	--
Lead 210 MDC	--	--	--	--	--	--	--	--
Polonium 210	<1.0	1.0	<1.0	1.0	<1.0	1.0	--	--
Polonium 210 Precision (±)	--	--	--	--	--	--	--	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<1.0	1.0	<0.2	0.2	<0.2	0.2		
Radium 226 Precision (±)	--	--	--	--	--	--	--	--
Radium 226 MDC	--	--	--	--	--	--	--	--
Thorium 230	<0.2	0.2	<0.2	0.2	<0..2	0.2		
Thorium 230 Precision (±)	--	--	--	--	--	--	--	--

Table 6.1-22 Three Crow Surface Water Dissolved Radiological Baseline Data 2007 - 2009

Radionuclide	Sampling Locations							
	Icehouse Pond		Grabel Pond		Cherry Creek Pond		Sulzbach Pond	
	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/l							
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0125	0.0003	0.0133	0.0003	0.0165	0.0003	--	--
Third Quarter 2007								
Lead 210	--	--	--	--	--	--	--	--
Lead 210 Precision (±)	--	--	--	--	--	--	--	--
Lead 210 MDC	--	--	--	--	--	--	--	--
Polonium 210	--	--	--	--	--	--	--	--
Polonium 210 Precision (±)	--	--	--	--	--	--	--	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<0.2	0.2	<0.2	0.2	<0.2	0.2	--	--
Radium 226 Precision (±)	--	--	--	--	--	--	--	--
Radium 226 MDC	--	--	--	--	--	--	--	--
Thorium 230	--	--	--	--	--	--	--	--
Thorium 230 Precision (±)	--	--	--	--	--	--	--	--
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0185	0.0003	0.0141	0.0003	0.0041	0.0003	--	--
Second Quarter 2007	--	--	--	--	--	--	--	--
Lead 210	<1.0	1.0	<1.0	1.0	<1.0	1.0	--	--
Lead 210 Precision (±)	--	--	--	--	--	--	--	--
Lead 210 MDC	--	--	--	--	--	--	--	--
Polonium 210	<1.0	1.0	<1.0	1.0	7.0	1.0	--	--
Polonium 210 Precision (±)	--	--	--	--	3.9	--	--	--
Polonium 210 MDC	--	--	--	--	--	--	--	--
Radium 226	<0.2	0.2	<0.2	0.2	<0.2	0.2	--	--
Radium 226 Precision (±)	--	--	--	--	--	--	--	--
Radium 226 MDC	--	--	--	--	--	--	--	--

Table 6.1-22 Three Crow Surface Water Dissolved Radiological Baseline Data 2007 - 2009

Radionuclide	Sampling Locations							
	Icehouse Pond		Grabel Pond		Cherry Creek Pond		Sulzbach Pond	
	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/l							
Thorium 230	<0.2	0.2	<0.2	0.2	<0.2	0.2	--	--
Thorium 230 Precision (±)	--	--	--	--	--	--	--	--
Thorium 230 MDC	--	--	--	--	--	--	--	--
Uranium Activity	--	--	--	--	--	--	--	--
Uranium, mg/l	0.0078	0.0003	0.014	0.0003	0.014	0.0003	--	--

Table 6.1-23 Three Crow Surface Water Non-Radiological Sampling Results

Parameter	Units	Ice House Pond (I-10)	Cherry Creek Pond (I-11)	Grabel Ponds	Sulzbach Pond (I-9)	Reporting Limit
Fourth Quarter 2008						
Alkalinity, Total, as $CaCO_3$	mg/l	229	223	214	236	1.0
Carbonate as CO_3	mg/l	<1.0	<1.0	<1.0	<1.0	1.0
Bicarbonate as HCO_3	mg/l	280	273	261	288	1.0
Calcium	mg/l	72	83	66	52	1.0
Chloride	mg/l	14	6	4	20	1.0
Fluoride	mg/l	0.7	0.6	0.6	1.4	0.1
Magnesium	mg/l	6	7	7	15	1.0
Nitrogen, Ammonia as N	mg/l	<0.05	<0.05	<0.0	<0.05	0.05
Nitrogen, Nitrate + Nitrite as N	mg/l	<0.05	1.27	1.63	<0.05	0.05
Nitrogen, Nitrite as N	mg/l	--	--	--	--	--
Potassium	mg/l	24	13	7	18	1.0
Silica	mg/l	41.9	65.1	69.5	21.8	0.1
Sodium	mg/l	38	30	23	45	2.0
Sulfate	mg/l	22	15	11	18	1.0
PHYSICAL PROPERTIES						
Conductivity	umhos/cm	521	444	411	518	1.0
pH	std. units	7.96	7.93	7.81	8.17	0.01
Solids, Total Dissolved @180°C	mg/l	349	332	323	371	10
METALS, DISSOLVED						
Aluminum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Arsenic	mg/l	0.005	0.003	0.003	0.005	0.001
Barium	mg/l	0.1	0.1	<0.1	<0.1	0.1
Boron	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Cadmium	mg/l	<0.005	<0.005	<0.005	<0.005	0.005
Chromium	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Copper	mg/l	<0.01	<0.01	<0.01	<0.01	0.01
Iron	mg/l	0.06	<0.03	<0.03	<0.03	0.03
Lead	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	mg/l	0.1	<0.01	<0.01	<0.01	0.01
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Molybdenum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Nickel	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Selenium	mg/l	<0.001	0.002	0.002	<0.001	0.001
Uranium	Mg/l	0.0159	0.0167	0.0134	0.013	0.0003
Vanadium	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Zinc	mg/l	0.02	<0.01	<0.1	<0.01	0.01
DATA QUALITY						
A/C Balance (± 5)	%	7.87	11.2	2.85	4.99	--
Anions	meq/l	5.47	5.07	4.78	5.72	--
Cations	meg/l	6.41	6.35	5.06	6.32	--
Solids, Total Dissolved Calc.	mg/l	369	377	343	340	--
TDS Balance (0.80-1.20)	dec.%	0.95	0.88	0.94	1.09	--

Table 6.1-23 Three Crow Surface Water Non-Radiological Sampling Results

Parameter	Units	Ice House Pond (I-10)	Cherry Creek Pond (I-11)	Grabel Ponds	Sulzbach Pond (I-9)	Reporting Limit
Third Quarter 2008						
Alkalinity, Total, as $CaCO_3$	mg/l	187	219	215	201	1.0
Carbonate as CO_3	mg/l	<1.0	<1.0	<1.0	14	1.0
Bicarbonate as HCO_3	mg/l	228	267	262	216	1.0
Calcium	mg/l	42	60	59	34	1.0
Chloride	mg/l	10	6	5	13	1.0
Fluoride	mg/l	0.7	0.6	0.7	1.5	0.1
Magnesium	mg/l	4	5	7	14	1.0
Nitrogen, Ammonia as N	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Nitrate + Nitrite as N	mg/l	<0.05	1.44	1.57	<0.05	0.05
Nitrogen, Nitrite as N	mg/l	--	--	--	--	--
Potassium	mg/l	18	12	8	16	1.0
Silica	mg/l	7.6	14.5	15	5	0.1
Sodium	mg/l	33	25	25	47	2.0
Sulfate	mg/l	17	12	12	19	1.0
PHYSICAL PROPERTIES						
Conductivity	umhos/cm	405	439	427	458	1.0
pH	std. units	7.54	7.56	7.62	8.94	0.01
Solids, Total Dissolved @180°C	mg/l	295	321	313	321	10
METALS, DISSOLVED						
Aluminum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Arsenic	mg/l	0.004	0.004	0.004	0.007	0.001
Barium	mg/l	<0.1	0.1	<0.1	<0.1	0.1
Boron	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Cadmium	mg/l	<0.005	<0.005	<0.005	<0.005	0.005
Chromium	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Copper	mg/l	<0.01	<0.01	<0.01	<0.01	0.01
Iron	mg/l	<0.03	<.03	<0.03	<0.03	0.03
Lead	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	mg/l	0.03	<0.01	<0.01	<0.01	0.01
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Molybdenum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Nickel	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Selenium	mg/l	0.002	0.002	0.002	<0.001	0.001
Uranium	Mg/l	0.0063	0.0147	0.0125	0.0029	0.0003
Vanadium	mg/l	<0.1	0.1	<0.1	<0.1	0.1
Zinc	mg/l	<0.01	<0.01	<0.01	<0.01	0.01
DATA QUALITY						
A/C Balance (± 5)	%	-0.679	-1.49	-0.46	4.08	--
Anions	meq/l	4.42	4.93	4.83	4.87	--
Cations	meg/l	4.37	4.78	4.79	5.28	--
Solids, Total Dissolved Calc.	mg/l	248	276	271	272	--
TDS Balance (0.80-1.20)	dec.%	1.19	1.16	1.15	1.18	--

Table 6.1-23 Three Crow Surface Water Non-Radiological Sampling Results

Parameter	Units	Ice House Pond (I-10)	Cherry Creek Pond (I-11)	Grabel Ponds	Sulzbach Pond (I-9)	Reporting Limit
Second Quarter 2008						
Alkalinity, Total, as $CaCO_3$	mg/l	194	248	203	254	1
Carbonate as CO_3	mg/l	ND	ND	ND	ND	1
Bicarbonate as HCO_3	mg/l	237	303	247	309	1
Calcium	mg/l	58	82	67	90	1
Chloride	mg/l	11	5	5	12	1
Fluoride	mg/l	0.6	0.7	0.6	1.3	0.1
Magnesium	mg/l	5	6	7	15	1
Nitrogen, Ammonia as N	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Nitrate + Nitrite as N	mg/l	<0.05	0.4	1.4	<0.05	0.05
Nitrogen, Nitrite as N	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Potassium	mg/l	19	10	7	13	1
Silica	mg/l	9.4	29	33.9	11.7	0.1
Sodium	mg/l	30	32	24	40	1
Sulfate	mg/l	16	19	14	41	1
PHYSICAL PROPERTIES						
Conductivity	umhos/cm	447	529	439	603	1
pH	std. units	8.28	7.99	7.98	7.83	0.01
Solids, Total Dissolved @180°C	mg/l	289	365	308	383	10
METALS, DISSOLVED						
Aluminum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Arsenic	mg/l	0.004	0.003	0.004	0.008	0.001
Barium	mg/l	<0.1	0.2	<0.1	0.2	0.1
Boron	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Cadmium	mg/l	<0.005	<0.005	<0.005	<0.005	0.005
Chromium	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Copper	mg/l	<0.01	<0.01	<0.01	0.01	0.01
Iron	mg/l	<0.03	<0.03	<0.03	0.05	0.03
Lead	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	mg/l	0.01	0.03	<0.01	0.04	0.01
Mercury	mg/l	<0.001	<0.001	<0.001	<0.001	0.001
Molybdenum	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Nickel	mg/l	<0.05	<0.05	<0.05	<0.05	0.05
Selenium	mg/l	0.002	0.002	0.003	<0.001	0.001
Uranium	Mg/l	0.013	0.013	0.0137	0.0154	0.0003
Vanadium	mg/l	<0.1	<0.1	<0.1	<0.1	0.1
Zinc	mg/l	0.01	0.01	0.01	<0.01	0.01
DATA QUALITY						
A/C Balance (± 5)	%	5.39	5.75	5.69	10.2	--
Anions	meq/l	4.58	5.56	4.59	6.33	--
Cations	meg/l	5.1	6.24	5.15	7.76	--
Solids, Total Dissolved Calc.	mg/l	269	341	294	378	--
TDS Balance (0.80-1.20)	dec.%	1.07	1.07	1.05	1.01	--

Table 6.1-23 Three Crow Surface Water Non-Radiological Sampling Results

Parameter	Units	Ice House Pond (I-10)	Cherry Creek Pond (I-11)	Grabel Ponds	Sulzbach Pond (I-9)	Reporting Limit
THIRD QUARTER 2007						
Alkalinity, Total as $CaCO_3$	mg/l	192	563	190	--	1.0
Carbonate as CO_3	mg/l	<1.0	<1.0	<1.0	--	1.0
Bicarbonate, as HCO_3	mg/l	234	686	231	--	1.0
Calcium	mg/l	42	87	53	--	1.0
Chloride	mg/l	14	25	6	--	1.0
Fluoride	mg/l	0.9	1.8	0.6	--	0.1
Magnesium	mg/l	9	22	8	--	1.0
Nitrogen, Ammonia as N	mg/l	0.05	0.15	0.05	--	0.05
Nitrogen, Nitrate + Nitrite as N	mg/l	<0.1	<0.1	0.4	--	0.1
Nitrogen, Nitrite as N	mg/l	<0.1	<0.1	<0.1	--	0.1
Potassium	mg/l	23	36	8	--	1.0
Silica	mg/l	29.3	39.8	45.4	--	0.1
Sodium	mg/l	41	142	26	--	1.0
Sulfate	mg/l	25	18	14	--	1.0
PHYSICAL PROPERTIES						
Conductivity	umho/cm	439	1140	365	--	1.0
pH	std. units	8.08	8.08	7.9	--	0.01
Solids, Total Dissolved @ 180°C	mg/l	294	770	258	--	10
METALS, DISSOLVED						
Aluminum	mg/l	<0.1	<0.1	<0.1	--	0.1
Arsenic	mg/l	0.006	0.005	0.004	--	0.001
Barium	mg/l	<0.1	0.3	<0.1	--	0.1
Boron	mg/l	<0.1	0.2	<0.1	--	0.1
Cadmium	mg/l	<0.005	<0.005	<0.005	--	0.005
Chromium	mg/l	<0.05	<0.05	<0.05	--	0.05
Copper	mg/l	<0.01	<0.01	<0.01	--	0.01
Iron	mg/l	<0.03	0.17	<0.03	--	0.03
Lead	mg/l	<0.001	<0.001	<0.001	--	0.001
Manganese	mg/l	0.02	0.17	<0.01	--	0.01
Mercury	mg/l	<0.001	<0.001	<0.001	--	0.001
Molybdenum	mg/l	<0.1	<0.1	<0.1	--	0.1
Nickel	mg/l	<0.05	<0.05	<0.05	--	0.05
Selenium	mg/l	0.002	ND	0.002	--	0.001
Vanadium	mg/l	<0.1	<0.1	<0.1	--	0.1
Zinc	mg/l	<0.01	<0.01	<0.01	--	0.01
DATA BALANCE						
A/C Balance (± 5)	%	4.06	3.68	3.49	--	--
Anions	meq/l	4.79	12.4	4.31	--	--
Cations	meg/l	5.19	13.3	4.62	--	--
Solids, Total Dissolved Calc.	mg/l	298	710	276	--	--
TDS Balance (0.80-1.20)	dec.%	0.99	1.08	0.93	--	--

Table 6.1-24 Three Crow Vegetation Monitoring 2009

Collection Date	Radionuclide	Three Crow West Side		Three Crow Middle Side		Three Crow East Side	
		Results	RL	Results	RL	Results	RL
		uCi/kg					
7/08/2009	Lead 210	4.80E-04	9.00E-06	3.60E-04	7.40E-06	5.8E-04	7.6E-06
	Lead 210 Precision (±)	9.30E-06		7.30E-06		8.8E-06	
	Lead 210 MDC	9.00E-06		7.40E-06		7.6E-06	
	Polonium 210	5.50E-05	1.40E-06	7.30E-06	7.80E-07	5.6E-06	6.7E-07
	Polonium 210 Precision (±)	1.60E-05		2.60E-06		1.9E-06	
	Polonium 210 MDC	1.40E-06		7.80E-07		6.7E-07	
	Radium 226	1.40E-05	4.80E-08	1.00E-05	4.10E-08	1.00E-05	4.2E-08
	Radium 226 Precision (±)	3.10E-07		2.40E-07		2.5E-07	
	Radium 226 MDC	4.80E-08		4.10E-08		4.2E-08	
	Thorium 230	8.80E-06	2.70E-06	8.60E-06	1.70E-06	<7.1E-06	7.1E-06
	Thorium 230 Precision (±)	2.40E-06		2.10E-06		4.3E-06	
	Thorium 230 MDC	2.70E-06		1.70E-06		7.1E-06	
	Uranium Activity	2.30E-05	2.00E-07	1.70E-05	2.00E-07	1.6E-05	2.0E-07
	Uranium, mg/kg	0.034	0.0003	0.025	0.0003	0.024	0.00030
	Uranium, mg/kg	0.034	0.0003	0.025	0.0003	0.024	0.00030
8/03/2009	Lead 210 Precision (±)	1.50E-05		1.20E-05		1.20E-05	
	Lead 210 MDC	1.50E-05		1.50E-05		1.50E-05	
	Polonium 210	2.10E-05	1.50E-06	6.20E-06	2.60E-06	1.20E-05	1.30E-06
	Polonium 210 Precision (±)	6.00E-06		4.00E-06		4.10E-06	
	Polonium 210 MDC	1.50E-06		2.60E-06		1.30E-06	
	Radium 226	1.10E-05	6.60E-08	1.10E-05	7.20E-08	8.40E-06	1.10E-07
	Radium 226 Precision (±)	4.80E-07		5.10E-07		5.40E-07	
	Radium 226 MDC	6.60E-08		7.20E-08		1.10E-07	
	Thorium 230	5.30E-06	1.00E-06	9.70E-06	1.00E-06	2.90E-06	1.30E-06
	Thorium 230 Precision (±)	1.40E-06		2.20E-06		1.30E-06	
	Uranium Activity	1.10E-05	2.00E-07	1.60E-05	2.00E-07	4.80E-06	2.00E-07
	Uranium, mg/kg	0.016	0.0003	0.023	0.0003	0.0071	0.0003

Table 6.1-24 Three Crow Vegetation Monitoring 2009

Collection Date	Radionuclide	Three Crow West Side		Three Crow Middle Side		Three Crow East Side	
		Results	RL	Results	RL	Results	RL
		uCi/kg					
9/01/2009	Lead 210	5.50E-04	9.40E-06	4.00E-04	8.60E-06	7.00E-04	8.00E-06
	Lead 210 Precision (±)	1.10E-05		9.30E-06		1.10E-05	
	Lead 210 MDC	9.40E-06		8.60E-06		8.00E-06	
	Polonium 210	5.50E-05	9.70E-07	3.80E-05	1.80E-06	7.50E-05	1.40E-06
	Polonium 210 Precision (±)	1.10E-05		1.00E-05		1.70E-05	
	Polonium 210 MDC	9.70E-07		1.80E-06		1.40E-06	
	Radium 226	2.20E-05	1.30E-07	1.50E-05	9.10E-08	1.40E-05	9.00E-08
	Radium 226 Precision (±)	7.60E-07		5.20E-07		5.10E-07	
	Radium 226 MDC	1.30E-07		9.10E-08		9.00E-08	
	Thorium 230	3.60E-05	2.50E-06	<0.00	2.70E-06	2.30E-06	1.40E-06
	Thorium 230 Precision (±)	8.00E-06		1.80E-06		1.40E-06	
	Uranium Activity	1.40E-05	2.00E-07	1.10E-05	2.00E-07	1.10E-05	2.00E-07
	Uranium, mg/kg	0.02	0.0003	0.016	0.0003	0.016	0.0003

MDC – Minimum Detection Concentration
RL - Reporting Limit

Table 6.1-25 Three Crow Soil Baseline Sampling 2008

Radionuclides	Sampling Locations													
	AM-15		AM-16		AM-17		AM-18		AM-19		AM-20		AM-21	
	Results	RL	Results	RL	Results	RL	Results	RL	Results	RL	Results	RL	Results	RL
	pCi/gm - Dry													
July 03 2008														
Lead 210	0.4	0.2	0.3	0.2	0.6	0.2	0.4	0.2	0.6	0.2	0.6	0.2	0.6	0.2
Lead 210 Precision (±)	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--
Lead 210 MDC	0.2	--	0.2	--	0.2	--	0.2	--	0.2	--	0.2	--	0.2	--
Radium 226	0.7	0.06	0.6	0.07	0.5	0.06	0.5	0.07	0.6	0.07	0.5	0.07	0.6	0.06
Radium 226 Precision (±)	0.1	--	0.1	--	0.09	--	0.1	--	0.1	--	0.1	--	0.1	--
Radium 226 MDC	0.06	--	0.07	--	0.06	--	0.07	--	0.07	--	0.07	--	0.06	--
Thorium 230	0.3	0.1	0.2	0.09	0.3	0.1	0.4	0.1	0.4	0.1	0.3	0.1	0.3	0.1
Thorium 230 Precision (±)	0.1	--	0.09	--	0.1	--	0.1	--	0.1	--	0.1	--	0.1	--
Uranium Activity	0.6	0.3	0.4	0.3	0.4	0.3	0.6	0.3	0.6	0.3	0.6	0.3	0.6	0.3
Uranium, mg/kg	0.8	0.5	0.6	0.5	0.6	0.5	0.9	0.6	0.8	0.5	0.9	0.5	0.8	0.5

MDC – Minimum Detection Concentration RL – Reporting Limits ND – Non Detection (<RL)

Table 6.1-26 Three Crow Sediment Baseline Sampling 2007 and 2008

Radionuclides	Date	Sampling Locations							
		Cherry Creek Pond		Ice House Pond		Grabel Pond		Sulzbach Pond	
		Results	RL	Results	RL	Results	RL	Results	RL
		pCi/g - Dry							
Lead 210		1.0	0.4	0.6	0.2	0.6	0.2	<2.3	2.3
Lead 210 Precision (±)		0.3	--	0.1	--	0.1	--	1.4	--
Lead 210 MDC		0.4	--	0.2	--	0.2	--	2.3	--
Radium 226		0.4	0.07	0.2	0.08	1.0	0.07	0.4	0.06
Radium 226 Precision (±)		0.09	--	0.07	--	0.1	--	0.08	--
Radium 226 MDC	8/01/2008[1]	0.07	--	0.08	--	0.07	--	0.06	--
Polonium 210		1.3	0.3	0.6	0.2	0.6	0.3	--	--
Polonium 210 Precision (±)		0.3		0.2	--	0.3	--	--	--
Thorium 230		0.08	0.07	<0.09	0.09	0.7	0.2	--	--
Thorium 230 Precision (±)		0.07		0.09	--	0.2	--	--	--
Uranium Activity		22.0	0.3	8.3	0.3	2.4	0.3	1.4	0.3
Uranium, mg/kg		32.5	0.5	12.3	0.5	3.6	0.5	2.1	0.5
Lead 210		0.8	0.1	4.1	0.01	1.2	0.1	--	--
Lead 210 Precision (±)		0.1	--	0.3	--	0.1	--	--	--
Lead 210 MDC		--	--	--	--	--	--	--	--
Radium 226	12/19/2007[2]	0.5	0.1	0.5	0.01	0.8	0.1	--	--
Radium 226 Precision (±)		0.1	--	0.1	--	0.1	--	--	--
Uranium Activity		1.56	0.02	6.29	0.02	2.38	0.02	--	--
Uranium, mg/kg		2.3	0.03	9.29	0.03	3.51	0.03	--	--

[1] Sulzbach Pond sampled 7/29/2008
[2] Ice House Pond sampled 1/21/2008
MDC – Minimum Detection Limit

Table 6.1-27 Three Crow Expansion Area Gamma Exposure Rate Results 2007 - 2008

Environmental Thermoluminescent Detetctor			Environmental Optically Stimulated Luminescence Detector		
Location	**Date**	**Gamma Exposure Rate (mrem/qtr)**	**Location**	**Date**	**Gamma Exposure Rate (mrem/qtr)**
AM-15	01/10/07 - 04/10/07	5	AM-15	01/02/08 – 04/02/08	6.6
	04/10/07 - 07/12/07	6		04/02/08 – 07/03/08	9.1
	07/12/07 - 10/01/07	6		--	--
	10/01/07 - 01/11/08	8		--	--
AM-16	01/10/07 – 04/10/07	7	AM-16	01/02/08 – 04/02/08	6.3
	04/10/07 – 07/12/07	4		04/02/08 – 07/03/08	11.8
	07/12/07 – 10/01/07	6		--	--
	10/01/07 – 01/11/08	8		--	--
AM-17	01/10/07 – 04/10/07	3	AM-17	01/02/08 – 04/02/08	2.7
	04/10/07 – 07/12/07	5		04/02/08 – 07/03/08	8.0
	07/12/07 – 10/01/07	6		--	--
	10/01/07 – 01/11/08	7		--	--
AM-18	01/10/07 – 04/10/07	5	AM-18	01/02/08 – 04/02/08	3.3
	04/10/07 – 07/12/07	4		04/02/08 – 07/03/08	12.4
	07/12/07 – 10/01/07	6		--	--
	10/01/07 – 01/11/08	8		--	--
AM-19	01/10/07 – 04/10/07	7	AM-19	01/02/08 – 04/02/08	5.4
	04/10/07 – 07/12/-7	5		04/02/08 – 07/03/08	8.5
	07/12/07 – 10/01/07	5		--	--
	10/01/07 – 01/11/08	10		--	--
AM-20	01/10/07 – 04/10/07	5	AM-20	01/02/08 – 04/02/08	7.9
	04/10/07 – 07/12/-7	5		04/02/08 – 07/03/08	12.2
	07/12/07 – 10/01/07	4		--	--
	10/01/07 – 01/11/08	9		--	--
AM-21	01/10/07 – 04/10/07	6	AM-21	01/02/08 – 04/02/08	7.4
	04/10/07 – 07/12/-7	3		04/02/08 – 07/03/08	13.4
	07/12/07 – 10/01/07	6		--	--
	10/01/07 – 01/11/08	10		--	--
AM-26[1]	01/02/07 – 04/02/07	5	AM-26[1]	01/02/08 – 04/02/08	8.1
	04/02/07 – 07/02/07	6		04/02/08 – 07/07/08	7.4
	07/02/07 – 10/01/07	7		--	--
	10/01/07 – 01/02/08	5		--	--

[1] Background

Table 6.1-28 Three Crow Expansion Area Preoperational Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	**Number**	**Location**	**Method**	**Frequency**	**Frequency**	**Type of Analysis**
Air Particulates	3	On TCEA northern boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Nearest Resident	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Control background location east of TCEA License Boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon Gas	3	On TCEA northern boundary	Continuous using RadTrak Type DRNF	Quarterly	Quarterly	Rn-222
	1	Nearest Resident	Continuous using RadTrak Type DRNF	Quarterly	Quarterly	Rn-222
	1	Control background location east of TCEA License Boundary	Continuous using RadTrak Type DRNF	Quarterly	Quarterly	Rn-222
Groundwater	1	Wells within 0.5 Mile of site boundary (W-269, W-274, W-275, W-312, W-314	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Th-230 Pb-210 & Po-210

Table 6.1-28 Three Crow Expansion Area Preoperational Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	Number	Location	Method	Frequency	Frequency	Type of Analysis
Surface Water	2 [1]	White River (W-4 and W-5) Cherry Creek, Unnamed Creek, Bozle Creek	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, & Th-230
			Grab	--	Semiannually	Suspended & Dissolved Pb-210 & Po-210
	1	Cherry Creek Pond, Ice House Pond, Sulzbach Pond, & Grabel Pond(s)	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, & Th-230
			Grab	--	Semiannually	Suspended & Dissolved Pb-210 & Po-210
Vegetation	3	Grazing areas near the site in different sectors that will have the highest predicted air particulate concentrations during milling operations	Grab	3 times during grazing season	3 Times	Natural Uranium, Ra-226, Th-2320, Pb-210, & Pb-210
Food	3	Crops	Grab	Time of Harvest or Slaughter	1	Natural Uranium, Ra-226, Th-230, Pb-210, & Po-210
	3	Livestock			1	
	3	Private Garden Vegetables			1	
Fish	Each Body of Water	Collection of fish from White River (W-4 & W-5); Cherry Creek & Bozle Creek	Grab	Semiannually	2	Natural Uranium, Ra-226, Th-230, Pb-210, & Po-210
Surface Soil [2]	Up to 40	300 meter intervals to a distance of 1500 meters in each of 8	Grab	Once prior to construction. Repeat	1	All samples for Ra-226, 10% of

Table 6.1-28 Three Crow Expansion Area Preoperational Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	Number	Location	Method	Frequency	Frequency	Type of Analysis
		directions from centerpoint of satellite facility; additional transects through wellfields		for location disturbed by excavation, leveling or contouring		samples natural uranium, Th-230 & Pb-210
	5	Same location used for collection of air particulates	Grab	Once prior to construction	1	Natural Uranium, Ra-226, Th-230 & Pb-210
Subsurface Soil [3]	5	At centerpoint of satellite facility & at distances of 750 meters in each of 4 directions	Grab	Once prior to construction. Repeat for location disturbed by construction	1	Ra-226 (all samples) Natural Uranium, Th-203 & Pb210 (one set of ssamples)
Sediment	2 from each stream	Up and down gradient samples from Cherry Creek, Unnamed Drainage, Bozle Creek & White River (W-4 & W-5)	Grab (Composite samples)	Once following spring runoff & late summer following period of extended low flow	2	Natural Uranium, Ra-226, Th-230 & Pb-210
	1 from each pond	Cherry Creek Pond, Ice House Pond, Sulzbach Pond & Grable Pond(s)	Grab	Once prior to construction	1	Natural Uranium, Ra-226, Th-230 & Pb-210

Table 6.1-28 Three Crow Expansion Area Preoperational Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	**Number**	**Location**	**Method**	**Frequency**	**Frequency**	**Type of Analysis**
Direct Radiation (Survey)	Up to 80	150 meter intervals to a distance of 1500 meters in each of 8 directions from centerpoint of satellite facility	Grab	Once prior to construction. Repeat for areas disturbed by site preparation or construction	1	Gamma exposure using sodium iodide scintillometer
Direct Radiation (Continuous)	5	Same location used for collection of air particulates	Grab	Once prior to construction	1	Gamma exposure using a continuous integrating device

[1] Two from surface water that could be impacted by project operations.
[2] Surface soil samples collected to a depth of 5 cm using a consistent technique.
[3] Subsurface soil samples collected to a depth of 1 meter; samples divided into 3 equal sections for analysis.

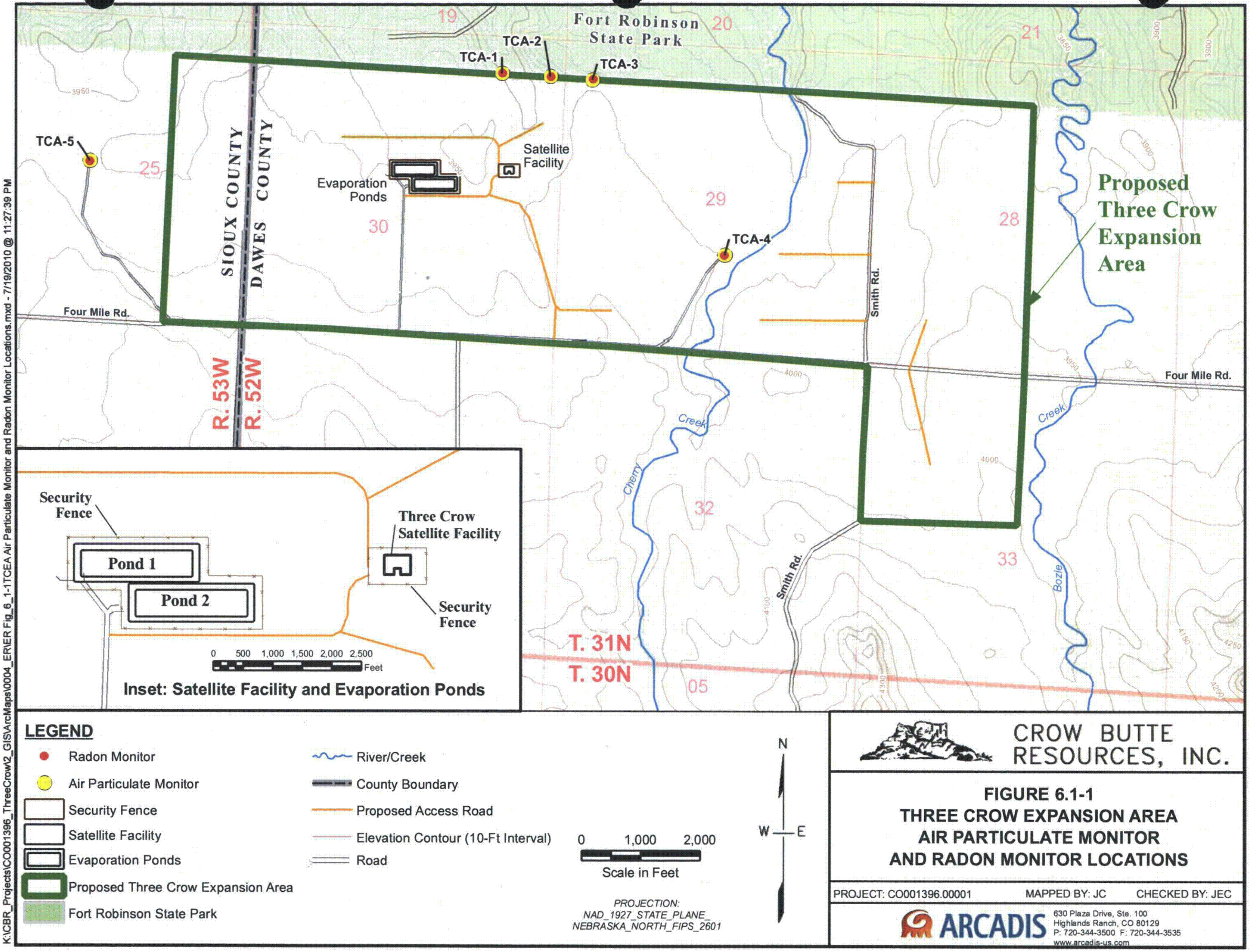
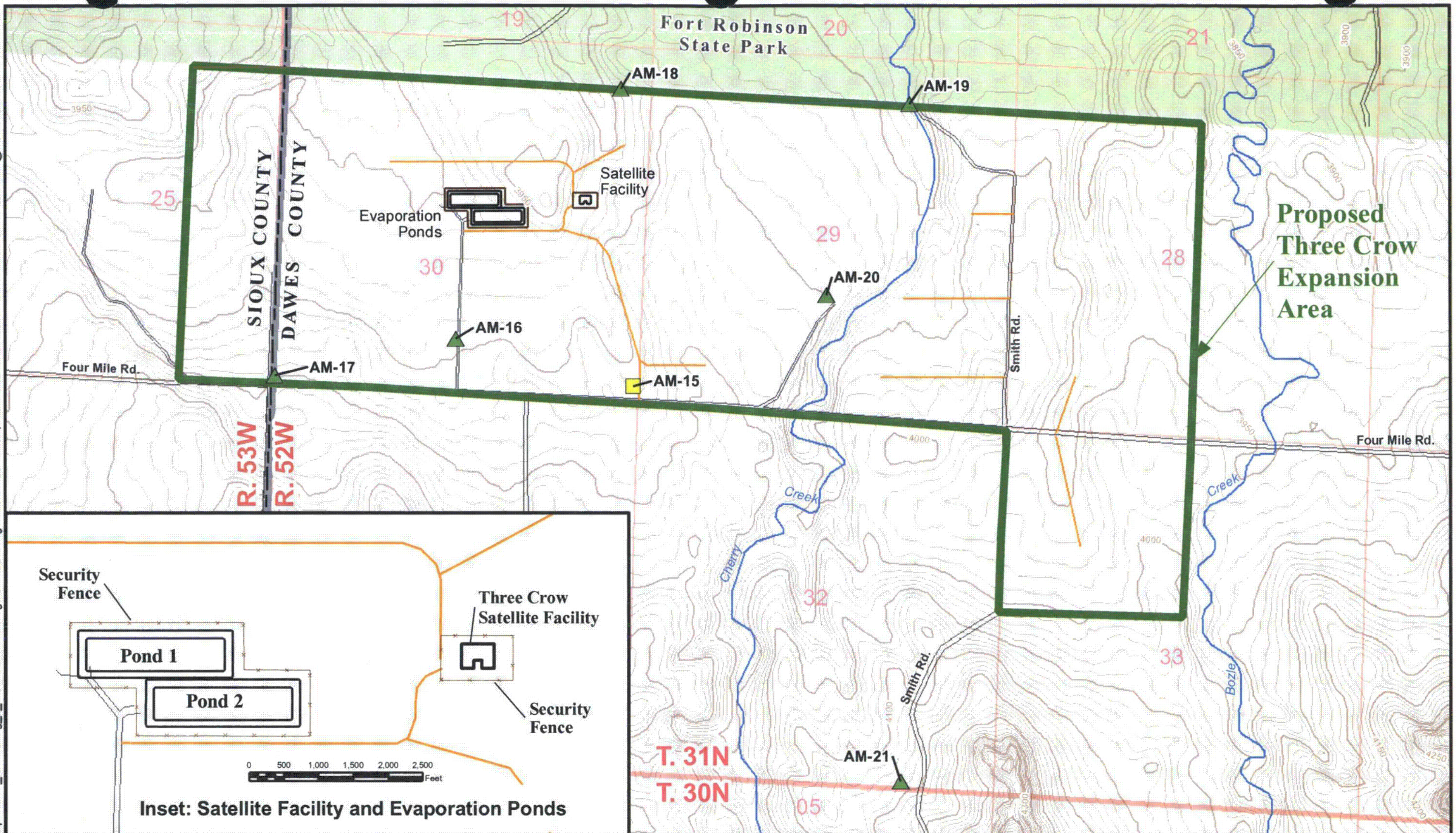


FIGURE 6.1-1
THREE CROW EXPANSION AREA
AIR PARTICULATE MONITOR
AND RADON MONITOR LOCATIONS

K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0004_ER\ER Fig_6_1-1TCEA Air Particulate Monitor and Radon Monitor Locations.mxd - 7/19/2010 @ 11:27:39 PM



LEGEND

- Monitor Location for Air Particulates, Radon and Gamma
- Monitor Location for Radon and Gamma
- Security Fence
- Satellite Facility
- Evaporation Pond
- Proposed Three Crow Expansion Area
- Fort Robinson State Park
- River/Creek
- County Boundary
- Proposed Access Road
- Elevation Contour (10-Ft Interval)
- Road

0 1,000 2,000

Scale in Feet

N W E

PROJECTION: NAD_1927_STATE_PLANE_NEBRASKA_NORTH_FIPS_2601

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-2
THREE CROW EXPANSION AREA RADIOLOGICAL MONITORING FOR AIR PARTICULATES, GAMMA AND RADON 2007 - 2008

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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K:\CBR_Projects\CO001396_ThreeCrow\2_GIS\ArcMaps\0001_TRITR Fig_2_9-2 TCEA Radiological Monitoring for Air Particulates, Gamma and Radon 2007 - 2008.mxd - 7/12/2010 @ 2:02:31 PM

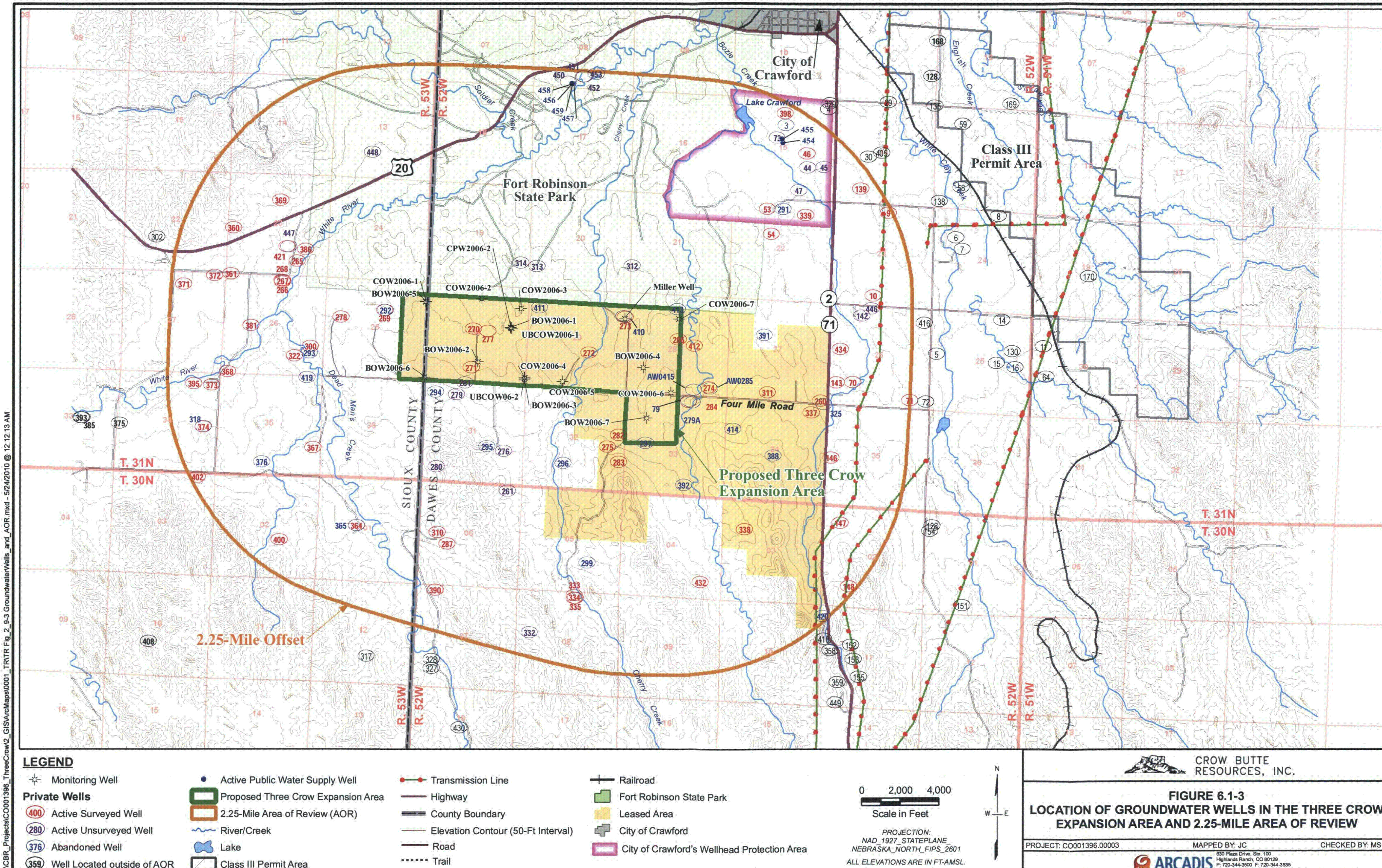

FIGURE 6.1-3
LOCATION OF GROUNDWATER WELLS IN THE THREE CROW EXPANSION AREA AND 2.25-MILE AREA OF REVIEW

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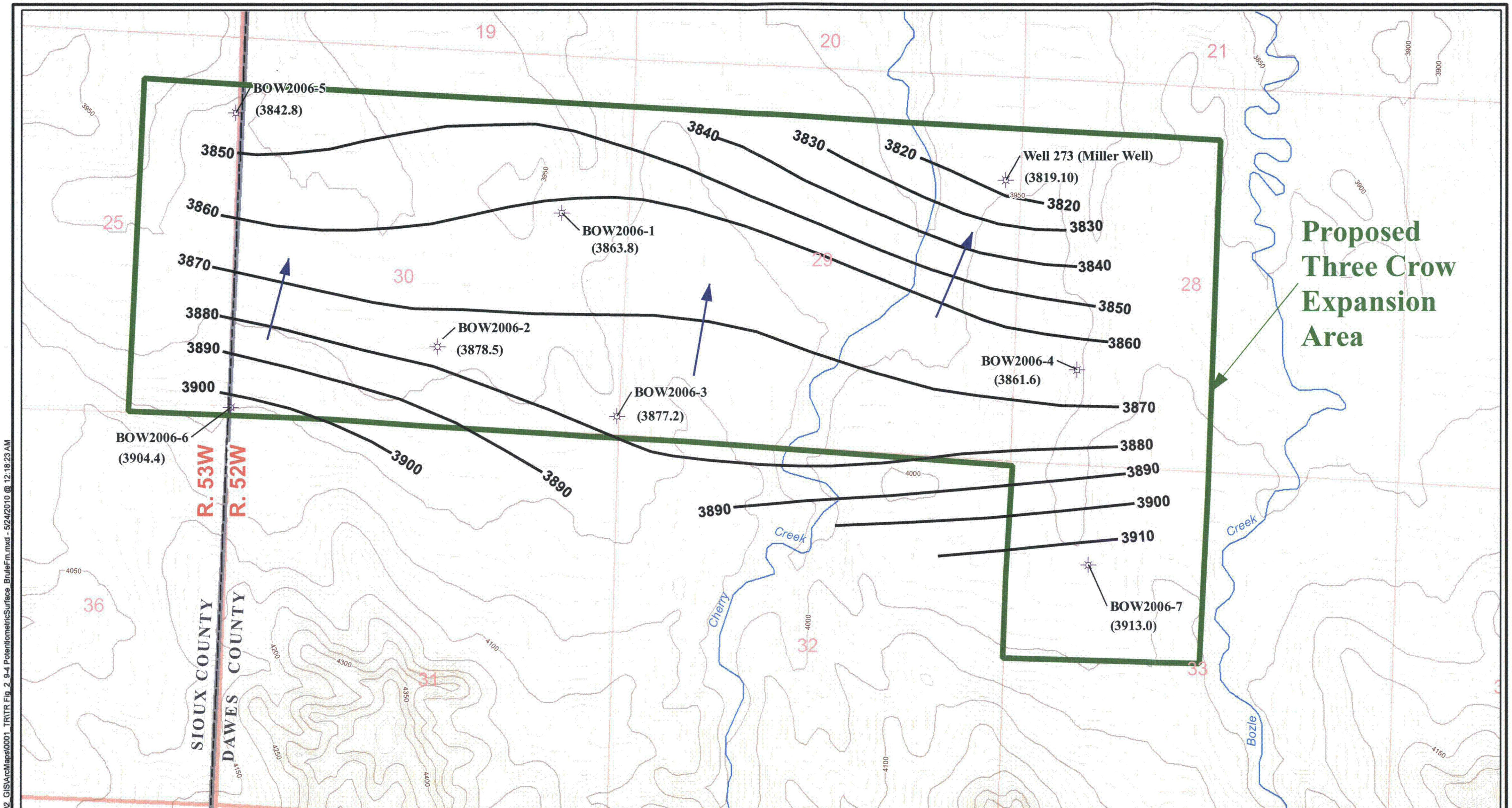

LEGEND

- Brule Formation Monitoring Well
- Groundwater Potentiometric Surface (FT-AMSL)
- (3879) Groundwater Elevation (FT-AMSL)
- Groundwater Flow Direction
- River/Creek
- Elevation Contour (10-Ft Interval)
- County Boundary
- Proposed Three Crow Expansion Area

Notes:
1. Water levels at all well locations were collected on 1/22/2010, with the exception of Well 273 (Miller Well), which was collected on 2/8/10
2. All Elevations are in ft-amsl.

0 750 1,500
Scale in Feet

PROJECTION:
NAD 1927, STATE PLANE
NEBRASKA NORTH FIPS 2601

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FIGURE 6.1-4
THREE CROW EXPANSION AREA WATER LEVEL MAP - BRULE FORMATION (01/22/10 & 02/08/10)

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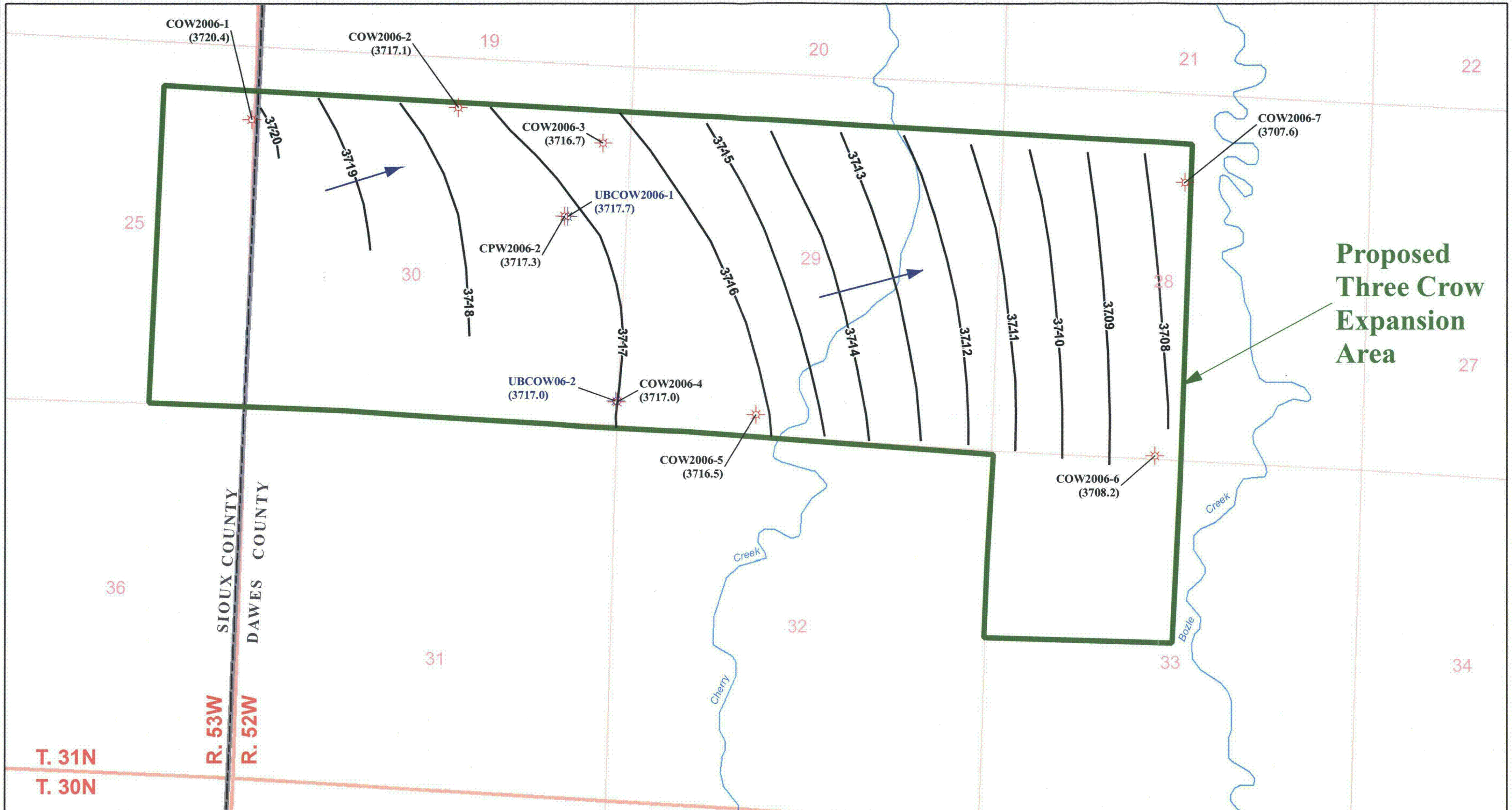
K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0001_TRITR Fig 2_9-4 PotentiometricSurface_BruleFm.mxd - 5/24/2010 @ 12:18:23 AM



LEGEND

- Lower Basal Chadron Sandstone Monitoring Well
- Upper Basal Chadron Sandstone Monitoring Well
- (3720.5) Groundwater Elevation (FT-AMSL)
- River/Creek
- County Boundary
- Groundwater Flow Direction
- Proposed Three Crow Expansion Area

Notes:
1. Groundwater elevations are shown for wells screened in the Upper Basal Chadron Sandstone, but were not included in contouring.
2. All elevations are in ft-amsl.

0 1,000 2,000
Scale in Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH FIPS 2601

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FIGURE 6.1-5
THREE CROW EXPANSION AREA POTENTIOMETRIC SURFACE - BASAL CHADRON SANDSTONE (01/22/2010)

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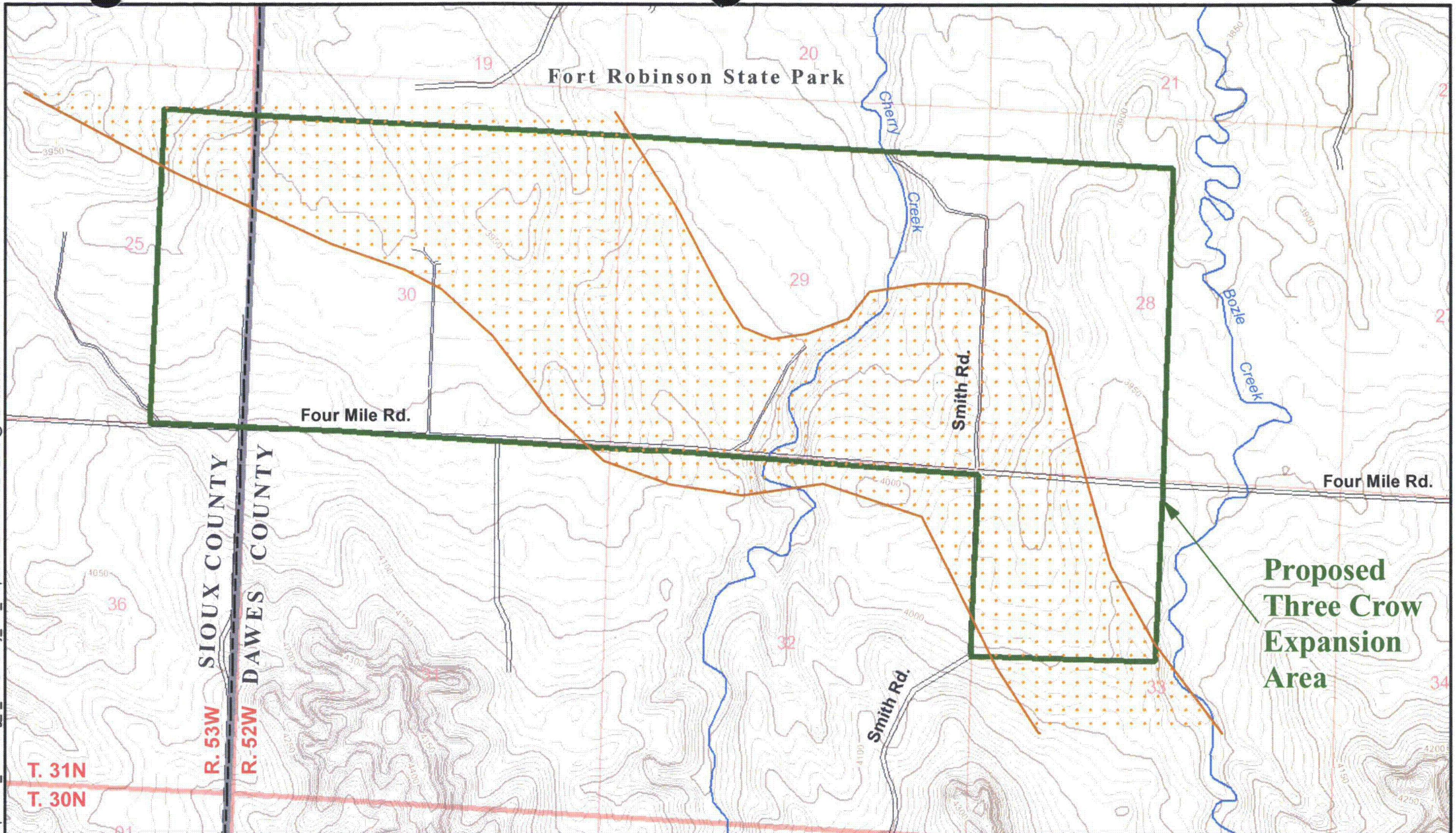
K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0001_TR\TR Fig_2_9-5 PotentiometricSurface_BasalChadronSandstone.mxd - 5/24/2010 @ 12:18:29 AM



LEGEND

- General Ore Trend
- Proposed Three Crow Expansion Area
- River/Creek
- County Boundary
- Elevation Contour (10-Ft Interval)
- Road

0 1,000 2,000
Scale in Feet

PROJECTION:
NAD 1927, STATE PLANE
NEBRASKA NORTH FIPS 2601

ALL ELEVATIONS ARE IN FT-AMSL

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FIGURE 6.1-6
THREE CROW EXPANSION AREA ORE BODY

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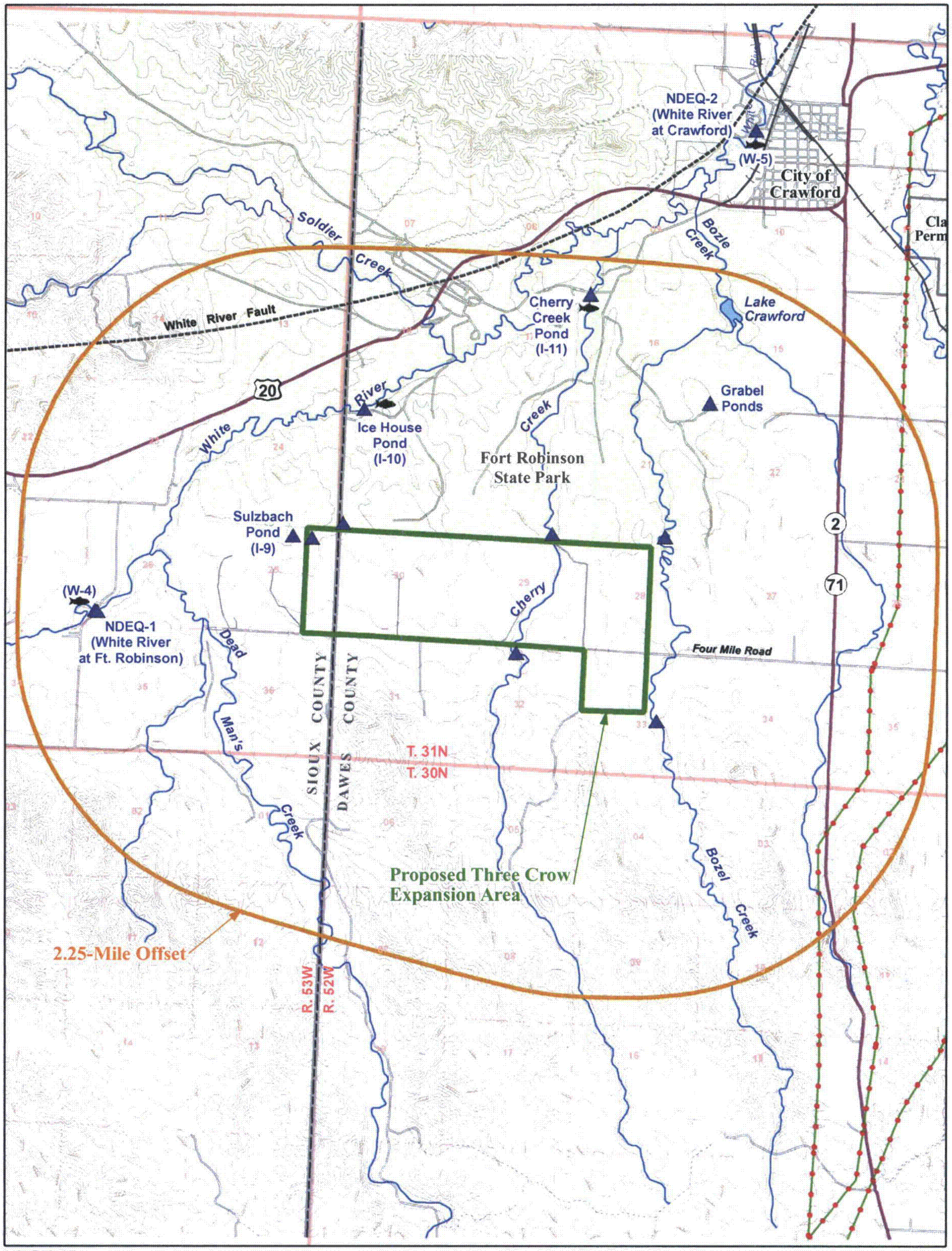

LEGEND

- Proposed Three Crow Expansion Area
- 2.25-Mile Area of Review (AOR)
- City of Crawford
- Fort Robinson State Park
- Lake
- River/Creek
- White River Fault
- Transmission Line
- County Boundary
- Surface Water Sample Point
- Fish Sampling Location
- Elevation Contour (50-Ft Interval)
- Railroad
- Highway
- Road
- Trail

0 2,000 4,000
Scale in Feet

PROJECTION:
NAD_1927_STATE_PLANE_
NEBRASKA_NORTH_FIPS_2601

ALL ELEVATIONS ARE IN FT-AMSL.

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FIGURE 6.1-7
THREE CROW EXPANSION AREA SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

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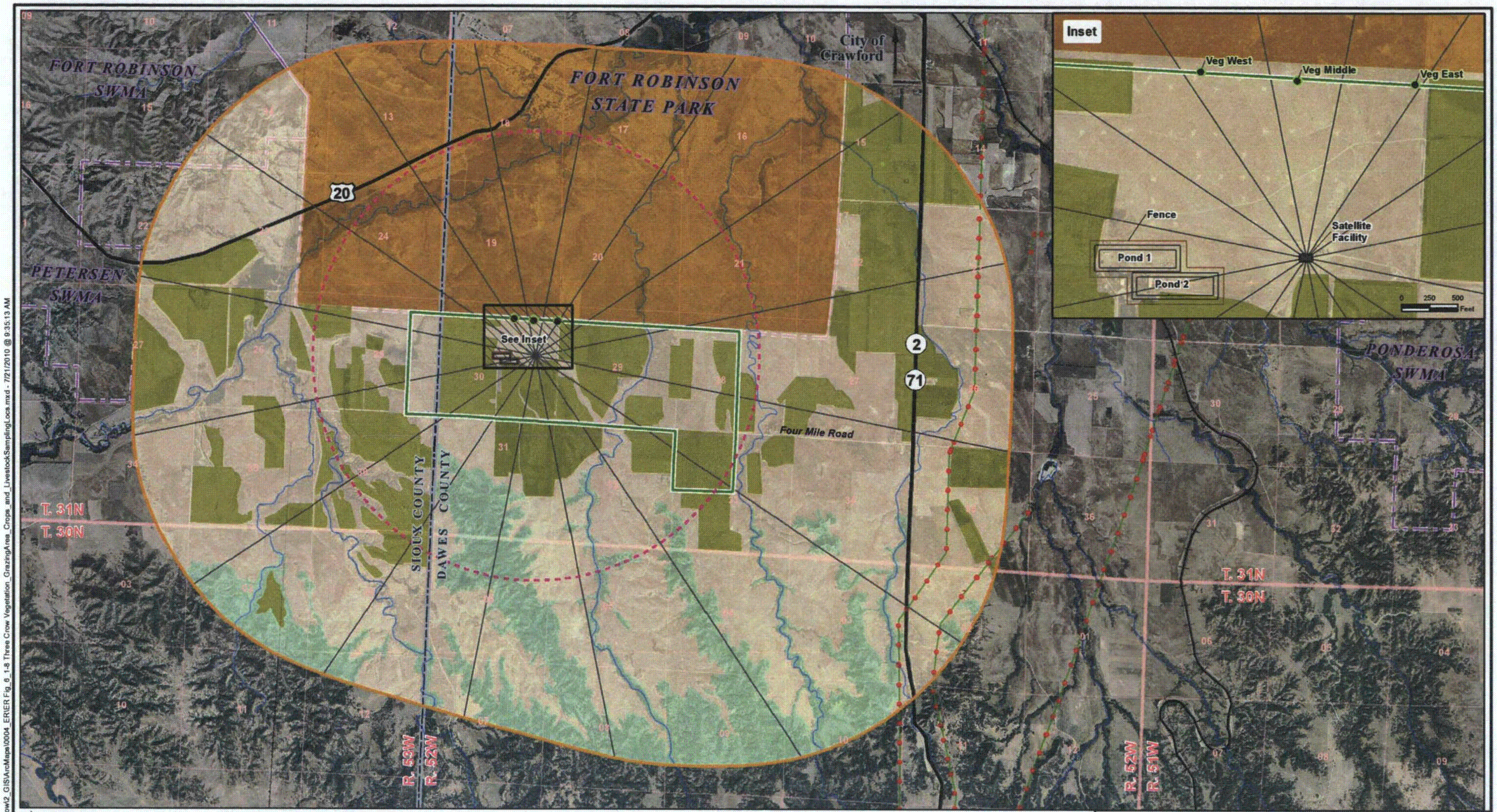
K:\CBR_Projects\CO001396_ThreeCrow2_GIS\ArcMaps\0004_ER\ER Fig_6_1-7Three Crow Expansion Area Surface Water and Sediment Sampling Locations.mxd - 7/29/2010 @ 3:41:16 PM



LEGEND

- Vegetation Sampling Location

Land Use

- Cropland
- Forested Land
- Rangeland
- Recreational Land

- Proposed Three Crow Expansion Area (TCEA)
- 2.25-Mile Buffer of Proposed TCEA Boundary
- 3000-Meter Radius from Center of Satellite Facility
- State Park or State Wildlife Management Area (SWMA)

- Fence
- Satellite Facility
- Evaporation Pond
- Grid Sector

- River/Creek
- Transmission Line
- Highway
- County Boundary
- Railroad

0 2,000 4,000
Scale in Feet

PROJECTION:
NAD_1927_STATE_PLANE_
NEBRASKA_NORTH_FIPS_2601

SOURCE:
AERIALS: NAIP 2006, DAWES COUNTY AND SIOUX COUNTY, NE
LAND USE: CROW BUTTE RESOURCES, INC.
STATE PARK & SWMA: USGS 1:100,000 TOPOGRAPHIC MAP - CRAWFORD (1986), NE

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FIGURE 6.1-8
THREE CROW EXPANSION AREA VEGETATION, GRAZING AREA, CROPS AND LIVESTOCK SAMPLING LOCATIONS

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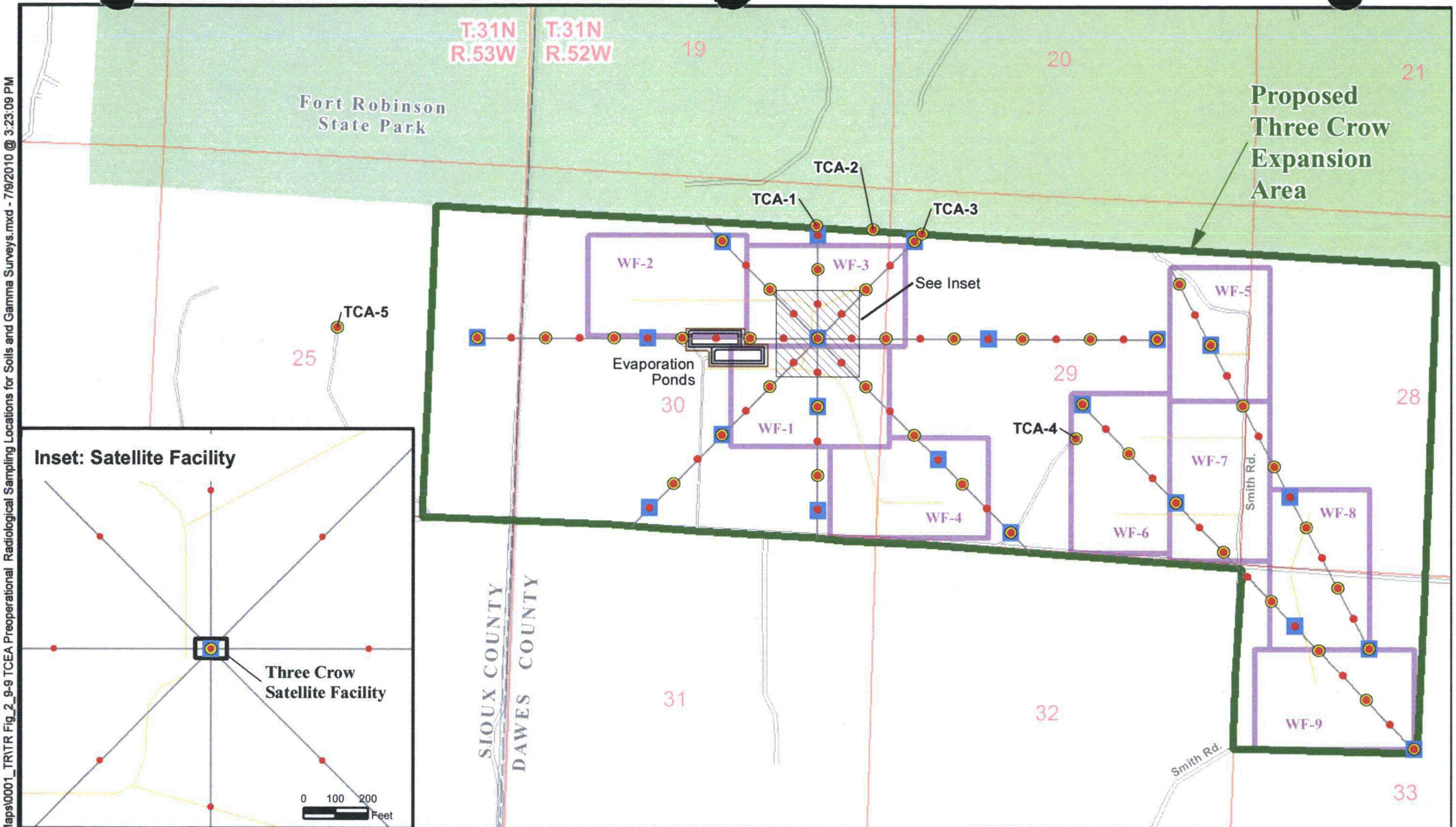
K:\CBR_Projects\CO001396_ThreeCrow\2_GIS\ArcMaps\0004_ER\ER Fig_6_1-8 Three Crow Vegetation_GrazingArea_Crops_and_LivestockSamplingLocs.mxd - 7/21/2010 @ 9:35:13 AM



K:\CBR_Projects\CO001396_ThreeCrow\2_GIS\ArcMaps\0001_TR\TR Fig_2_9-9 TCEA Preoperational Radiological Sampling Locations for Soils and Gamma Surveys.mxd - 7/9/2010 @ 3:23:09 PM

LEGEND

- Gamma Survey Location
- Surface Soil Sampling Location
- Subsurface Soil Sampling Location
- Survey Transect
- Proposed Three Crow Expansion Area
- Well Field Boundary
- Fort Robinson State Park
- Fence
- Satellite Facility
- Evaporation Pond
- Proposed Access Road
- Road

0 1,000 2,000

Scale in Feet

PROJECTION: NAD_1927_STATE_PLANE_NEBRASKA_NORTH_FIPS_2601

N W E

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-9
THREE CROW EXPANSION AREA
PREOPERATIONAL RADIOLOGICAL SAMPLING LOCATIONS FOR SOILS AND GAMMA SURVEYS

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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7 COST-BENEFIT ANALYSIS

7.1 General

The general need for production of uranium is assumed to be an integral part in the nuclear fuel cycle with the ultimate objective being 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 operation required for the fuel cycle are justified in terms of the benefits of energy generation to the society in general. However, the specific site-related benefits and costs of an individual fuel-cycle facility such as the CPF and the proposed satellite facility must be reasonable as compared to that typical operation.

7.2 Economic Impacts

Monetary benefits have accrued to the community from the presence of the CPF, 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 satellite facility.

7.2.1 Tax Revenues

Table 7.2-1 summarizes the tax revenues from the CPF.

Future tax revenues are dependent on uranium prices which cannot be forecast with any accuracy; however, these taxes are also somewhat dependent on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of around $40.75 per pound U_3O_8 on June 21, 2010 [UxC 2010]), the increased production from the satellite facility should contribute to higher tax revenues.

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

7.2.2 Temporary and Permanent Jobs

7.2.2.1 Current Staffing Levels

CBR currently employs approximately 67 employees and 2 contractors employing 14 people on a full-time basis. Short-term contractors and part time employees are also used for specific projects and/or during the summer months and may add up to 5 percent to the total staffing. This level of employment is significant to the local economies. The private employment in Dawes County in 2008 was 2,491 out of a total labor force of 3,065. Based on these statistics, CBR currently provides approximately 3.0 percent of the private employment in Dawes County. In 2006, CBR's total payroll was over $3,941,000. Of the total Dawes County wage and salary payments of $86,633,000 in 2008, the CBR payroll represented about 5 percent.

Total CBR payroll for the past four years was:

2005	$2,382,000
2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,216,870 (estimated)

The average annual wage for all workers in Dawes County was $49,167 for 2008. By way of comparison, the average wage for CBR was about $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including bonus or benefits.

7.2.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of future satellite facilities will provide approximately ten to fifteen temporary construction jobs for a period of up to one 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 five 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 2008, total unemployment in Dawes County was 933 individuals, or 4.3 percent of the total work force of 4,936. 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 ten to twelve full-time CBR employees for each active satellite facility. These new employees will be needed for satellite facility operators and wellfield operator and maintenance positions. Contractor employees (i.e., drilling rigs) 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.

7.2.3 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 four years were:

2005	$4,570,000
2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$7,838,700

The vast majority of these purchases were made in the City of Crawford and Dawes county.

This level of business is expected to continue and should increase somewhat with the addition of expanded production from the proposed satellite facilities and from restoration activities, although not in strict proportion to production. While there are some savings due to some fixed costs (CPF utilities for instance), there are additional expenses that are expected to be higher (well-field development for the satellites is expected to be more expensive). Therefore, it can be assumed that the overall effect on local purchases will be relatively 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.

7.2.4 Economic Impact Summary

As discussed in this section, the CBR project currently provides a significant economic impact to the local Dawes County economy. Approval of this license amendment request would have a positive impact on the local economy as summarized in **Table 7.2-2**.

7.2.5 Estimated Value of Three Crow Resource

CBR is currently continuing to develop the reserve estimates for the TCEA. Based on the current recoverable resource estimate of 3,750,481 pounds U_3O_8 and the current market price of uranium ($40.75 per pound on June 21, 2010 [UxC 2010]), the total estimated value of the energy resources at Three Crow is approximately $150,000,000. This value will fluctuate as the market price and realized price varies.

7.2.6 Short-Term External Costs

7.2.6.1 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), in 2000 (last US census) a total of 492 housing units were vacant in Dawes County out of a total housing base of 4,004 units (NDED 2010). Of the vacant units, 176 were available for rent. In addition to this availability of rental housing units, there are two small hotels in the City of Crawford that generally have vacancies and routinely provide units for itinerant workers such as railroad crews. Temporary housing resources have experienced little change in the past two decades.

More recent data indicate that in 2008 there were a total of 533 houses in the City of Crawford, with 468 occupied (345 owner occupied and 123 renter occupied) (City-Data 2010a). This indicated that 65 housing units were available for purchase or rent. The housing density was 467 houses/condos per square mile. The median rent being asked for vacant rental units in 2008 was $337/month. The median purchase price for a home was $51,856.

The City of Chadron, which is located within communicating distance to the City of Crawford and the TCEA project, was reported that in 2008 there were a total of 2,447 houses with 2,189 occupied (1,216 owner occupied and 973 renter occupied) (City-Data 2010b). This indicated a total of 973 housing units were available for purchase or rent. The housing density was 675 houses/condos per square mile. The median rent asked for vacant rental units in 2008 was $368/month. The median purchase price for a home was $127,963.

7.2.6.2 Noise and Congestion

CBR projects an increase in the noise and congestion in the immediate area of the 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 south by Four Mile Road.

A BNSF rail line is located east of SH 2/71 and is approximately 2.9 miles from the TCEA boundary at the closest point. Noise from the trains on the BNSF rail line would be intermittently audible to receptors within and in close proximity to the TCEA. The rail line is used for combining local "pusher" engines with south bound trains to assist them in climbing the Pine Ridge south of the City 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.

7.2.6.3 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 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.

7.2.7 Long-Term External Costs

7.2.7.1 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 Three Crow area 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 2008, total unemployment in Dawes County was 933 individuals, or 4.3 percent of the total work force of 4,936. CBR expects that the new positions at the satellite facility will be filled from this pool of available labor.

7.2.7.2 Noise and Congestion

CBR projects a minor increase in the long term noise and congestion in the immediate area of the 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 IX resin from the satellite facility to the CPF. Delivery and IX 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 9.2.6.2, there is significant existing noise in the immediate area generated by the adjacent rail line and highway.

In the area around the City of Crawford, the increased traffic will be unnoticeable due to the presence of U.S. Highway 20 and Nebraska 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 the City of Crawford for 2008 was 1,650 and 215, respectively (NDOR 2010). The limited additional traffic related to the TCEA operation will not significantly affect these main routes.

7.2.7.3 Aesthetic Impacts

The primary visible surface structures proposed for the TCEA include wellhead covers, wellhouses, electrical distribution lines, and one satellite processing building and evaporation ponds. The project will use existing and new roads to access each wellhouse, the deep disposal well building, evaporation ponds and the satellite processing building. 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 agricultural land.

In foreground-middleground views, the satellite processing building, evaporation ponds, 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 processing building, wellhouses, and wellhead covers would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from Four Mile Road and residences within the Expansion Area, but would be subordinate in scale to the rural landscape.

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 these 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.

7.2.7.4 Land Access Restrictions

Property owners of land located within the immediate wellfield and facility 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.

7.2.8 Most Affected Population

The expected impacts from the proposed 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

The Crow Butte project has been positive for the City of 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 satellite facility. Most residents located in the proposed TCEA license area are land owners that have mineral and/or surface leases with CBR and will benefit economically from the presence of the facility.

7.2.9 Satellite Facility Decommissioning Costs

Approval of the proposed 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.

7.3 The Benefit Cost Summary

The benefit-cost summary for a fuel-cycle facility such as the CPF 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 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 on-going environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the CPF.

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.

7.4 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 TCEA is favorable, and that issuing an amendment to SUA-1534 is the appropriate regulatory action.

Table 7.2-1 Tax Revenues from the Current Crow Butte Project

Type of Taxes	2009	2008	2007	2006	2005
Property Taxes	914,000	1,120,000	1,102,000	627,000	351,000
Sales and Use Taxes	136,000	140,000	90,000	238,000	185,000
Severance Taxes	403,000	512,000	1,066,000	545,000	338,000
Total	**1,453,000**	**1,772,000**	**2,258,000**	**1,410,000**	**874,000**

Table 7.2-2 Current Economic Impact of Crow Butte Uranium Project and Projected Impact from TCEA

Activity	Current Crow Butte Operation	Estimated Economic Impact due to Three Crow Expansion Area
Employment		
Full Time Employees	67	+ 10 to 12
Full Time Contractor employees	14	+ 4 to 7
Part Time Employees and Short Term Contractors	3	+ 4 to 7**
CBR Payroll, 2009	$4,216,870*	+ $400,000 to $480,000
Taxes		
Property Taxes	$914,000	-
Sales and Use Taxes	$136,000	-
Severance Taxes	$403,000	-
Total Taxes	$1,453,000	+ $1,000,000 to $1,200,000
Production Royalties		
Royalty Payments, 2009	462,000	+ 325,000
Local Purchases		
Local Purchases, 2009	$7,838,700	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	**$13,970,570**	**+ $5,375,000 to $6,355,000**

*Estimated
**All construction workers

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8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This Environmental Report (ER) has characterized the existing baseline environment of the TCEA and the surrounding area in Section 3. The potential environmental impacts (adverse and positive) of the proposed action were discussed in detail in Section 4. In this impact analysis, CBR identified unavoidable impacts of the proposed action. Alternatives for mitigation were discussed in Section 5.

This section summarizes the environmental impacts that cannot be avoided. Where available, means of mitigation is summarized.

Table 8-1 summarizes the unavoidable environmental impacts of the proposed construction, operation, and decommissioning of the TCEA. Each impact is quantified (where possible). All impacts are short-term, i.e., the predicted impact will exist during the construction, operation, and decommissioning of the TCEA. No significant long-term impacts that would extend beyond the duration of the project have been identified. For each impact, mitigative measures are summarized.

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Table 8-1 Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Production		
Production of U3O8 (lbs./yr.)	600,000	None
Use of Natural Resources		
Temporary Land Surface Impacts (acres)	Significant land surface impacts to 14 acre satellite plant site; minimal disturbance to remaining 1,629 acres of wellfield; impacted for the duration of the project.	Sediment and topsoil management during construction and operation; Surface reclamation following operational activities to return surface to pre-operational condition.
Temporary Land Use Impacts	Restriction of agricultural use of proposed 1,643 acre site; impacted for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Lost cattle production ($/yr.)	$7,160	Compensation to landowners through surface leases and/or mineral royalties.
Lost wheat production (Bu.)	Up to 11,833	Compensation to landowners through surface leases and/or mineral royalties.
Lost hay production (tons/yr.)	Up to 615	Compensation to landowners through surface leases and/or mineral royalties.
Groundwater consumption in Basal Chadron Formation (net gpm)	50	None
Groundwater quality impacts	Temporary impacts to groundwater quality in the Basal Chadron mining zone.	Proven groundwater restoration following mining to return Chadron groundwater quality to baseline or pre-operational water uses.
Visual and scenic impacts	Noticeable minor industrial component in existing agricultural/rural landscape; VRM Class III objectives met.	Use of harmonizing colors; use of existing vegetation and topography; avoidance of straight line site roads to follow topography; removal of construction debris.
Emissions		
Dust emissions (tons/yr.)	16.9	Dust control measures implemented where appropriate.
Radon emissions (Curies/yr.)	1614	None

Table 8-1 Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
Radiological Impacts		
Additional maximum predicted dose (mrem/yr.)	32.3	None
Socioeconomic Impacts		
Employment		
Additional full time employment	10 to 12	None
Additional contractor employment	4 to 7	None
Part time and contractor employment (during satellite construction)	10 to 15	None
Additional CBR payroll ($/yr.)	$400,000 to $480,000	None
Taxes Paid ($/yr.)	$1,000,000 to $1,200,000	None
Local purchases	$3,650,000 to $4,350,000	None
Waste Management Impacts		
Wastewater (gpm)	50	None
Solid waste produced (yd^3/yr.)	700	None
11(e)2 byproduct waste produced (yd^3/yr.)	60	None

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