4 ENVIRONMENTAL IMPACTS

The objective of the mining and environmental monitoring program is to conduct an economically viable and environmental responsible operation. The environmental monitoring programs used to ensure that the potential sources of land, water, and air pollution are controlled and monitored are presented in Section 6.

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 MEA.

4.1 Land Impacts

4.1.1 Land Surface Impacts Associated with Construction

CBR has developed plans for the development of the site based largely on the knowledge on the size of the ore body (depth, width, and length) and U_3O_8 content arrived at through exploration and delineation work at the MEA site.

It is estimated that a total of approximately ~~1,753~~1,754 acres could be affected over the life of the MEA Project. Estimates of acreages have been provided in **Table 4.1-1** for the currently planned facilities as well as potential additional acreages that may be developed in the future (based on current knowledge of the ore body).

Approximately ~~591~~592 acres will be required for the currently planned facilities, which consist of the satellite building and associated facilities (1.8 acres), six ~~the two~~ DDWs (0.79~~1.0~~ acre), access roads to the satellite facility and DDWs (1.7 acres), and 11 MUs (587.6 acres). The number of acres associated with roadways located within the MUs is included in the total MU acreage estimates. For a number of the proposed DDWs, the estimated disturbance area (0.5 acre each for a total of 3 acres) overlaps areas to be disturbed by MU development; therefore this overlapped acreage of the DDWs within the MUs is not included in the estimated DDW disturbance acreage. The number of acres of different types of habitat cover estimated to be impacted by the current planned construction activities are presented in **Table 4.1-1**.

Based on the current knowledge of the MEA ore body, it has been estimated that 1,162 acres in addition to the ~~591~~592 acres may be impacted over the life of the project. Estimates of the additional number of acres of different types of habitat cover that may be affected are shown in **Table 4.1-1**. As shown, the major type of habitat that would be affected is mixed-grass prairie, which makes up approximately 65 percent of the total ~~1,753~~1,754 acres. The ~~1,753~~1,754 acres will include cropland (~~128.4~~128.6 acres) and livestock range (~~1,370.7~~1,371 acres [~~1,142.7~~1,143 acres mixed-grass prairie and 228 acres degraded rangeland]). The entirety of this approximately ~~1,753~~1,754 acres may be dedicated to the project's needs over the life of the project. Using the assumptions above, construction activities over the life of the project could result in the loss livestock production of approximately ~~$55,376~~$55,388.

Currently planned site preparation and construction associated with the MEA satellite facility will include the following:

- Construction of a satellite building located approximately 11.1 miles (17.9 km) south-southeast of the CPF processing building (centerpoint to centerpoint). 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

- Placement of a modular office building
- Construction of chemical storage facilities and other support facilities
- Construction two DDWs for disposal of wastewater
- A deep well injection building and associated facilities
- Access roads, as required
- Construction of 11 wellfields

Site preparation and construction will include activities such as topsoil salvage, building erection, foundation installation, some contouring, trenching, and access road construction.

Environmental impacts of construction of the satellite facility are estimated in this section with mitigation measures discussed in Section 5. The impacts are also projected based on experience with the current operation and those that have been associated with this type of construction at the Crow Butte project over the past 17 years of commercial operation by CBR.

As stated above, currently planned construction of the satellite facility will require disturbance of an estimated ~~591~~592 acres for the satellite facility and support facilities such as 11 MUs, DDWs, and road improvements. Of this total, approximately ~~2.3~~4.29 acres will be associated with the satellite facility (1.8 acres), ~~and~~ six DDWs (0.79 acres), ~~plus~~and 1.7 additional acres of access roads. Surface disturbances will include construction of access roads, facility site grading, construction of DDWs, and contouring for control of surface runoff. All areas disturbed will be reclaimed during final decommissioning/reclamation/reclamation. The planned timeline for construction, production, restoration, and decommissioning was presented in Section 1.1.3.2.

The primary surface disturbances associated with solution mining are the sites containing the processing facilities, associated facilities, and the DDWs. Surface disturbances also occur during well drilling, 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 ISR mining and the lack of evaporation ponds, no areas will be disturbed to the extent that subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. 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.

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.

4.1.2 Land Use Impacts of Construction and Operations

The principal land uses for the approximately ~~591~~592 acres (**Table 4.1-1**) associated with the currently planned 11 MUs, processing facility, DDWs, and access roads consist primarily of cropland (~~71.7~~71.9 acres) and livestock range (~~491.2~~491 acres [~~347.6~~347.6 acres of mixed grass prairie and 143.6 acres of degraded rangeland]). The entirety of this approximately ~~591~~592-acre area will be dedicated to the project's needs over the 1-year construction period. As presented previously, livestock and livestock products carry a value of $40.40 per acre, while non-livestock lands carry a value of $13.61 per acre (NASS 2009). Based on this information, and assuming all available and suitable acreage within the MEA is currently employed to its greatest efficiency and effect, construction activities in the MEA would result in the lost livestock production of approximately ~~$19,845~~$19,836 per year, and the lost production of crops valued at ~~$976~~$978 per year. The exclusion of agricultural activities from this area during construction would not have a significant impact on local agricultural production due to the small size of land taken out of production; construction and operation would not have a significant impact on landowners due to the payment of royalties and leases, which will offset the losses from the land being removed from agricultural production.

The principal land uses for the MEA and the 2.25-mile (3.6 km) AOR is grazing livestock and raising of crops. Rangeland accounts for 82.6 percent of the land use in the MEA and surrounding 2.25-mile (3.6 km) AOR as discussed in Section 3.1.2. The secondary land use within the MEA license boundary is cropland, which accounted for 8.9 percent of the land use in the MEA and the AOR. Land use was discussed in detail in Section 3.1.

For the proposed disturbance of ~~591~~592 acres for the proposed MUs, satellite facilities, 11 MUs, and roadways, cropland accounts for ~~71.7~~71.9 acres or approximately 12~~12.2~~ percent of the ~~591~~592-acre total area. Rangeland accounts for ~~491.2~~491 acres or 83.0 percent of the total area. Rangeland rehabilitation (6.9 acres), structural biotope (8.9 acres), forest land (5.6 acres), and drainage (7.3 acres) are the only other impacted land uses. **Table 4.1-1** provides the acres disturbed by the MEA satellite facility, MUs, DDWs, and access routes, and **Figure 3.1-1** shows the land use for the MEA AOR.

As a result of site preparation and construction, cattle production will be excluded from the areas under development. The total estimated area that will be impacted during the course of the currently planned project is the ~~491.2~~491 acres (mixed-grass prairie and degraded rangeland) associated with the satellite facility, wellfields, DDWs, and roads. As discussed in Section 3.1.2.1, livestock and livestock products had a value of $40.40 per acre, indicating that livestock production on impacted rangeland within the MEA has a potential value of approximately ~~$19,845~~$19,836.

As a result of site preparation and construction, crop production will be excluded from the areas under development. The total estimated cropland area that will be impacted during the course of the project is ~~71.7~~71.9 acres associated with the satellite facility, wellfield, and roads. As presented previously, non-livestock lands carry a value of $13.61 per acre. Based on this information, the lost production of crops would be valued at ~~$976~~$978 per year.

Considering the relatively small size of the area impacted by operations, the exclusion of agricultural activities from this area over the course of operation 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 MU construction. Additionally, CBR recently completed surface and subsurface reclamation of a significant portion of MU 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

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 2010 average daily traffic counts for a segment of SH 2/71 near Marsland at the southern end of the MEA was 675 total vehicles, including 90 heavy commercial vehicles. Traffic levels on SH 2/71 increase to 695 total vehicles, including 90 heavy commercial vehicles in the vicinity of E. Belmont Road (NDOR 2010). Secondary and private roads connect with E. Belmont Road, River Road, Hollibaugh Road, and Squaw Mound Road to provide access to residences and agricultural lands within the MEA. The limited additional traffic related to the MEA operation will not significantly affect these routes.

Access to the MEA site will be primarily via existing roads, with approximately 0.43 mile (0.69 km) of a new gravel road on site (Hollibaugh Road to the satellite building). The main access route to the MEA is via SH 2/71 west of Marsland, then east along Niobrara Street and River Road, and then north on either Squaw Mound Road or Hollibaugh Road (**Figure 1.4-1**). As noted in Section 3.2, Nebraska SH 2/71 and U.S. Highway 20 converge at Crawford. Nebraska SH 2/71 lies to the west of the MEA (**Figure 1.4-1**).

Road access impacts associated with air emissions and fauna and wildlife are discussed in Sections 4.6 and 4.5.4, respectively.

The junction of the BNSF and DM&E Railroads is located in the City of Crawford. No railways cross the MEA 2.25-mile (3.6 km) 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.

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. Because 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 timeline 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 CO_2, O_2, 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 Byproduct Material from the Site to a Licensed Disposal Facility

Low-level radioactive waste or unusable equipment contaminated with 11(e)2 byproduct 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 byproduct material generated, these shipments will be infrequent (averaging two per year if using roll-off containers).

11(e)2 byproduct 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 Marsland satellite facility to the CPF and Return Shipments of Barren, Eluted Resin from the CPF back to the Marsland 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 daily. The transfer of resin between the two sites will occur on a portion of SH 2/71, country roads, and private roads. CBR has established a Primary Access Route and Alternative Routes A and B (**Figure 1.4-1**). The total miles for the Primary Access Route between the two sites will be 30 miles (48.3 km), with 11.6 miles (18.7 km) on unpaved county and private roads. The Alternative Route A is approximately 14 miles (22.5 km) long, with all of the roads being unpaved county and private roads. Alternative Route B is approximately 24.7 miles (39.7 km) long (approximately 14.8 miles [23.8 km] on SH 2/71 and approximately 9.9 miles [15.9 km] on unpaved county and private roads).

The Primary Access Route will be used unless weather conditions or some other unforeseen event (weather, roads closed, etc.) occurs that would cause the use of Alternative Route A or B. It is currently estimated that the Primary Access Route will be utilized approximately 99 percent of the time and Alternative Route A or B less than 1 percent of the time. Alternative Route B would be preferred over Alternative Route A since there are fewer unpaved roads and less potential for generation of roadway dust.

A discussion of the impacts of air particulate emissions due to vehicles traffic on the access routes is presented in Section 4.6.2

Resin or eluate shipments will be treated similar to 11(e)2 byproduct material shipments in regards to 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 MEA 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 because 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 sandstone of the Chadron Formation will be on the order of 1 percent or less, and the anticipated drawdown over the life of the project is expected to be on the order of 10 percent of the available head or less. Further, once mining and restoration operations are completed and restoration approved, groundwater levels will return to near original conditions under a natural gradient. No faults are present within the project area that would be subject to potential reactivation due to fluid injection.

Impacts to paleontological resources due to operations are expected to be minimal.

4.3.1.1 Soil Impacts

Soils in the MEA are typically shallow to deep silt loams and loamy very fine sands. Consequently, wind and water erosion pose the most significant risks to soil health and productivity, especially where vegetation has been disturbed. A detailed discussion of the soils characteristics are presented in Section 3.3.1.6.

Construction of the facilities at the MEA will affect soils. With proper implementation of BMPs, effects to soils are not expected to be significant within the MEA. Operational impacts to soils are expected to be minor, and would only occur if BMPs and mitigation measures are not properly constructed, maintained, and monitored. Improper surfacing of access roads could lead to rutting and erosion. 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 MEA 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 MEA would continue until the area is revegetated.

Wind erosion is possible at the MEA. Hazards for wind erosion are generally high to moderately high within the proposed MUs. 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 necessary, avoiding clearing and grading on erosive areas, surfacing roads with locally obtained gravel, and timely reclamation. Many soils meet the criteria for high wind erosion hazard (NRCS 1977).

Water erosion is also possible at the MEA, especially in areas disturbed by road and wellfield construction. Various soils within the MEA meet the criteria for severe water erosion hazard. 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.

Assessments of the potential for flooding or erosion potential that could impact the proposed ISR mining processing facilities and MUs was performed for the MEA. The results of this study are discussed in Section 1.3.2.13. The complete reports, including tables and figures, are provided in **Appendices K-1** and **K-2** (ARCADIS 2012, ARCADIS 2013). The studies addressed guidance in RG-1569 for an NRC licensee to assess the potential effects of erosion or surface water flooding on a proposed ISR facility. The ultimate objective of the MEA studies was to determine whether the potential for erosion or flooding may require implementation of special design features or mitigation measures. The results of these studies will be used for further analysis, mitigation measures, or modification of location of surface facilities, including well locations during the final engineering phase and prior to well installation and construction activities.

Sedimentation in streams and rivers at the MEA 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 Niobrara River. 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 and productivity. Off-road travel could lead to unforeseen vegetation removal, soil compaction, and localized soil loss due to wind and water erosion. Therefore, off-site travel will be minimized to the extent possible.

A number of erosion and productivity problems resulting from the MEA 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 is accomplished. Reduction in soil fertility levels and reduced productivity would affect diversity of re-established vegetative communities. Moisture infiltration would be reduced, creating soil drought conditions. Vegetation would undergo physiological drought reactions.

Surface spillage of hazardous materials during construction or operations could occur at the MEA. 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

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 MEA. 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 areas around the disturbed area.
- Retain sediment within the disturbed area.
- Do not direct surface drainage 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 BMPs do not result in compliance with applicable standards, modify or improve such BMPs 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, 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

- Restrict the length and grade of roadbeds.
- Surface roads with durable material (i.e., locally obtained native gravel).
- Create cut and fill slopes that are stable.
- Revegetate the entire road prism including cut and fill slopes.
- Create and maintain vegetative buffer strips, and construct 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, and other activities.
- 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.
- 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 satellite facility.

4.4 Water Resources Impacts

4.4.1 Surface Water Impacts of Construction

When stormwater drains off a construction site, it can carry sediment and other pollutants that can potentially harm lakes, streams, and wetlands. The 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 may need to be controlled by the NDEQ NPDES regulations.

Construction activities at the CBR project to date have had a minimal impact on the local hydrological system. CBR conducts construction activities under NDEQ permitting regulations for control of construction stormwater discharges contained in Title 119 (NDEQ 2005). CBR is required by NDEQ General Construction Stormwater NPDES Permit NER 100000 to implement procedures that control runoff and the deposition of sediment in surface water features during construction activities. These procedures are contained in 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.

Administrative and engineering controls implemented by CBR during initial site preparation and construction of the satellite facility and related facilities are expected to ensure that surface water impacts are 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 ongoing 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 failure or an uncontrolled release of process liquids due to a wellfield accident. Section 4.4.1 discussed the measures to prevent and control wellfield spills. Wellfield areas are installed with dikes or berms as an additional measure to protect surface water. The berms prevent surface spills from entering all surface water bodies and drainages that connect to surface water bodies and eliminate public dose and contaminant pathways to surface water.

The satellite building will have secondary containment (curbing around the structure) to contain any accidental spills or releases of contaminated fluids. This will eliminate the potential for such discharges to the adjoining groundwater surface and potential contamination of the surrounding soils and the Brule Formation. In addition, there is a regular program of inspections and preventive maintenance. Furthermore, 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 satellite facility operation will be fully assessed in an Industrial Groundwater Permit application required by NDNR (application to be submitted following NDEQ approval of the MEA Class III UIC permit). Information from the existing Groundwater Permit for the current license area indicates that the drawdown from mining operations in the basal sandstone of the Chadron Formation is minimal (e.g., on the order of 10 percent of the available head). Based on drawdown data from years of operation in the current license area, and on the formation characteristics from the MEA 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 operation is expected to be on the order of 0.5 to 2.0 percent of the total mining flow (6,000 gpm). Consumptive volume (1,500 gpm) will increase during aquifer restoration, especially during the groundwater sweep phase. However, it is expected that in peak years the net consumption for the entire operation will be on the order of 50 to 100 gpm.

A simple hydrologic drawdown-distance analysis using the Theis (1935) equation for confined aquifers was conducted by CBR to estimate drawdown at the MEA. The results of this analysis is discussed in Section 4.14.1.3 (Groundwater).

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, or poor well integrity.

To date, there have been several confirmed horizontal excursions in the basal sandstone of the Chadron Formation in the current license area. These excursions were quickly detected and recovered through overproduction in the immediate vicinity of the excursion. In the majority of the excursions, the reported vertical excursions were actually due to natural seasonal fluctuations in Brule groundwater quality and very stringent UCLs. In no case did the excursions threaten the water quality of an underground source of drinking water because the monitor wells are located well within the aquifer exemption area approved by the EPA and the NDEQ. **Table 4.4-1** summarizes the excursions reported for the current license area.

The subsurface interval composed of the Lower Dakota, Morrison, and Sundance Formations has been identified as the DDW Injection Zone at the MEA. The subsurface geologic characteristics beneath the MEA will prevent disposal fluids injected into the Injection Zone from impacting the overlying fresh water aquifers (i.e., Brule and Chadron Formations). Between the lowermost Chadron Formation and the Injection Zone are more than 2,500 feet of sediments primarily consisting of low permeability shale. This separating aquitard protects against vertical migration of injected fluids to the overlying Brule and Chadron Formations. Shales above and below the Injection Zone will encase the disposal fluids within the receiving formations, and no structural elements with the potential to disrupt the natural vertical containment have been identified. The primary groundwater supply in and near the MEA is the Brule Formation, typically encountered at depths from approximately 30 to 200 feet below land surface, with the exception of locations where the overlying alluvium is not present. In general, the static water level for the Brule Formation wells in the MEA ranges from 50 to 150 feet below land surface, depending on local topography. The estimated concentrations of TDS within the Injection Zone are in excess of 10,000 milligrams per liter (mg/L). No harmful or reactive incompatibility between the formation brine and the waste constituents are expected.

CBR has satisfactorily operated a Class I DDW at the nearby CBR CPF facility since 1994 without any adverse impacts. A second DDW well was approved and placed into operation in fourth quarter of 2011.

4.4.3.3 Potential Groundwater Impacts from Accidents

Groundwater quality could potentially be impacted during operations due to an accident such as an uncontrolled release of process liquids due to a wellfield accident. If there should be a wellfield accident, potential contamination of the shallow aquifer (Brule), as well as surrounding soil, could occur. Wellfield accidents could take the form 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.

The satellite building will have curbing around the structure to contain any accidental spills or releases of contaminated fluids. This will eliminate the potential for such discharges to the adjoining groundwater surface and potential contamination of the surrounding soils and the Brule Formation.

The DDWs will receive wastewater from wastewater tanks located in the satellite processing facility via an underground PVC/HDPE pipeline. Flow rates from the tankage, tank levels, and flowrates are all controlled and monitored to ensure any potential leakage is rapidly detected. All flows and pressures will have limits and alarms programmed in to alert the operator as limits are approached and to control feed pumps. The details of these systems will be addressed in the Class I permit application that will be submitted to the NDEQ as part of the required permitting process. CBR has successfully operated a Class I DDW for approximately 19 years without any significant spills or releases.

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. To control these types of releases, all piping is either PVC, HDPE 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 impact significance 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 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;
- A substantial increase in direct mortality of wildlife caused by road kills, harassment, or other causes;
- Incidental take of a special status species to the extent that such impact would threaten the viability of the local population;

- Elimination or permanent reduction in size of an officially designated critical wildlife habitat, or otherwise rendering such habitat unsuitable;
- Any effect, direct or indirect, resulting in a long-term decline in recruitment and/or survival of a wildlife population; and
- Construction disturbance during the avian 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, which would violate the regulations prescribed by the MBTA.

4.5.2 Vegetation

As described in detail in Section 3, a total of 11 wellfields, a satellite facility, and access roads will be constructed in 2014 with an expected mine life of operation of approximately 7 years. As shown on **Figure 3.5-1**, wellfield development will occur primarily in areas dominated by mixed-grass prairie and degraded rangeland vegetation.

Vegetation removal and soil handling associated with the construction and installation of wellfields, pipelines, access roads, and satellite facilities would affect vegetation resources both directly and indirectly. 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 4,622.3-acre permit area over the long-term operation of the project will be approximately ~~1,753~~1,754 acres (**Table 4.1-1**). Initially, the construction of the satellite building(s)/associated facilities, MU 1, and necessary roadways would result in short-term surface disturbances of approximately 78 acres (approximately 2 percent of the total permit boundary acreage). The production building and associated facilities would disturb an area of 1.8 acres (area containing the production facilities). **Table 4.1-1** provides a breakdown of the area of disturbance by the type of habitat cover acreage.

Over the life of the project, it is currently estimated that 38 percent of total permit area acreage would be disturbed due to site development and operation. The likelihood of impact is greatest for the primary vegetation cover types of mixed-grass prairie (1,143 acres) and degraded rangeland (228 aces), which occupy approximately 78 percent of the total acreage with the potential for disturbance (~~1,753~~1,754 acres). Mixed-grass prairie and degraded rangeland habitat cover (1,143 and 228 acres, respectively) account for 25 percent and 5 percent, respectively, of the total permit acreage of 4,622.3 acres. There are no plans to disturb the deciduous streambank forest habitat cover type within the permit boundary; other cover types would be subject to minor amounts of disturbance (**Table 4.1-1)**.

The majority of new roads are located within proposed wellfields. A new access road will serve as the entrance roadway to the satellite production facility and offices. Estimated acreage disturbance was based on a 25-foot wide entrance road and 12-foot wide MU roads. Road locations and distances are illustrated on **Figure 1.4-1.**

The proposed six DDWs will be located as shown in ~~to the northwest of the satellite facilities~~ ~~(~~**Figure 1.1-7**~~)~~, with the ~~located~~locations being primarily within mixed-grass prairie habitat and consisting of an area of approximately 50 x 50 feet. The potential disturbance area of 0.5 acre per DDW (total of 3 acres) has used for assessing potential impacts associated with DDW construction and operations. Approximately 2.21 acres of the 3-acre disturbance area are located within the MU boundaries, and therefore this acreage has already been addressed for potential impacts due to MU construction and operations. As a result, only an additional area of 0.79 acres have been assessed for disturbances of habitat due to the placement of the six DDWs. Potential impacts from the DDWs are considered minimal, based on the operating history of the DDW 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 MEA. Non-native species invasion and establishment as a result of previous and current disturbance has become an increasing 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 MEA has a relatively high level of noxious weeds and other unwanted invasive, non-native species in the areas adjacent to roads, 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-existing contours and ripped to depths of 12 to 18 inches to relieve compaction. Mixed-grass prairie tracts disturbed by surface activities would be completely reclaimed. Reclamation of mixed-grass prairie would generally include: (1) complete cleanup of the disturbed areas (wellfields and access roads); (2) restoring the disturbed areas to the approximate ground contour that existed before construction; (3) replacing topsoil, if removed, over all disturbed areas; (4) ripping disturbed areas to a depth of 12 to 18 inches; and (5) seeding recontoured areas with a locally adapted, certified weed-free seed mixture.

4.5.3 **Surface Waters and Wetlands**

Dooley Spring, Willow Creek, and other ephemeral features are the only potentially available surface waters within the MEA. These features lack defined banks and have no streambed. Generally, these features are dry, and they would only be expected to carry water during exceptional precipitation events. Direct disturbance to these features would take place where they would be crossed by access roads. This would occur in several locations, including one location along the main access road to the satellite facility. Culverts will be installed below each road crossing to maintain natural flows. Therefore, there would not be any long-term direct impacts on the integrity of any of the drainages within the MEA.

The Niobrara River is a perennial stream located downstream of the MEA; this river could potentially be indirectly affected by changes in water quality or quantity. Water quantity would not be changed by the proposed project. Hydrologic analysis completed for this project indicates that the MEA generally carries a low potential for erosion (and therefore a low potential for sediment delivery to the Niobrara River). However, there are some small, localized areas within the MEA that carry a moderate to high erosion potential. If wells cannot be placed outside of areas within the wellfields deemed to carry moderate to high erosion risks, mitigation measures (e.g., berms) will be implemented to minimize the potential for flooding and erosion. The mitigation measures will be defined during final engineering and prior to any construction. As a result of these mitigation measures, sediment delivery to the Niobrara River will be negligible.

One wetland site was identified by HWA (2012) within the MEA. This wetland is located outside of the area proposed for disturbance. Therefore, no direct impacts to wetlands are anticipated. Additionally, the potential for sedimentation of wetlands within and near the MEA is anticipated to be minimal due to mitigation measures that would be implemented to reduce erosion risk.

4.5.4 **Wildlife and Fisheries**

The effects on wildlife would be associated with construction and operation of project facilities, which include displacement of individuals of some wildlife species, loss of wildlife habitats, and an increase in the potential for collisions between wildlife and motor vehicles. Other potential effects include a rise in the potential for 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 **Big Game Mammals**

The principal wildlife impacts likely to be associated within the proposed project include: (1) a direct loss of elk, deer, and pronghorn habitat; (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.

Direct removal of habitat used by big game mammals would include 1,143 acres of mixed-grass prairie. Small amounts of drainage (31.~~2~~3 acres), mixed conifer (194.6 acres), and range rehabilitation (7.1 acres) cover types would also be removed. Because mixed-grass prairie would be the primary vegetation type affected, the proposed project would be more likely to affect big game species that primarily inhabit grassland vegetation (e.g., pronghorn) than big game species that primarily inhabit shrubland, forested, or riparian areas (e.g., elk, deer). The amount of habitat disturbed would decline over time as construction areas not needed for the production phase were reclaimed to their pre-existing contours and vegetation type. Overall, direct loss of habitat would have a minor, short- to long-term impact on big game species using the MEA.

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. Big game habitat would effectively be reduced by an amount greater than the disturbance footprint acreage, because big game would avoid a wider area than just the infrastructure itself. Big game mammals may adjust their ranges or seasonal migration routes slightly to avoid the new source of disturbance on the landscape. This could result in reduced herd productivity if animals have to expend more energy to travel between seasonal ranges or if adjacent habitats are not of a similar or higher quality to the habitats lost or cannot absorb the additional individuals. If avoidance responses extend out to 0.5 mile (0.8 km) beyond the MEA, this would equate to 1.8 percent of the overlapping elk herd unit, 0.5 percent of the overlapping deer herd unit, and 0.5 percent of the overlapping pronghorn herd unit being affected by the proposed project.

However, big game mammals are adaptable and may adjust over time to non-threatening, predictable human activity. 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 wellfield is put into production. By the time the wellfield is under full production, construction activities will have ceased, and traffic and human activities in general would be greatly reduced. As a result, this impact over the long term would be minimal, and it is unlikely that big game mammals would be permanently 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. Forage would be restored once disturbed areas were reclaimed.

The potential for vehicle collisions with big game mammals would increase as a result of increased vehicular traffic associated with the presence of construction crews and would continue (although at a reduced rate) throughout all phases of the wellfield operations. To minimize the potential for wildlife collisions, drivers would be required to follow posted speed limits. Development of new roads would allow greater access to more areas and may lead to an increased potential for poaching of big game animals. Vehicle collision impacts and poaching of big game mammals are anticipated to occur infrequently, and no long-term adverse effects on populations are expected.

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

4.5.6 Carnivores and Small Mammals

The direct disturbance of wildlife habitat in the MEA likely would reduce the availability and effectiveness of habitat for a variety of common small mammals and their predators. The initial phases of surface disturbance and noise would result in some direct mortality to small mammals and avoidance of the area by carnivore species that are more sensitive to human disturbance. In addition, a slight increase in mortality from increased vehicle use of roads in the area would be expected.

Carnivores and small mammals inhabiting the mixed-grass prairie and degraded rangeland vegetation types would be more affected by direct habitat loss than carnivores and small mammals inhabiting other vegetation types in the MEA. The temporary disturbances expected to occur during the construction period would tend to favor generalist wildlife species that are relatively tolerant of human activity, such as ground squirrels and striped skunks, and would have more impact on species that are relatively sensitive to human activity, such as mountain lions.

Because of the high reproductive potential of small mammals, they would rapidly repopulate reclaimed areas as habitats become suitable. 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. No black-tailed prairie dog colonies are located within or near the proposed disturbance area, so there would not be any impacts on this species.

Bats have a lower reproductive potential than other small mammals, so the removal of bat roost sites, maternity colonies, or hibernacula could have an adverse effect on local bat populations. However, the majority of habitat that would be affected by the proposed project is open, mixed-grass prairie, which is not generally suitable for bat roosting. There would be 194.6 acres of impact to any forested habitat (mixed conifer), and no deciduous streambank forest (the most likely bat roosting habitat in the MEA) would be affected.

4.5.7 Passerines and Upland Game Birds

Impacts to passerines would include short- and long-term habitat loss, primarily for birds using mixed-grass prairie habitat, and an effective loss of habitat extending beyond the disturbed areas if birds avoid the project facilities due to noise or activity. These effects are likely to attenuate with time as construction areas are reclaimed to the original habitat and as human activity decreases after the construction period ends. Generalist species that are more tolerant of human activity (e.g., mourning doves) are likely to be least affected by the proposed project, while specialist species that are more sensitive (e.g., grasshopper sparrows) may be affected more. Overall, given the reclamation practices that would be put into place, the minimal long-term surface footprint of the project, and the measures that would be taken to avoid impacting nesting birds, impacts on passerines are anticipated to be minor and not significant at the population level for any species.

The potential effects of the operation and maintenance of project facilities on upland game birds may include direct mortality of eggs or nestlings (if construction were to take place during the nesting season), habitat loss, and nest abandonment and reproductive failure caused by project-related disturbance and increased noise. Other potential effects on upland game birds involve increased public access and subsequent human disturbance that could result from new construction and production activities. These effects will attenuate with time as areas no longer needed for the project are reclaimed and human activity decreases after the construction phase.

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 will be avoided within 0.25 mile (0.4 km) of leks. If disturbance activities within the 0.25-mile (0.4 km) lek buffer areas are avoided, no impacts are expected. Areas with large tracts of mixed-grass prairie would provide the best quality nesting habitat, 1,143 acres of which would be directly affected by the proposed project. Some of this area would be reclaimed once no longer needed for the production phase. To protect sharp-tailed grouse nesting habitats, construction activities will be limited within a 1-mile (1.6 km) 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.

4.5.8 Raptors

As noted in Section 3.5.7.3, seven raptor nests were observed within the MEA boundary during the 2011 field survey. The potential impacts to raptors within the MEA include: (1) direct loss of nesting habitat; (2) disturbance to nesting raptors from noise and activity and reduction in nest productivity; (3) temporary reductions in prey populations; and (4) mortality associated with roads.

The proposed project would result in the loss of 1,337 acres of potential raptor nesting habitat in the MEA over the life of the project, which includes mixed-grass prairie and mixed conifer vegetation types. Over time, some of this habitat would be restored through reclamation of areas no longer needed for production. Overall, long-term habitat losses would be minor. The development of proposed wellfield pads and satellite facilities would disturb an estimated 1,143 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 8 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 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 MEA.

There will be no new public roads constructed. However, there will be increased traffic due to site operations on current county roads. 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 would be reduced by requiring drivers to follow all posted speed limits.

4.5.9 Reptiles and Amphibians

The primary impacts on reptiles and amphibians would include 1) direct mortality of individuals during the construction period; 2) ongoing mortality of individuals from increased vehicle traffic; 3) short- and long-term loss of terrestrial habitats; and 4) changes in water quality in aquatic habitats.

The proposed project has the potential to result in the direct mortality of individual reptiles and amphibians that use terrestrial habitats where construction will take place. Quantifying these changes is not possible because population data are lacking; however, once construction was completed and human activity greatly reduced, the potential for direct mortality would decrease significantly. Mortality could also result from increased vehicle traffic on project roads. This would be a long-term affect but is not likely to result in population-level changes to any amphibian or reptile species.

There would be 1,143 acres of habitat loss for amphibians and reptiles that use native grassland habitats, and 194.6 acres of habitat loss for amphibians and reptiles that use coniferous habitats. Reptiles and amphibians may also use degraded rangeland, drainages, and range rehabilitation habitats in the MEA, of which 228 acres, 31.~~2~~3 acres, and 7.1 acres would be lost, respectively. Some of the construction areas would be reclaimed when no longer needed and could then be re-populated by reptiles and amphibians. Long-term loss of both terrestrial and aquatic habitats would be minimal overall. As described in Section 4.5.3, mitigation measures would be used to minimize impacts on surface waters that may be used by reptiles and amphibians, and there would be no direct loss of wetland habitats that could serve as amphibian breeding sites.

4.5.10 **Fish and Macroinvertebrates**

Suitable habitat for fish and macroinvertebrates exists within the Niobrara River and its tributaries. Fish and macroinvertebrates in the Niobrara River could be affected by reductions in water quality as a result of upstream activities. Construction activities could result in runoff carrying sediment into surface waters downstream of the MEA. As discussed in Section 4.5.3, the potential for this to occur is low, given the low erosion potential of most the MEA and the mitigation measures that would be implemented for the limited areas of moderate to high erosion potential.

4.5.11 **Threatened and Endangered Species**

Black-footed Ferret

Because there are no known black-footed ferret populations in Nebraska, impacts to this species are highly unlikely. Also, there is no suitable habitat for this species (black-tailed prairie dog colonies) within the proposed disturbance area.

Whooping Crane

No impacts to whooping cranes are anticipated to occur as a result of the proposed project because suitable migration stopover habitat is not present within the MEA.

Gray Wolf

Gray wolves are highly unlikely to occur in the MEA; therefore, impacts on this species would be highly unlikely. If dispersing gray wolves were to pass through the vicinity, these individuals would likely avoid the area due to anthropogenic noise and activity.

Swift Fox

Because swift fox are known to occur within the region, and suitable mixed-grass prairie habitat occurs throughout the MEA, potential impacts to this species may result from project implementation. Construction activities within these mixed-grass prairie habitats could affect potential swift fox denning and foraging habitats. Destruction of swift fox dens could result in direct mortality of adults or pups. If swift fox are denning in the immediate vicinity of a planned project facility, construction activities may 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 mortality and/or displacement of swift fox from construction and operational activities exists within mixed-grass prairie, mitigation measures will be implemented to avoid and/or reduce such incidents. Prior to beginning construction activities in suitable swift fox habitat, CBR will have qualified biologists perform surveys for swift fox dens, and avoidance measures will be implemented to protect any dens that are located. Surveys will be conducted that are consistent with the NGPC standard protocol included in the CBR Mineral Exploration Permit Number NE0210824 as Attachment 1, issued by the NDEQ on August 19, 2009. The procedures set forth in Attachment 1 are specific to drilling of boreholes; therefore, these procedures have been expanded to include MEA project development activities (e.g., 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 in the MEA is presented in **Appendix O** of Volume II of this application.

Based upon the analysis of the effects of project implementation and the current and potential status of this species in the MEA, it is concluded that the proposed project and planned mitigation measures will result in no adverse population-level effects on the swift fox.

Fish

Three state-listed fish species (the blacknose shiner, northern redbelly dace, and finescale dace) may occur downstream of the MEA and therefore may be affected by the proposed project. No direct effects to these species are anticipated because they do not occur within the MEA. However, indirect effects may include changes in water quality of the Niobrara River associated with upstream activities. As discussed in Section 4.5.3, the potential for sediment delivery to the Niobrara River is low given the low erosion potential of most of the MEA and the mitigation measures that would be implemented for the limited areas of moderate to high erosion potential.

4.5.12 **Cumulative Impacts**

Significant cumulative impacts to ecological resources are not anticipated, as no substantive impairment of ecological stability or diminishment of biological diversity within the MEA is expected to occur as a result of the proposed project. The project would add to the effects of other past, present, and future activities occurring in the region, including the effects of other past, present, and future uranium mining operations. When combined with these other activities, the MEA would have minor cumulative effects on ecological resources. The most substantial of these effects would be the loss of 1,143 acres of mixed-grass prairie habitat. However, because the overall long-term surface footprint of the project would be minimal, and much of the area proposed for disturbance during the construction phase would be promptly reclaimed to the pre-existing contour and cover type, long-term loss of mixed-grass prairie habitat would have a minor impact on regional ecological resources. Similarly, disturbance to wildlife from noise and activity would initially have a minor cumulative impact on the region's wildlife. This impact would diminish over time as human presence decreases after the construction phase is completed.

4.6 Air Quality Impacts

4.6.1 Air Quality Impacts of Construction

The relatively dry air in the MEA region, combined with seasonal high temperatures and wind extremes, create the potential for airborne dust from wellfield construction activities and traffic on unpaved roads. Under these conditions, it is expected that air quality will be impacted in the immediate vicinity of the proposed project over the short term. However, based on historical experience, overall construction activities at the satellite facility are expected to cause minimal effects on local air quality.

Effects to air quality would be increased by the addition of fugitive dust generated from vehicular traffic on unpaved roads (in addition to existing fugitive dust caused by wind erosion) and diesel emissions from construction equipment. Application of water (as necessary) to unpaved roads would reduce the amount of fugitive dust. Diesel emissions from construction equipment are expected to be short-term only, ceasing once the operational phase begins. NRC estimated fugitive dust emissions during the construction phase of uranium ISR operations are to be less than 2 percent of the NAAQS for $PM_{2.5}$ and less than 1 percent for PM_{10} (NRC 2009).

There will be an increase in the total suspended particulates (TSP) in the region as a result of construction of the satellite facility. This increase will be greatest during the site preparation phase of the satellite facility. Revegetation will be performed where possible to mitigate the problems associated with the resuspension of dust and dirt from disturbed areas. All areas disturbed during construction will be revegetated with the exception of facility pad areas, roads, and parking/storage areas. Of these, the most significant source of TSP is dust emissions from unpaved roads.

Specific regulatory issues associated with air quality impacts of operation are discussed in Section 4.6.3.

4.6.2 Air Quality Impacts of Operations

The primary new emission source of non-radiological fugitive dust will be from re-entrained dust from vehicle travel on paved and unpaved roads. Fugitive dust emissions would be 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 traffic delivering supplies to the site and product from the site.

Particulate matter with a diameter of ten micrometers (PM_{10}) was estimated using equations from EPA's AP 42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources, Sections 13.2.2.2 (EPA 2006) and 13.2.1.3 (EPA 2011).

For this analysis, PM_{10} from tailpipe emissions are estimated using On Road Emission Factors from California ARB EMFAC2002 Scenario Year 2004 (Model Year A11965 to 2004). These emissions are expected to be minor and should not affect the local ambient air quality. Tailpipe emissions would also include NO_x, CO, SO_2, and non-methane-ethane VOCs which are not estimated in this analysis.

The project will be located in a NAAQS attainment area for all criteria pollutants. The operations of the satellite facility are not expected to result in significant amounts of fugitive dust. emissions, and would therefore not be considered a major source of emissions under state permitting regulations.

4.6.2.1 Particulate Emissions During Operations

The amount of dust, as $PM_{10,}$ generated from traveling on unpaved roads during operations can be estimated from the following equations taken from AP 42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources (13.2.2.2 equations 1a and 1b). While both equations 1a and 1b provide a PM emission factor for unpaved roads, the difference is based on whether the road is within an industrial site or accessible to the public.

$$E = k\,(s/12)^{a}\,(w/13)^{b} \qquad (1a)$$

$$E = \frac{k\,(s/12)^{a}\,(S/30)^{b}}{(M/0.5)^{c}} - C \qquad (1b)$$

where k, a, b, c and d are empirical constants given below and

E = size-specific emission factor (lb/VMT)

s = surface material silt content (%)

W = mean vehicle weight (tons)

M = surface material moisture content (%)

S = mean vehicle speed (mph)

C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The constants for Equations 1a and 1b are taken from Tables 13.2.2-2 and 13.2.2-4, where:

k = 1.5 lb/VMT(equation 1a) and k = 1.8 (equation 1b)

a = 0.9 (equation 1a) and a= 1 (equation 1b)

b = 0.45 (equation 1a)

c = 0.2 (equation 1b)

d = 0.5 (equation 1b)

C= 0.00047 (equation 1b)

Surface material silt content is estimated at 10 percent by using the stone quarrying and processing mean average from Table 13.2.2-1 (EPA 2006). Mean vehicle weight is estimated at an average of 5.5 tons per vehicle based on estimated weights of 2 tons for employee and contractor vehicles, 5 tons for delivery vehicles and 40 tons for resin transfer trucks. Resin transfer trucks make up approximately 3 percent of the vehicle traffic. Mean vehicle speeds are estimated at 30 miles per hour on paved roads. Surface moisture content is estimated at 13 percent based on Table 13.2.2-3 (EPA 2006).

Onsite Emissions

Onsite emissions are generated within the project boundaries. Fugitive dust emissions generated within the project boundaries are calculated by estimating vehicle miles traveled (VMTs) within the MEA and the CPF. The roads located within the MEA and CPF boundaries are unpaved. Equation 1a from 13.2.2.2 (EPA) is used to calculate an emission factor for vehicles traveling on unpaved surfaces at industrial sites. Calculations are for $PM_{10.}$

The total travel on unpaved within the project boundaries for personnel, resin transfer, deliveries and incidental travel will be approximately 22,854 miles (36,780 km) per year. This is based on the following assumptions:

- Twelve employees and seven contractors arriving at the MEA and traveling 1.22 miles (2 km) round trip (RT) daily
- Ten employees traveling both within the CPF (1.34 miles 2.1 km RT daily) and the MEA (1.22 RT miles [2 km] daily)
- Seven delivery trucks (50 per week) traveling within the MEA (1.22 RT miles [2 km[daily)
- Two resin trucks traveling both within the CPF (1.34 miles RT [2.1 km] daily) and the MEA (1.22 RT miles [2 km] daily)

Equations 1a and 1b emission factors can be extrapolated to annual average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation (EPA 2006) where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation

Onsite Emission - Unpaved

With an emission factor of 1.27 lb per VMT there will be a total PM_{10} emission of approximately 14.5 tons per year, uncontrolled, as a result of increased traffic on unpaved roads onsite. Mitigation measures such as the application of water to unpaved roads will be implemented as necessary. Application of water as dust control would reduce the total PM_{10} emisisons. Assuming a 10% control efficiency with the application of water as dust control, total PM_{10} emissions would be approximately 13.05 tons per year, controlled.

For this analysis, PM_{10} from tailpipe emissions are estimate using On Road Emission Factors from California ARB EMFAC2002 Scenario Year 2004 (Model Year A11965 to 2004). Assuming 22,854 VMT per year onsite and assuming a worst case scenario that all vehicles are diesel-powered heavy duty trucks (using the All Model Year Diesel Powered Heavy Duty Trucks from California Climate Action Registry General Reporting Protocol, Version 3.1, January 2009, Table C.4), PM_{10} emissions are estimated at 11.86 pounds per year.

Off Site Emissions

Off site emissions are generated outside the project boundaries. Fugitive dust emissions generated outside the project boundaries are calculated by estimating VMTs from Crawford to the MEA and VMTs between the MEA and the CPF. The roads traveled outside the project boundaries are both paved and unpaved. Equation 1b from 13.2.2.2 (EPA 2006) is used to calculate an emission factor for vehicles traveling on publicly accessible roads, dominated by light duty vehicles on unpaved surfaces. Calculations are for $PM_{10.}$ Equation 2 from 13.2.1.3 (EPA 2011) is used to calculate the quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road extrapolated to average uncontrolled conditions by application of a precipitation correction term. Calculations are for $PM_{10.}$

The total travel on paved and unpaved outside the project boundaries for personnel, resin transfer, deliveries and incidental travel will be approximately 713,780 miles per year (1,148,717 km). Unpaved VMTs (201,445 miles [324,194 km]) and paved VMTs (512,334 miles [824,521 km]) are based on the following assumptions:

- Twelve employees and 7 contractors traveling from Crawford to the MEA (11.94 miles RT [19 km] daily unpaved and 36.8 RT [59 km] daily paved)
- Ten employees traveling between the MEA and the CPF (19.98 miles [32 km] RT daily unpaved and 36.8 miles [59 km] RT daily paved)
- Seven delivery trucks (50 per week) traveling from Crawford to the MEA (11.94 RT miles [19 km] daily unpaved and 36.8 miles [59 km] RT daily paved)
- Two resin trucks traveling between the MEA and the CPF (19.98 miles [32 km] RT daily unpaved and 36.8 miles [59 km]RT daily paved)

The number of VMT for resins trucks (assumed 5 tons) is reduced for offsite travel. Therefore, the mean vehicle weight is estimated at an average of 4.6 tons.

Offsite Emission - Unpaved

The emission factor is extrapolated to annual average uncontrolled conditions based on natural mitigation because of rainfall and other precipitation from the above referenced EPA equation (EPA 2006). Unpaved roads off site are graveled. Surface material silt content is estimated at 4.8% by using the sand and gravel processing mean average from Table 13.2.2-1 (EPA 2006).

With an emission factor of 0.29 lb per VMT for PM_{10} generated on unpaved roads that are unpaved, there will be a total dust emission of approximately 29 tons per year, uncontrolled, as a result of increased traffic on unpaved roads off site. Mitigation measures such as the application of water to unpaved roads will be implemented as necessary. Application of water as dust control would reduce the total PM_{10} emissions. Assuming a 10% control efficiency with the application of water as dust control, total PM_{10} emissions would be approximately 26 tons per year, controlled.

Offsite Emission - Paved

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

E_{ext} = [k (sL)0.91 x (W)1.02] (1 – P/4N) (equation 2 from 13.2.1.3)

where k, sL, W, and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k

P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period

N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).:

k = particle size multiplier for particle size range and units of interest

sL = road surface silt loading (grams per square meter) (g/m2), and

W = average weight (tons) of the vehicles traveling the road.

For PM_{10}, k is 0.0022 lb/VMT (Table 13.2.1-1) and the average weight of vehicles is estimated at 4.6 tons. Silt loading is estimated at 0.2 (Table 13.2.1.-2). The number of wet days is estimated at 85 annually (Figure 13.2.1-2). The number of days in the averaging period is 365.

With an emission factor of 0.0.0023 lb per VMT for PM_{10} generated on paved roads that are paved, there will be a total dust emission of approximately 0.58 per year, uncontrolled, as a result of increased traffic on unpaved roads off site. Mitigation measures such as the application of water to unpaved roads would reduce annual emissions.

For this analysis, PM_{10} from tailpipe emissions are estimate using On Road Emission Factors from California ARB EMFAC2002 Scenario Year 2004 (Model Year A11965 to 2004). Assuming 713,780 VMT per year off site and assuming a worst case scenario that all vehicles are diesel-powered heavy duty trucks (using the All Model Year Diesel Powered Heavy Duty Trucks from California Climate Action Registry General Reporting Protocol, Version 3.1, January 2009, Table C.4), PM_{10} emissions are estimated at 373 pounds per year.

4.6.3 Criteria Pollutant Regulatory Compliance Issues

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

The NAAQS for PM_{10} are 150 micrograms per cubic meter ($\mu g/m^3$; 24-hour average), and 50 $\mu g/m^3$ (annual average). The NAAQS standards for other pollutants are presented in **Table 3.6-16**. All counties within the 50-mile (80 km) radius of the project are in attainment of NAAQS. Concentrations of the criteria pollutants from the operations are not expected to exceed the regulated or “threshold” level for one or more of the NAAQS pollutants within the 50-mile (80 km) radius.

In addition to the NAAQS, there are national standards for the PSD of air quality. The PSD program is administered by the States 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 3.6-26.**

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. Class II areas are essentially all other areas of the state not designated as Class I 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 Cave National Park is the closer of the two to the MEA, at a distance of approximately 60 miles (96.5 km). Therefore, due to the distances to the MEA project site, no impacts associated with PSD requirements at these sites would be expected based on the estimated amount of emissions from the MEA operations site.

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 noise from the BNSF rail line located approximately 1 mile (1.6 km) west of the MEA boundary at its closest point. Intermittent, low levels of traffic noise from Hollibaugh and River Roads and agricultural equipment also occur. These roads are used primarily to access local residences and agricultural lands. Nebraska SH 2/71 is located about 4.5 miles (7.2 km) west of the MEA boundary. Noise from BNSF trains on the rail line and traffic noise from the roads would be intermittently audible to receptors within and in close proximity to the MEA.

Increased vehicle travel and the operation of construction equipment at the satellite facility during the construction phase of the project would result in a slight increase in noise impacts to residents who live close to the MEA. Potential noise impacts from construction equipment are expected to occur primarily from operation of drilling rigs during wellfield development. Although noise levels associated with a typical water well drilling rig may reach or exceed 100 A-weighted decibels (dBA) within 6.6 feet (2 meters) of the rig compressor, noise levels decrease to less than 90 dBA within 20 feet (6 meters) (NRC 2009) and 55 dBA at 3,500 feet (1,067 meters) from the source (BLM 2005). Impacts to residences and other sensitive receptors 984 feet (300 meters) or more from the facility would be small (NRC 2009). One occupied residence, located within the MEA, is approximately 656 feet (200 meters) from the proposed wellfield in MU 4. Construction noise impacts at this residence would likely be moderate. All other residences near the MEA boundary are more than 984 feet (300 meters) from the proposed wellfield.

Construction activities would typically occur over an 8-hour work day, 5 days per week. Noise from construction would not be generated during nighttime hours. 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 the BNSF railroad. Noise from construction and construction traffic would be temporary and would briefly add to existing noise levels.

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 MEA would be minimal and is not expected to add to existing noise sources. Increases in noise levels due to operation are expected to be lower than those generated during construction. Therefore, it is expected that noise levels during operation would be barely perceptible over the existing ambient noise dominated by the BNSF railroad.

4.8 Historic and Cultural Resources Impacts

ARCADIS (Graves et al. 2011) completed an intensive pedestrian block cultural resources inventory of approximately 4,500 acres for the MEA during the period from November 2010 to February 2011. The MEA was inventoried for the presence of historic properties (cultural resources that are listed or eligible for listing on the NRHP) and may be impacted by proposed mine development. This inventory recorded 15 newly discovered historic sites and five historic isolated finds and updated the documentation on two previously recorded historic farmstead sites. All of the newly recorded historic sites were recommended not eligible for the NRHP and do not qualify as historic properties. Isolated finds are by definition not eligible for the NRHP. Historic farmstead DWOO-242 is recommended not eligible for the NRHP, but appears to be currently or recently occupied. Site DWOO-243 may have the potential to yield information important in history and may be potentially eligible for the NRHP, but is not recommended eligible based on the currently available information. Avoidance of these two sites by project actions is recommended. If these recommendations are followed, the proposed project will have no adverse effect on historic properties, and no further cultural resource investigations are recommended.

4.9 Visual/Scenic Resources Impacts

4.9.1 Environmental Consequences

The visible surface structures proposed for the MEA 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 tan 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 turnaround. There would be an estimated 10 to 12 wellhouses in the MEA.

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 preconstruction 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 Squaw Mound Road and the residences within or in close proximity to the MEA, 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. VRM classes are discussed in Section 3.9.2.1. 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 wellhouses, 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 preliminary evaluation of socioeconomic impacts of the commercial facility 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 current Cameco facility operations on the local and regional economy has been beneficial. Purchases of goods and services by the mine and mine employees contribute directly to the local economy. Local, state, and 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.

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, CBR currently employs a workforce of approximately 68 employees and two contractors with 14 employees. The majority of these employees have been hired from the surrounding communities.

In summary, monetary benefits have and continue to accrue to the community from the presence of the existing Crow Butte 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 potential economic impact of the MEA.

4.10.1 **Tax Revenues**

Table 4.10-1 summarizes the recent tax revenues from the Crow Butte project in U.S. dollars.

Future tax revenues depend on uranium prices, which cannot be forecast with accuracy; however, these taxes also somewhat depend on the number of pounds of uranium produced by CBR. Spot market values for U_3O_8 peaked at approximately $125 per pound in 2007 and have since fallen to approximately $50 per pound as of August 2011 (UxC 2011). 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.

Present taxes are based on a relatively consistent production rate of 800,000 pounds per year. The additional production from the MEA facility should be approximately 553,000 pounds per year. The incremental contribution to taxes would be on the order of $950,000 per year in combined taxes.

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.

4.10.2 **Temporary and Permanent Jobs**

4.10.2.1 Current Staffing Levels

CBR currently employs approximately 68 employees and two contractors employing 14 people on a full-time basis. Short-term contractors and part-time employees are also employed for specific projects and/or during the summer months. This level of employment is significant to the local economies. Total employment in Dawes County in 2010 was 5,691 (BEA 2011). Based on these statistics, CBR currently provides approximately 1.5 percent of all employment in Dawes County. In 2009, the CBR total payroll was $4,155,000. Of the total Dawes County wage and salary payments of $106,652,000 in 2009, the CBR payroll represented about 4 percent.

Total CBR payroll for the past 5 years was:

2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,155,000
2010	$4,200,000

The average annual wage for all workers in Dawes County was $27,347 in 2009. By way of comparison, the average wage for CBR employees was approximately $58,821. Entry-level workers for CBR earn a minimum of $16.15 per hour or $33,600 per year, not including overtime, bonuses, or benefits.

4.10.2.2 Projected Short-Term and Long-Term Staffing Levels

The MEA will require 10 to 12 full-time employees, four to seven 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 (e.g., drilling rig operators) may also increase by four to seven employees depending on the desired production rate. It is anticipated that the majority of the proposed MEA full-time and part-time workforce and contractors would be available from the current labor force in Dawes County. The annual unemployment rate in Dawes County in 2010 was 4.5 percent, equating to 216 individuals (BLS 2011). CBR expects that any new positions will be filled from this pool of available labor. These additional positions should increase payroll by approximately $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 CBR staff (less than 5 percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal.

Because skills and services required for the proposed MEA 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 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 represent 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 MEA construction and operations would not affect municipal water systems.

Electricity, water, propane and other fuel, sanitary water, and 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 total quantities of electricity, water, propane, and other fuel consumed by CBR activities for a limited period of time during operations at MEA because the satellite facility would commence operations as those in the Crow Butte Permit Area are winding down. Because the scope of production at MEA would be similar to current operations in the Crow Butte Permit Area, it is anticipated that fuel and utility requirements would be similar. No substantial increases are likely for new operations at the satellite facility over existing operational uses.

It is not anticipated that construction or operational 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 MEA 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 satellite facility would be similar to those associated with current CBR operations. In addition to providing a 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 in the local area. **Table 4.10-1** summarizes the tax revenues from the CPF.

Total CBR payments made to Nebraska businesses for the past 5 years were:

2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$8,185,000
2010	$4,330,900

The vast majority of these purchases were made in the City of Crawford and Dawes County. This level of business is expected to continue depending upon CBR project activities in any given year, although not in strict proportion to production. As production at the CPF mine site ceases due to depleted ore reserves, expansion areas will be brought on stream. These expansion areas will be sequenced (brought online) in a manner that will continue CPF production consistent with current production rates.

While there are some savings due to some fixed costs, additional expenses are expected to be higher (e.g., wellfield development). Therefore, it can be estimated that the overall effect on local purchases will be proportional to the number of pounds of uranium produced. Local purchases that will be made annually for the MEA are estimated to be in excess of $1,000,000. 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 $532,000 were paid to landowners in 2010. Additional royalty payments would be made to MEA landowners. Most of the landowners are residents of Dawes County; therefore, beneficial impacts to county revenues and local businesses will be accrued through the spending and circulation of these dollars in the local economy.

4.10.4 Economic Impact Summary

As discussed in this section, CBR currently provides a positive economic impact to the local Dawes County economy. Development of the MEA would have a positive impact on the local economy as summarized in **Table 4.10-2**. 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 combined population of the Census Block Groups within or adjacent to the MEA was 32. The entire population was white; one individual identified as Hispanic. The next nearest minority populations reside within the City of Crawford, located approximately 15.1 miles (24.3 km) north-northwest of the MEA satellite building, and the Town of Hemingford, located approximately 15.4 miles (24.8 km) south-southeast (centerpoint of MEA satellite building to centerpoint of communities). Races in the City of Crawford consist of white non-Hispanic (95.6 percent), American Indian (0.9%), Hispanic (1.0 percent), person reporting two or more races (2.3 percent), and smaller percentages of races. Races in the Town of

Hemingford consists of white non-Hispanic (96.1 percent), American Indian (1.2 percent), Hispanic (4.6 percent), persons reporting two or more races (2.1 percent), and smaller percentages of other races. 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 MEA. There would be no disproportionate impact to minority population from the construction and implementation of the MEA.

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 MEA 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 Non-radiological 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. Non-radiological emissions include NO_x, CO, SO_2, VOC, and PM_{10} (operating equipment and fugitive dust due to traffic on unpaved areas).

In addition to gaseous and airborne effluents, three types of wastes would be generated at the proposed satellite facility: liquid, solid, and sanitary. 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 per the site's SPCC Plan.

Solid wastes generated would consist primarily of domestic waste. These wastes are classified as contaminated or non-contaminated waste according to radiological survey results. Non-contaminated solid waste is collected regularly on the site and disposed of in a sanitary landfill permitted by the NDEQ. CBR's estimate of annual quantities of non-contaminated generated solid waste for the MEA 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 MEA is expected to only generate a small amount of hazardous waste and is expected to be classified as a CESQG. 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. No hazardous waste materials will be disposed of on-site; all such wastes will be managed as per NAC Title 128 (hazardous waste regulations) and either recycled or disposed of at an approved hazardous waste handling and disposal facility.

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 UIC Regulations. Septic tank solids will be periodically removed 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 MEA operations.

For any spill, the free liquids would be recovered and any contaminated soils would be removed and placed in an off-site 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 non-radiological waste materials. For example, CBR would use diking or flow cut-off and flow isolation procedures for radiological and non-radiological spill control. A quality assurance/quality control (QA/QC) system will be used, which would involve preoperational testing of equipment, periodic testing and regular inspection of equipment (e.g., pipelines, manifolds), and associated monitoring of line flows and pressures with automatic shutdowns in response to flow or pressure changes. Consequently, any spills should be small with little impact on the environment.

4.12.2 **Radiological Effects**

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

The satellite facility will have a production flow capacity of approximately 6,000 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 1,500 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 facility will be via two DDWs, which will receive fluids from wastewater tanks located in the satellite building. 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 satellite facility 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 primary airborne radiological emission from the facility will be radon-222 gas (radon) and its decay products. 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 Appendix D to NUREG 1569..

MILDOS-AREA 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 (Savignac 2013).

The following sections briefly discuss the assumptions and methods used to estimate the potential radiological impacts of the satellite facility coupled with the CPF. 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 proposed satellite facility is an ISR uranium recovery facility. The only source of planned radioactive emissions from the facility is radon gas and its decay products, which are 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 radon 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 on **Figure 4.12-1.**

The satellite facility will have pressurized downflow IX columns capable of processing 6,000 gpm of production solution. The satellite facility will also have IX and RO equipment with a capacity of 1,500 gpm to process restoration solutions. Up-flow IX columns are not planned for the MEA.

Within the pressurized columns, most of the radon will remain in solution and will be returned to the formation. There will be minor releases of radon during the air blowdown prior to resin transfer to the resin trailer. The air blowdown and the gas released from the vent during column filling will be vented into the exhaust manifold and discharged via the main radon exhaust stack. It is estimated that less than 1 percent of the total radon contained in the process solutions will be vented to atmosphere.

In the source term calculation, Cameco estimates that, in the absence of evaporation ponds, 75 percent of the contained radon released will be vented from the satellite facility, and 25 percent of the radon will be released from the wellfields.

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

The injection wells will generally be closed and pressurized, but periodically vented. A sensitivity analysis demonstrated that radiation doses using a 25 percent/75 percent distribution of radon released from the MU wellhouses and from the satellite facility did not appear to be significantly different from the doses calculated using a 10 percent/90 percent distribution, respectively (Savignac 2013). See discussions in Section 4.12.2.6 and **Appendix M**.

Atmospheric emissions of radon will disperse to all quadrants of the area surrounding the MEA 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 that all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon were evaluated using MILDOS-AREA (Savignac 2013).

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 not have evaporation ponds or surge tanks to store waste solutions, thereby eliminating the potential of releases and exposures via water pathways. Wastewater tanks used to manage project wastewater will be located in the satellite building. The satellite facility will be located on a curbed concrete pad to prevent any liquids from entering the environment. The pad will be of sufficient size to contain the contents of the largest tank if it ruptures. Solutions used to wash down equipment will drain to a sump and be pumped to the DDWs.

Chemical storage tanks located outside the satellite building will be located within spill containment dikes in order to control any spills or releases from the storage tanks.

The wastewater collected in the wastewater tanks within the satellite building will discharge to two DDWs, which will be the primary method of waste disposal at the satellite facility. The DDWs will be completed at a depth of approximately 4,000 to 5,000 ft, isolated from any underground source of drinking water by approximately 1,500 ft of Pierre Shale. The well will be constructed under a permit from the NDEQ and will meet all requirements of the UIC program.

Because 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 the satellite vent system or from the wellfield. As shown on **Figure 4.12-1**, atmospheric releases of radon can result in radiation exposure via three pathways: inhalation, ingestion, and external exposure.

Radiation dose rates were determined using the NRC computer code MILDOS for the proposed MEA project (Savignac 2013. The objective of this evaluation was to:

- Determine the radiation doses to members of the public within a 50-mile (80 km) radius of the MEA using the NRC computer code MILDOS.
- Determine the potential annual dose rate to workers on the site.
- Determine the sensitivity of the MILDOS estimates of radiation dose.

This section summarizes the major findings of the MILDOS evaluation. For more detailed information on assumptions, inputs, outputs, and other elements of the model, the MILDOS report is provided in **Appendix M.**

For comparison, naturally occurring background radiation from cosmic and terrestrial sources, is approximately 365 mRem/yr.

4.12.2.4 MILDOS Output – Radiation Dose Rates

Table 4.12-1 presents the dose rates calculated for the major cities and towns within 50-mile (80 km) radius of the MEA; eight residences; two unoccupied structures; and for the north, south, east, and west property boundaries. Residences #1 and #2 are not currently occupied, but are occupiable. Locations of the nearby and regional receptors are shown on **Figures 4.12-2** and **4.12-3**, respectively. The dose rates were calculated using the MEA on-site meteorological data and using the 315 gpm maximum wastewater flow rate expected in years 9 through 20..

Because radon is released from both the mine fields header houses and from the satellite plant, the doses were proportioned 25 percent from the mine fields and 75 percent from the satellite. **Table 4.12-2** presents the total dose from the satellite facility, MEA MUs 1 through 5 and A through F under typical operating conditions from both sources of radon**.** Conclusions from those dose rates are as follows:

- All dose rates to the public at the property boundaries, the cities and towns within a 50-mile (80 km) radius from the MEA, and at the nearest residence were below the 100 mRem/yr limit specified in 10 CFR 20.
- The highest cumulative MEA boundary dose rate was 65 mRem/yr at the south property boundary.
- The highest cumulative dose rate at an occupiable but currently unoccupied residence was 25 mRem/yr at Residence # 2.
- The highest cumulative dose rate from all existing and proposed ISR facilities at cities and towns within a 50-mile (80 km) radius from the MEA was 6.0 mRem/year at Crawford, and 2.4 and 33.2 mRem/yr at the Towns of Hemingford and Marsland, respectively.
- The 10 CFR 190 dose rate was 0 mRem/yr, which was below the 10 mRem/yr dose limit for emissions that exclude radon and its progeny.
- The total population effective dose rate was 3~~,~~06~~0~~ person-rem/year.

For comparison, naturally occurring background radiation, from cosmic and terrestrial sources, is approximately 365 mRem/yr.

The radiation doses from the production wells and from the wells in restoration are identical. The doses from the new wells are all zero. See **Appendix M** for production well doses, restoration well doses, new well doses. The doses presented in these appendices have not been proportioned among the mine field emissions and the satellite stack emissions.

4.12.2.5 MILDOS Output – Public and Occupational Radiation Dose Rates

Dose rates for the public apply to delivery personnel, regulatory inspectors, visitors, or other personnel that may spend 10 hours per month on site. Occupational dose rates apply to personnel that may spend an estimated 2,000 hours per year working on site, such as company employees or contractors.

Table 4.12.2 shows the MEA public and occupational dose rates. At maximum flow during years 9 through 20, the maximum dose rate to the public attributable to Marsland was 0.4 mRem/yr, and the maximum occupational dose rate to employees and contractors was 42.6 mRem/yr (with an average of 20.9 mRem/yr).

4.12.2.6 Radon Release Points

The radiation dose rates from typical operations used the following:

- 25 percent radon released from the MU wellhouses
- 75 percent radon released from the satellite plant vent stack

That distribution has been used historically in MILDOS assessments. For comparison, dose rates were calculated using:

- 10 percent radon released from the MU wellhouses
- 90 percent radon released from the satellite plant vent stack

The dose rates from both distributions are presented in **Appendix M**. A comparison of the 25 percent/75 percent distribution of radon in column 2 with the 10 percent/90 percent distribution of radon release shows that the averages and standard distributions are nearly identical. That similarity suggests that, within the range of values selected for the radon distribution between releases at the mine fields and releases at the satellite plant, the distribution is not important for assessing the doses to people around the MEA site.

A MILDOS sensitivity analysis was conducted to identify how input parameters affect the calculated radiation dose. Input parameters and variables are discussed in **Appendix M.**

The sensitivity analysis demonstrated that:

- When assuming a wastewater discharge rate of 315 gpm, neither the occupational dose rate nor the public dose rate exceeded 100 mRem/yr.
- Radiation doses calculated using a 25 percent/75 percent distribution of radon released from the MU wellhouses and from the satellite plant did not appear to be significantly different from the doses calculated using a 10 percent/90percent distribution, respectively.
- Assuming a wastewater discharge rate of 315 gpm, the maximum dose to the public on site 10 hours/month is 0.4 mRem/yr.
- Assuming a wastewater discharge rate of 315 gpm, the maximum occupational dose rate to employees and contractors on site 2,000 hours/yr is 42.6 and 20.9 mRem/yr, respectively.
- A sensitivity analysis was performed to identify how input parameters affect the calculated radiation dose.

4.12.2.7 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).

- Radon Releases

Radon emissions at uranium ISR 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 for exposure to flora and fauna due to deposition of radon-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 radon-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 1987), and the doses were found to be negligible. Based on this evaluation, the proposed MEA, TCEA, and NTEA projects are not expected to have a measurable impact on dose to flora and fauna.

The potential exists for individual mobile fauna (e.g., small mammals and birds) to have contact with higher but short-term contact with concentrations of radon-222 than the public due to the potential proximity to releases. However, due to the typical mobility of such animals, it is likely that exposure to individuals would be intermittent, 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 that protection of humans from radiation exposure implicitly ensures an adequate protection of other living organisms and, therefore, the environment (Brechignac 2002 [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). The ICRP has issued a draft report for public comment primarily documenting methods that allow prediction of known concentrations of radionuclides within an organism's habitat (ICRP 2010). This work is still underway.

- Fluid Discharges

There are currently no planned discharges from the satellite facility, with wastewaters being discharged to two Class I DDWs. 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. The satellite processing building, fuel tanks, and chemical tanks would be constructed on pads 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, the satellite facility would not be expected to significantly impact food sources such as vegetation and seeds upon which local animals depend.

4.12.3 **Effects of Accidents**

Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences than accidents associated with underground and open pit mining methods. ISR mining provides a higher level of safety for personnel and neighboring communities 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 RG–0706 and specifically at uranium ISR facilities in RG/CR-6733 (NRC 1980, CNWRA 2001). These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures are followed and properly trained personnel are employed. The CBR emergency management procedures contained in the CBR SHEQMS Volume VIII, Emergency Manual*,* have been developed to implement the recommendations contained in the NRC analyses. Training programs contained in the CBR SHEQMS Volume VII, Training Manual have been developed to ensure that CBR personnel have been adequately trained to respond to all potential emergencies. The CBR SHEQMS Volume II, Management Procedures requires periodic testing of emergency procedures and training by conducting regular drills.

RG-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. RG-0706 also considered transportation accidents. Some of the analyses in RG-0706 are applicable to ISR facilities, such as transportation accidents; however, many of the analyses do not apply due to the significantly different mining and processing methods. ISR 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 lower than that of a mill site.

RG/CR-6733 specifically addressed risks at ISR facilities and identified the following “risk insights”.

4.12.3.1 Chemical Risk

RG/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 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. The satellite facility will use O_2, CO_2, and $NaHCO_3$ for addition to the injection solution. Na_2S may be used as a reductant during groundwater restoration activities. All other operations requiring process chemicals described in RG/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.

O_2

O_2 presents a substantial fire and explosion hazard. The O_2 storage facility is typically designed and installed by the O_2 supplier and meets applicable industry standards. As currently practiced at the CPF, CBR will install wellfield O_2 distribution systems at the MEA. Combustibles, such as oil and grease, will burn in O_2 if ignited. CBR ensures that all O_2 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 O_2 systems in the wellfield is addressed by procedures contained in the SHEQMS Volume III, Operations Manual. Emergency response instructions for a spill or fire involving O_2 systems are contained in the SHEQMS Volume VIII, Emergency Manual.

CO_2

The primary hazard associated with the use of CO_2 is concentration in confined spaces, presenting an asphyxiation hazard. Bulk CO_2 facilities are typically located outdoors and are subject to industry design standards. Floor-level ventilation and CO_2 monitoring at low points is currently performed at the CPF to protect workers from undetected leaks of CO_2. Operation of CO_2 systems is currently addressed by procedures contained in the SHEQMS Volume III, Operations Manual. Emergency response instructions for a leak involving CO_2 are contained in the SHEQMS Volume VIII, Emergency Manual.

$NaHCO_3$

$NaHCO_3$ is primarily an inhalation hazard. CBR typically uses soda ash and CO_2 to prepare $NaHCO_3$ 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 $NaCO_3$ systems is currently addressed by procedures contained in the SHEQMS Volume III, Operations Manual. Emergency response instructions for a spill involving $NaHCO_3$ 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 would present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the processing building. O_2, H_2O_2, CO_2, propane, and fuel will be stored outside in 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 any 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 would be repaired or replaced as necessary.

Facility Pipe Failure

The rupture of a pipeline within the satellite processing area would be easily visible and could 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 ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements 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 monitor well ring. A vertical excursion is a movement of ISR 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 MU, the wellfield is said to be balanced.

CBR monitors for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. The current NRC License and NDEQ Class III UIC Permit require that Chadron aquifer monitor wells be located no more than 300 feet from the nearest mineral production wells and no more than 400 feet from each other. These spacing requirements have proven to be 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 is discussed in detail in Section 6.2.2.1.

Section 3.11.1.2 provided a discussion of horizontal excursions reported at the current CBR operation. 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 RG/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 5.1.3.1. 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 4 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 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 a release of either 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, 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 MU 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 detecting significant piping failures (e.g., failed fusion weld) in the current operation.

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.

4.12.3.5 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 because production from the proposed satellite facility is planned to replace declining production at the current facility. The shipment of loaded IX resin from the satellite facility and the return of barren, eluted resin represent an additional transportation risk that was not considered for the current operation.

RG-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 RG/CR-6733 determined were conservative with respect to probability distributions used in a later NRC transportation risk assessment (CNWRA 2001). For Marsland, uranium-loaded and barren resin will be routinely transported by tank truck from the satellite facility to the CPF. For the Crown Point ISR site located in New Mexico, NRC determined that the probability of an accident involving such a truck was 0.009 in any year (NRC 1997).

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

Accidents Involving Shipments of Process Chemicals

Based on the current production timeline 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 CO_2, O_2, bicarbonate, H_2O_2, and soda ash.

Accidents Involving Radioactive Wastes

11(e)2 byproduct material or unusable contaminated equipment generated during operations will be transported to an approved licensed disposal site. Because of the low levels of radioactive concentrations 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 daily.

The transfer of resin between the satellite facility and the CPF will occur on SH 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 approximately 18.0 miles (29.0 km) of travel on SH 2/71 and approximately 12 miles (19.3 km) on county and private roads (**Figure 1.4-1**). The Alternate A access route is approximately 14 miles (22.5 km) long, with all of the roads being unpaved county and private roads. The planned access routes are discussed in more detail in Section 4.2.21.

Resin or eluate shipments will be treated similar to yellowcake shipments in regards to 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 be documented 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 help determine 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. These procedures would be followed to minimize the impacts from such an accident:

- Each resin hauling truck will be equipped with a radio that 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 ensure a reasonably quick response time in the case that the driver is incapacitated in an accident.
- Each resin transport vehicle will be equipped with an emergency spill kit that 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.

4.12.3.6 Natural Disaster Risk

RG/CR-6733 evaluates the potential risks to an ISR facility from natural disasters. Specifically, the risk from an earthquake, a tornado strike, fire, and flooding 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. RG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities. CBR is committed to following these standards.

Tornado Risk

NUREG/CR 6733 evaluates tornado risks associated with ISR facilities for the release of radioactive materials or hazardous chemical due to the effects of a tornado. It was determined that, in the event of a tornado strike, chemical storage tanks could fail, resulting in the release of chemicals. This guidance document concluded the risk of a tornado strike on an ISR facility was very low and that no design or operational changes were necessary to mitigate the potential risks. However, it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident.

The Crow Butte operation is located in an area subject to tornados. The site is located in Dawes County, Nebraska in which five tornado touchdowns were reported during the period of 2000 and 2012 between the months of May and August (NOAA 2012). The five tornado events did not exceed a Fujita or Enhanced Fujita scale (F- or EF-scale, respectively) magnitude of F0 or EF0 and no injuries, deaths, property damage, or crop damage occurred. According to the Fujita Tornado Damage Scale, a typical F0 tornado event will exhibit wind estimates less than 73 mph and produce light damage to the surrounding area. Most tornado events were reported to have taken place in open country, rangeland, and wooded areas. One of the tornados reported in

Chadron had a magnitude of EF0 and damaged a tree and a windmill. The tornado events had damage paths ranging from 0 to 0.4 mile in length and had path widths ranging from 20 to 30 yards. Although Dawes County can be considered relatively weak in tornado risk, surrounding counties such as Sheridan County have been known to have tornado events classified as F1. Within the same time period, Sheridan County experienced an F1 tornado that caused approximately $150,000 in property damage.

It has been concluded that tornado risk in Dawes County is relatively low compared to that of the surrounding region. Dawes County historical area-adjusted tornado activity is significantly below Nebraska state average, and is 1.6 times below the overall U.S. average (City-Data 2012). The tornado index, a measure of the probability of tornado events and calculated using historical tornado events data and USA.com algorithms, was 205.07 for the State of Nebraska as a whole and 64.92 for Dawes County (USA.com 2013). During the final design phase, CBR will assess the location(s) and construction of chemical storage tanks and containment features in order to reduce the risk of potential leaks caused by tornado damage which may result in harmful chemical reactions.

CBR emergency procedures currently contained in the SHEQMS Volume VIII, Emergency Manual*,* provide instructions for response and mitigation of natural disasters and spills or radioactive materials. CBR's Emergency Manual contains emergency provisions such as notification to personnel of severe weather; evacuation procedures, security plans, and threats associated with source material; medical emergencies; damage inspection/assessment and reporting; and cleanup and mitigation of chemical spills. CBR will have separate containment berms around storage tanks to reduce the risk of mixing of incompatible chemicals in the event of a spill. In addition, the site's SOPs, training, and personal protective equipment will be available to personnel for response and mitigation of hazardous chemical releases.

Seismic Risk

The project area, along with most of the State 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. Dawes County-area historical earthquake activity is significantly above Nebraska state average, but it is 85 percent below the overall U.S. average (City-Data 2012). Seismology was discussed in detail in Section 2.6. No historical earthquake events that had recorded magnitudes of 3.5 or above have been reported in or near Dawes County (USA.com 2013).

NUREG/CR-6733 concluded that risk from earthquakes at ISR facilities was no greater than for a tornado strike, and that no design or operational changes were required to mitigate the risk. However, the NRC advised that it was important to locate chemical storage tanks far enough from each other to prevent contact of reactive chemicals in the event of an accident.

As stated above for potential tornado strikes, CBR emergency procedures currently contained in the SHEQMS Volume VIII, Emergency Manual provide instructions for response and mitigation of natural disasters and spills or radioactive materials. CBR will have separate containment berms around storage tanks to reduce the risk of mixing of incompatible chemicals in the event of a spill. In addition, the site's SOPs, training, and personal protective equipment will be available to personnel for response and mitigation of hazardous chemical releases.

Fires

Historically, there have been no fires of any significance during CBR commercial operations, and none would be expected to occur at the proposed MEA site. CBR's Emergency Manual maintains procedures for dealing with potential fires, whether associated with man-made events at the operations or associated with wildfires.

Wildfires have typically not been a problem in the area of the MEA and are not considered a major threat to the MEA site. On August 31, 2012, CBR was ordered by the Dawes County Sheriff's Office to evacuate the current Crow Butte operations site due to threatening wildfire to the east of the project (CBR 2012). CBR advised the NRC of this order, operations were temporarily shut down, and site personnel were evacuated. All project personnel were evacuated with the exception of a crew of five CBR personnel that remained on site for security purposes. On September 1, 2012, the evacuation order was lifted and operations were restarted on September 2, 2013. The wildfire never entered the licensed area and, as a result, there were no releases to the environment. During the evacuation, all source material on the site was kept under 24-hour surveillance. CBR's Emergency Manual procedures were followed during the evacuation, and there were no incidents.

Flooding

Flooding is considered a low-risk issue due to the lack of permanent streams or rivers flowing through the MEA project and historical annual rainfalls and snowmelt. CBR personnel are unaware of any historical flooding of the site. CBR conducted an erosion analysis of the MEA site and will use the results of that study in siting assets and providing mitigation measures to prevent any potential damage associated with flooding. The potential for flooding or erosion that could impact the proposed in-situ Marsland mining processing facilities and mine units is discussed in Section 1.3.2.13.

4.13 Waste Management Impacts

This section describes the waste management impacts from the satellite facility. The effluents of concern at ISR operations include the release or potential release of 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 composed 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 during solution sampling and spills, filter changes, IX resin transfer, RO system operation during groundwater restoration, and maintenance activities. These are considered minimal and infrequent radon-222 releases. The impacts from release of radon-222 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 ISR 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:

Water Generated during Well Development

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 management of these waters is discussed in Section 3.12.2.1.

Liquid Process Waste

For the years 2013 through 2021, 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 a DDW water supply tank located in the satellite building. Process bleed is estimated at 0.5 to 2.0 percent of the process flow of 6,000 gpm. The impact of this process bleed was discussed in Sections 3.12.2.1 and 4.4.3. Starting in 2022, the wastewater flows will rise sharply as the bleed from the RO process used during restoration must be addressed.

Aquifer Restoration Waste

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

1. Groundwater transfer
2. Groundwater sweep
3. Groundwater treatment
4. 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

As discussed in Section 3.1.7, from 2015 through 2021, the majority of the wastewater produced at the MEA satellite facility requiring disposal will be the production bleed (25 to 65 gpm over the life of project). Starting in 2022, the wastewater flows will rise sharply as the bleed from the RO process used during restoration must be addressed.

Other liquid production wastewater will consist of process liquids (e.g., affected well development water, laundry water, and plant washdown water). These waste streams will account for an intermittent discharge with an maximum average of 1 to 2 gpm. The disposal water balance discussed below is of such a magnitude that these small quantities of wastewaters will be easily managed in the proposed disposal system. The well development water will be collected using a dedicated vacuum truck and delivered to the well workover fluid tank located in the satellite building (**Figure 3.2-1**). The other liquid wastes (i.e., laundry and plant washwater originated in restricted areas) will flow to plant sumps and will be transferred to a wastewater tank located within the satellite building. All of the above waste streams and tankage will be disposed of through the DDWs. The satellite building will not have a laboratory, and a septic system will be used for discharges from toilets, lavatories, and a sink in the lunchroom/break area. The MEA water balance is discussed in Section 3.1.7, with discussions on the management of the production and restoration waste streams.

Upon well completion, all water generated during baseline or operational monitoring is discharged to the surface with the exception of well rehabilitation work and excursions. When a monitor well is on excursion, the purge water is collected and disposed in the wastewater disposal system or taken to the evaporation ponds at the CPF. All water and solids resulting from well rehabilitation will be captured in water trucks and discharged into the wastewater disposal system or taken to the evaporation ponds at the CPF.

Restoration for MU 1will begin approximately in the sixth year of operation. Two major waste streams generated during restoration that will require disposal will be RO bleed and brine. The RO bleed will range from 167 to 250 gpm beginning in the year 2021 and continuing until 2037.

One primary method of disposal of liquid wastes proposed for the satellite facility is by DDW. CBR has operated the DDW at the CPF license area for more than 10 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 DDW. A second DDW became operational at the CPF in late 2011.

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 DDWs. No adverse environmental impacts are expected from this type of disposal.

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. In additional, some waste materials will be generated during drilling activities, such as drill cuttings (see discussions in Section The solid waste will be segregated based on whether it is clean or carries the potential for contamination with 11(e).2 byproduct materials. As with the current CPF, CBR will follow written waste management procedures per the SHEQMS; by following these procedures, no environmental impacts associated with waste generation, handling, and disposal would be expected. All solid waste generation, handling, and disposal will be carried out in compliance with all applicable county, state, and federal regulations. Good housekeeping is a requirement of the SHEQMS, which includes keeping facilities, equipment, and process areas clean and free of industrial waste or other debris. Good housekeeping includes promptly cleaning any spillage or process residue on floor or other areas that could be spread and collecting solid wastes in designated containers or areas until proper disposal.

Non-contaminated Solid Waste

Non-contaminated solid waste is waste that is not contaminated with 11(e).2 byproduct material or that 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 that are not contaminated or that may be successfully decontaminated. Release of contaminated equipment and materials is discussed in further detail in Section 5 of the MEA Technical Report.

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 ISR facilities consists of filters, PPE, spent resin, piping, and other items. 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 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 RCRA. Based on waste determinations, CBR is a 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.

4.14 Cumulative Effects

Since the 2007 submission of the NTEA application to amend the CBR Source Materials License, Cameco Resources has submitted two additional applications for expansion. The TCEA and the MEA license amendment applications were submitted in 2010 and 2012, respectively. Each application addresses the cumulative environmental effects relevant at the time of submission; however, evolving business decisions have altered the planned sequence of activities.

This section evaluates the potential cumulative effects resulting from the proposed MEA project when added to other past, present, or reasonably foreseeable future actions (RFFAs). With the exception of 136 acres of the TCEA license boundary that extends into Sioux County, the proposed expansion projects are all located in Dawes County, Nebraska and within the Nebraska-South Dakota-Wyoming Uranium Milling Region as defined in the NRC GEIS (NRC 2009). The GEIS analyzed cumulative effects from proposed ISR facility construction, operation, groundwater restoration, and decommissioning by identifying and considering other past, present, and RFFAs in the Nebraska-South Dakota-Wyoming Uranium Milling Region. This analysis uses the GEIS methodology for cumulative effect analysis and provides updated information regarding past, present, and RRFAs near the Crow Butte Operation. The geographic boundary or Resource Study Area (RSA) for each resource is addressed in the cumulative impact analysis discussions of this section.

As stated in each of the applications, CBR would use the additional mineral resource available at the expansion areas to replace the declining resource at the CPF site. The addition of the expansion areas would be sequenced (brought on line) in a manner that continues production consistent with current CPF levels.

As noted in the MEA application (CBR 2012; ML12160A513), CBR is focused on obtaining an NRC license amendment to the current NRC Radioactive Materials License SUA-1534 and NDEQ permits required for construction and operation of the proposed MEA project. If licenses and permits are granted, construction of the MEA would begin in 2014, with production starting in mid-2015 and extending until approximately 2033.

Similarly, as noted in the TCEA application (CBR 2010; ML102220278), if licenses and permits are granted, construction of the TCEA would begin in 2015, with production starting in mid-2016 and extending until 2032. CBR plans to use the NTEA to complement the MEA and TCEA operations when their production begins to decline. To accomplish this, the NTEA would be constructed in 2023, with production starting in 2024 and extending until 2032.

This submission is intended to update the timeline, highlight relevant information, and assess the cumulative effects of the proposed approach. The following tables from each application summarize the predicted environmental effects of each expansion area:

- Table 2-2: Comparison of Predicted Environmental Impacts, Environmental Report, North Trend Expansion Area, pages 2-12 and 2-13;
- Table 2.6-1: Comparison of Predicted Environmental Impacts, Environmental Report, Three Crow Expansion Area, pages 2-9, 2-10 and 2-11; and
- Table 2.6-1: Comparison of Predicted Environmental Impacts, Environmental Report, Marsland Expansion Area, pages 2-11 and 2-12.

Note that fugitive dust emission estimates have been revised for NTEA, TCEA and MEA, so the values in the above tables will be different.

4.14.1 Other Past, Present and Reasonable Foreseeable Future Actions

Crow Butte's CPF is the only operating ISR facility in Nebraska. CBR has identified several additional resource areas in the region near the CPF that could conceivably be developed as expansion areas with satellite facilities. Development of these facilities depends on further expansion area investigations by CBR and the future of the uranium market. If conditions warrant, CBR may submit additional license amendment requests to permit development of these additional resources. However, CBR currently projects that development of these areas would be primarily intended to maintain production allowed under the current license as reserves in the current licensed area and at the expansion areas are depleted.

Other than the CBR expansion projects, there are no other uranium exploration projects underway or proposed within 50 miles (80 km) of the expansion areas. Based on a review of past, present, and RFFAs, CBR has not identified any projects that would occur within the timeframe and geographic context of the proposed expansion projects; therefore, they would not contribute overlapping effects. The past, present, and RFFAs evaluated included uranium recovery projects, coal and other mining projects, oil production and exploration activities, potential wind energy projects, and proposed infrastructure and transportation projects. Identified projects within the region would not have overlapping effects because they were located more than 50 miles (80 km) from the proposed expansion projects or would not be expected to occur within the same timeframes the proposed expansion projects.

4.14.2 Methodology

This analysis of cumulative effects uses the same methodology and significance levels as those used in the GEIS (NRC 2009). The following terms describe the level of cumulative effect:

- Small: The environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource considered.
- Moderate: The environmental effects are sufficient to alter noticeably, but not destabilize, important attributes of the resource considered.
- Large: The environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource considered.

CBR has taken the information in the NTEA, TCEA, and MEA applications, especially the tables in the ER Attachment, and compiled two tables. **Table 4.14-1** reiterates the individual effects described in each application and describes the effects of the combined CBR activities. **Table 4.14-2** presents the unavoidable combined environmental effects of the combined CBR activities, along with CBR's proposed mitigation measures.

The existing CPF would transition to the proposed expansion areas to allow continued production at current levels. Late in the project life (2025 to 2040), all three expansion areas and the existing CPF would be operational with varying levels of activity.

There are no other ISR or industrial facilities in the vicinity of the proposed expansion areas. Other than the CBR uranium recovery activities, no known planned uranium recovery operations were identified in Nebraska. There are no other operating or proposed uranium recovery facilities located within a 50-mile (80 km) radius of the proposed expansion projects. Therefore, the cumulative effects associated with implementation of the proposed expansion projects are primarily limited to the combined effects when all of the proposed CBR operations and facilities are operating simultaneously.

Other operating and proposed uranium facilities exist within the Nebraska-South Dakota-Wyoming Uranium Milling Region; however, these facilities would not contribute overlapping effects because they are more than 50 miles from the proposed expansion projects. The operating uranium recovery facility closest to the proposed expansion projects is the Smith Ranch-Highland uranium ISR facility located near Douglas (Converse County) in eastern Wyoming (NRC 2009). The proposed uranium ISR facilities closest to the proposed expansion areas that have filed applications are Powertech Uranium's Dewey-Burdock facility in Fall River and Custer Counties of South Dakota and Uranium One's Moore Ranch project in Converse County, Wyoming. These facilities are located more than 65 miles from CBR in the neighboring States of Wyoming and South Dakota.

4.14.3 **Analysis of Effects**

Cumulative effects are described by resource in the following subsections. The resource areas addressed in the cumulative effects analysis include land surface, land use, transportation, geology and soils, surface water, groundwater, ecological, air quality, noise, historic and cultural, socioeconomics, non-radiological health, radiological health, waste management, and mineral resource recovery.

4.14.3.1 Land Surface

No planned land development projects were identified in the surrounding region of the proposed project. Construction of the expansion projects would require temporary and relatively superficial surface disturbances for construction of satellite plants and appurtenant facilities. There are only a few areas to be disturbed such that subsoil and geologic materials are removed, causing significant topographic changes that would need backfilling and re-contouring. Late in the project life, the footprint of the satellite plants and appurtenant facilities within the three expansion areas would result in a combined long-term ground disturbance of approximately 58 acres.

Effects to the land surface would be 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 re-establishment of drainage patterns would be accomplished by returning the earthen materials moved during construction to their approximate original locations. In combination with other past, present, and RFFAs, implementation of the proposed expansion projects would result in a small cumulative increase in land surface disturbances.

4.14.3.2 Land Use

No planned land development projects were identified near the proposed project. The original license area for the CPF site is approximately 2,861 acres, and the surface area affected over the estimated life of the project is approximately 2,000 acres. Late in the project, when all three expansion areas and the existing operation are operating simultaneously, the expansion areas will displace an additional combined total of approximately 2,543 acres (assuming only 11 MUs) from crop production or livestock grazing. Wheat and hay are the major crops grown on croplands within the area. In 2007, Dawes County had 44,100 acres of cropland used to grow alfalfa hay and 43,445 acres used for winter wheat (NASS 2009).

Dawes County is composed of approximately 202,946 acres of cropland and 616,467 acres of permanent pasture and rangeland (other than cropland and woodland pastured), for a total of 819,413 acres of agricultural land (NASS 2013). The land uses displaced by the CBR proposed projects represent approximately 0.003 percent of this total agricultural land in Dawes County. Landowner mineral royalties and leases will offset the loss of crops. Considering the relatively small size of the area affected, the exclusion of agricultural activities from the expansion areas over the life of the operation should not have a significant effect on local agricultural production.

These effects would occur over the life of the project; however, once mining is completed, these effects would be reversible by returning the land to its former cropland or rangeland uses through post-mining surface reclamation. Mitigation measures for the loss of agricultural production over the course of the project are discussed in Section 5.1. When considered with all the other past, present, and RFFAs in the vicinity, implementation of the proposed expansion projects would result in a small cumulative effect on land uses.

4.14.3.3 Transportation

Over the long term, the volume of traffic on public roads would increase proportional to regional population growth. No planned transportation projects were identified in Dawes or Sioux Counties. 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 2010 was 1,190 and 145, respectively (NDOR 2010). The 2010 average daily traffic counts for a segment of Highway 2/71 near the Four Mile Road intersection was 755 vehicles, including 95 heavy commercial vehicles (NDOR 2010).

At the peak of activities, the heavy truck traffic and additional vehicle traffic associated with the CBR facilities would increase to 1,000 trips per year and 12 to 16 trips per day, respectively. Relative to the current traffic volume on U.S. Highway 20 and Nebraska Highway 2/71, the additional traffic related to operation of the expansion areas would represent an increase of less than 5 percent. The additional traffic related to the construction and operation of the expansion areas would not significantly affect these main routes. In the area around the City of Crawford, the increased traffic is not anticipated to be unnoticeable because U.S. Highway 20 and Nebraska Highway 2/71are both significant transport routes.

The additional traffic also would accelerate the rates of county road degradation and increase maintenance costs. The costs associated with Dawes County road maintenance, however, would be offset by tax revenues and CBR’s assistance with maintenance materials, such as gravel, road signs, and new culverts. Consequently, when considered with all the other past, present, and RFFAs in the vicinity, the expansion projects would result in a small increase in cumulative effects on transportation facilities.

4.14.3.4 Geology and Soil

The proposed expansion projects would have no effects on geology. Therefore, there would be no cumulative effects.

Soils in the area would continue to be disturbed from past, present, and RFFAs. With proper implementation of BMPs to prevent erosion and control sediment, however, cumulative effects to soils are not expected to be significant. Rather, the proposed expansion projects would result in minimal or no cumulative effects to soils.

4.14.3.5 Surface Water

Population projections (see Section 2.3) suggest that future water use near the expansion areas would likely be similar to current conditions. Development of irrigation within the license area is unlikely because water supplies, topography, and climate are limiting. Irrigation within the review area is anticipated to be consistent with past practices (e.g., limited irrigation in the immediate vicinity of the White River). It is anticipated that the City of Crawford's municipal water supply would continue to be provided by the groundwater and infiltration galleries related to the White River and associated tributaries. Past, present, and RFFAs in the area are expected to result in no effects or only minimal effects to surface water effects. This conclusion is based on the determination that BMPs, including SPCC plans and SWPPPs, will be implemented to prevent erosion and control sedimentation. Therefore, the proposed expansion projects would result in minimal or no cumulative effects to surface water quality.

4.14.3.6 Groundwater

Uranium mineralization is limited to the basal sandstone of the Chadron Formation, which is isolated from underlying and overlying sands. Because the basal sandstone of the Chadron Formation (production zone) is a deep confined aquifer, the mining operations are expected to affect water quality only in the area of mining influence within this formation. Restoration will be conducted in this formation following completion of mining, restoring the groundwater to acceptable water quality levels approved by the NDEQ and NRC.

There is no documented domestic or agricultural use of groundwater from the basal sandstone of the Chadron Formation in the vicinity of the proposed expansion areas; therefore, no effects to other users of groundwater are anticipated.

CBR has evaluated the cumulative impact of the operations of the MEA, TCEA, NTEA, and CPF mining activities as per the proposed timeline of development. The results of this evaluation are discussed below.

Potential cumulative impacts to groundwater resources are expected to be minimal due to the site controls and distance from the MEA site to the CPF and proposed TCEA and NTEA. The operational control and instrumentation systems and excursion monitoring system to be used at the MEA site are designed to quickly detect potential excursions and any leaks, spills, or releases. Therefore, any area of impact would be considered to be small. These same conditions will also apply to operations at the proposed NTEA and TCEA, and already apply at the CPF site. Therefore, it would be extremely unlikely for any groundwater impacts reaching beyond the license boundary at the MEA site, as well as the CPF, NTEA, and TCEA could contribute to any cumulative impacts.

The NRC has indicated a concern with potential cumulative impacts on groundwater from operating multiple ISR facilities in the Crawford basin. In an effort to address these concerns, an evaluation of the potential cumulative impacts associated with development of expansion areas was conducted, and includes an assessment of water levels and water quality in the basal sandstone of the Chadron Formation, as well as overlying and underlying aquifers. Additionally, the effect of DDW operation on the Morrison and Sundance Formations was assessed. Existing water level data collected prior to and during active mining at the CPF site and expansion areas, hydraulic testing results, water quality results, and DDW design calculations were consulted in conjunction with the anticipated mine development and production timelines to assess potential cumulative impacts.

Water Level Impacts

As has been demonstrated at the CPF, water levels in the basal sandstone of the Chadron Formation have decreased approximately 60 feet due to production (bleed rate implementation) in order to maintain an inward hydraulic gradient. Water quality in the basal sandstone of the Chadron Formation is considered poor compared to the shallower Brule formation. Therefore, there are limited wells completed in the basal sandstone of the Chadron Formation to allow for monitoring of offsite water levels. According to a 1991 Industrial Groundwater Use Permit, water levels in Crawford are expected to decrease up to 20 feet from static levels as a result of mining operations at the CPF site (CBR 2007).

Additionally, pumping tests have been conducted in the basal sandstone of the Chadron Formation at similar rates as anticipated production bleed rates. These tests have generally been less than 3 days in duration, and have resulted in estimated water level decreases greater than 1 foot at a distance up to 5,700 feet from the pumping well (Petrotek 2002). The cone of depression would continue to expand during long-duration pumping, as is the case during production and groundwater restoration activities. Therefore, the results of pumping tests as well as observed and projected water levels resulting from the CPF mining operations indicate that water levels in the basal sandstone of the Chadron Formation will decrease in a mining unit, with drawdown propagating up to several miles from the pumping center.

Observed water levels in the overlying Brule Formation resulting from CPF mining operations and during pumping tests indicate the basal sandstone of the Chadron Formation and Brule Formations are hydraulically disconnected. Therefore, sustained water level decreases in the basal sandstone of the Chadron Formation are expected to have an insignificant effect on Brule Formation water levels.

The disposal option for process bleed water and groundwater restoration that is likely to impact groundwater levels or water quality is injection into the Morrison and/or Sundance Formations using DDWs. Each expansion area is expected to operate up to two DDWs. Characterization of the injection zone of DDW-#-2 at the CPF site indicates that the formation thickness is approximately 67 feet. In order to calculate a radius of influence resulting from DDW injection over the course of 10 years, mobile porosity was assumed to be 10 percent. The radius of influence resulting from injecting 45 gpm into a single well over 10 years is approximately 1,200 feet. The calculated radius of influence assumes uniform flow across the full injection interval (thickness) and area, and that no impediments to injection such as injection pressure or aquifer boundaries exist.

Additional calculations made for radius of influence for a DDW located at the MEA site are summarized in **Table 1.3-7**. In addition to the assumptions above, assumptions were 17 years of operations, a formation thickness of 200 feet, and a formation porosity of 0.25. The summary table in **Table 1.3-7** shows different flow rates (ranging from 25 to 400 gpm) with the corresponding radius of emplaced fluid. As an example, the calculated radius of influence for the injection of 50 or 400 gpm in one DDW would be approximately 617 feet or 1,745 feet, respectively. Although it is currently estimated that six DDWs may be required over the life of the project, evaluations of the operations of the initial two DDWs will be used to more effectively to determine the required number, configurations and locations of additional DDWs. ~~While DDW configurations and locations at each expansion area are not yet determined,~~ The calculations discussed above do ~~this calculation~~ provide~~s~~ some estimate of the area where DDWs will displace formation groundwater, which may result in increased pressures or redistribution of groundwater to adjacent areas.

Potential cumulative impacts associated with groundwater drawdown are expected to be minimal due to site controls and distance from the MEA site to the CPF and proposed TCEA and NTEA. This position is supported by a drawdown analysis conducted by Cameco in July 2013 (**Appendix W**). A simple hydrologic drawdown-distance analysis, using the Theis (1935) equation for confined aquifers, was conducted to estimate the drawdown at the MEA. The analysis used the water balance disposal estimate for the year 2024, which corresponds to the tenth year of operations. The year 2024 in the Marsland water balance is the year during which the highest consumptive ground water use is assumed. The analysis assumes that four MUs are in restoration with an estimated 250 gpm of consumptive water use, and five MUs are in production with a bleed stream of 65 gpm. The total consumptive water use estimated for that year is 315 gpm. The 315 gpm consumptive water use represents the worst case water for water use during the operation of the MEA.

The drawdown for the Crow Butte Project referenced in Section 4.4.3.1 states that based on the operating data, the available head over the formation has been reduced 10 percent, or for every 100 ft of water column over the formation, the column has been reduced by 10 ft. Consistent with Section 4.3.1, the available head over the formation is expected to be reduced by 10 percent.

The drawdown analysis of the MEA estimates that the drawdown during the worst case year of operation is approximately 30 feet in the areas where active restoration is occurring. The estimated drawdown is about 6 to 7 percent of the total head available. The static water level at Marsland is about 465 ft, and the expected water level during the tenth year of operations is estimated to be 435 ft. The draw down in the basal sandstone of the Chadron Formation, at the monitor well ring, is approximately 15 ft and the worst case drawdown at the edge of the 2.25 mile review area will be about 2 ft. As such, this analysis of the MEA is in reasonable agreement with the actual operating data from the CBR Mine.

CBR reviewed private wells within a 2.25 mile radius of the MEA and found that All of the registered wells and nonregistered wells within a 2.25-mile radius of the MEA were not completed in the basal sandstone of the Chadron Formation. All of the known well completions are completed in the overlying Brule Formation and Arikaree Group, because the wells are much shallower (60’ to 300 feet) than the basal sandstone of the Chadron Formation (1000 ft +), and the water quality of the overlying formations is superior to that of the basal sandstone of the Chadron Formation. Further, the pumping test demonstrated the integrity of the confining layer that separates the aquifer in the basal sandstone of the Chadron Formation from the overlying aquifers.

Potential cumulative impacts to the Morrison and Sundance Formations resulting from operation of DDWs at expansion area mines are unclear. While radius-of-influence calculations indicate the area where formation water will be displaced by injected water, it is unclear where the displaced water migrates. The ability of these confined aquifers to accept injected water is limited by the presence of overlying and underlying confining units, aquifer storage, and hydraulic connection within the injected formation and with adjacent aquifers. Little characterization of the Morrison or Sundance Formations is available in the area of interest that would enable a meaningful evaluation of overlapping influences among the four mines.

Surface water levels have been shown to be unaffected by current mining operations, as no discharge to surface water is permitted, and the deep disposal aquifers appear to be hydraulically disconnected from surface water. No changes to the lack of surface water impacts are expected as a result of expanded mining operations.

Water Quality Impacts

Water quality in the basal sandstone of the Chadron Formation during mining is controlled by induced hydraulic gradients toward the mine unit that limit injectate excursions. Monitoring wells outside the production wellfield are sampled biweekly to ensure that extraction wells are adequately removing the injectate. Changes to extraction well pumping rates are made to remedy observed injectate excursions that are indicated by perimeter monitoring well water quality results. Therefore, water quality in the basal sandstone of the Chadron Formation is not expected to be significantly affected during mining.

Mining unit-specific groundwater restoration water quality goals are determined as endpoints for restoration activities. During groundwater restoration, water is returned to at or near background conditions using the best practice technology for treatment. If background concentrations for mining-related groundwater constituents cannot be achieved using best practice cleanup technologies, NDEQ groundwater standards become the restoration goal. The objective of groundwater restoration is to return water quality back to that which is consistent with pre-mining use. Future use of groundwater is not expected to be affected by mining activities.

The combined water quality controls in place during mining and aquifer restoration goals should result in water quality in mine units that are not significantly different than background and do not influence future use. Therefore, cumulative influences on water quality of the basal sandstone of the Chadron Formation resulting from operation of multiple mines is not expected. Injected water quality in the Morrison and Sundance Formations is monitored daily or weekly, depending on the parameter, and reported to the NDEQ monthly. Therefore, water quality in the deep injection formations will not be adversely impacted beyond what is permitted due to operation of DDWs at multiple mines as long as injectate water quality does not deviate from permit limitations.

Conclusions

Water levels in the basal sandstone of the Chadron Formation have been shown to decrease near an active mine unit, with potentiometric surface depressions expanding several miles after years of active mining. This provides hydraulic control of injected water in order to minimize excursions that cause water quality issues. However, these water level decreases are expected to radiate from all mines that simultaneously draw water from the basal sandstone of the Chadron Formation during either production or groundwater restoration, and will induce overlapping potentiometric surface cones of depression. It is unclear as to the magnitude of decreases that may result from pumping at multiple mining areas, but it is expected to be on the order of tens of feet. The majority of the regional water wells are completed in the Brule Formation, and not the basal sandstone of the Chadron Formation, as water from the Brule Formation is preferred due to higher water quality and the preference for shallower wells.

Wastewater injected into the Morrison and Sundance Formations using DDWs will likely have injected radii of influences of greater than 1,000 feet. These injections will displace formation groundwater, although it is unclear where that water will migrate. Little characterization of the Morrison and Sundance Formations has been completed, and only observations of injection pressures and flowrates can be used to infer the ability to dispose of water using this method. The Morrison Formation has demonstrated the capacity to accept large volumes of an injected waste stream over an extended period of time at the nearby CPF.

The subsurface geologic characteristics beneath the proposed expansion areas will prevent disposal fluids injected into the DDW injection zone from impacting the overlying fresh water aquifers. Between the lowermost drinking water source aquifer and the DDW injection are more than 2,500 feet of sediments primarily consisting of low permeability shale. This separating aquitard protects against vertical migration of injected fluids to the drinking water source aquifers. Shales above and below the DDW injection zone will encase the disposal fluids within the receiving formations, and no structural elements with the potential to disrupt the natural vertical containment have been identified.

Water quality in the basal sandstone of the Chadron Formation during production is maintained by providing hydraulic control of the injectate. Extraction well operations are adjusted to remedy observed injectate excursions. Formation water quality is restored to either background conditions or conditions that are consistent with pre-mining water quality under the direction of the NDEQ. As a result, no significant degradation of water quality is expected to result from operation of expansion area mines. Water quality of the Morrison and Sundance Formations is protected by permitted specifications on injectate water quality. Therefore, if permit limitations are not exceeded, there will be no adverse cumulative impact beyond permitted levels as a result of operation of multiple mines. The EPA and NDEQ will not authorize deep disposal via a Class I injection well unless the permitting process demonstrates that adequate operating procedures and controls will be in place and the well will be properly sited so that the confinement zones and proper well construction minimize the potential for migration of fluids outside of the approved injection zone. The conditions and conclusions addressed in this section apply to the current CPF operations and the proposed MEA, TCEA, and NTEA sites.

4.14.3.7 Ecological

Mixed-grass prairie habitat in the area would continue to be disturbed from past, present, and RFFAs. The project would add to the effects of other past, present, and future activities occurring in the region, including the effects of other past, present, and future uranium mining operations. Significant cumulative effects to ecological resources are not anticipated because no substantive impairment of ecological stability or diminishment of biological diversity within the expansion areas is expected to occur as a result of the proposed project.

The most substantial of these effects would be the loss of mixed-grass prairie habitat. However, because the overall long-term surface footprint of the project would be minimal, and much of the area proposed for disturbance during the construction phase would be promptly reclaimed to the pre-existing contour and cover type, long-term loss of mixed-grass prairie habitat would have a minor effect on regional ecological resources. Similarly, disturbance to wildlife from noise, construction, and operational activities would initially have a minor cumulative effect on the region's wildlife. This effect would diminish over time as human presence decreases after the construction phase is completed. Implementation of the proposed expansion projects would result in a small incremental effect on ecological resources when considered with all the other past, present, and RFFAs in the vicinity.

4.14.3.8 Air Quality

Agricultural activities and vehicles traveling on public roads would continue to generate dust and vehicle emissions. Implementation of the proposed project would result in fugitive dust and pollutant emissions from the combustion of fuel to power the engines of construction vehicles and equipment. Combustion of gasoline and diesel fuels by combustion engines (e.g., vehicles, generators, construction equipment) would generate local emissions of PM, NO_x, CO, VOCs, and SO_2 during the site preparation and construction period. While construction equipment specs, including size, number of vehicles, and the hours each piece of equipment would operate, are not quantified, the emissions for these operations would be small.

When all three expansion areas and the existing Crow Butte Operation are operational, the maximum combined dust emissions would be approximately 90 tons per year for uncontrolled emissions. A comparison of the fugitive emission dust estimates associated with unpaved and paved roads is as follows:

Site	Uncontrolled Emissions			Controlled Emissions	
	Onsite	Offsite		Onsite	Offsite
	Unpaved	Unpaved	Paved	Unpaved	Unpaved
NTEA	6.53	7.62	0.127	5.87	6.85
TCEA	12.5	18.98	0.126	11.25	17.08
MEA	14.5	28.93	0.58	13.05	26
Total	**33.53**	**55.53**	**0.833**	**30.17**	**49.93**

Mitigation measures, such as the application of water to unpaved roads would be implemented as necessary, along with speed limits on the mine property. In addition, gravel that exists on offsite public unpaved roads contributes to some control efficiency, due to reduction in silt content. The controlled emissions listed above are based on using a 10 percent control efficiency.

As far as cumulative impacts, the MEA is located to the south of the Pine Ridge Escarpment, whereas the NTEA, TCEA, and CPF sites are located to the north of the escarpment in the Crawford Basin (**Figure 1.1-3**). The escarpment rises roughly 300 to 900 feet above the basal plain and bounds three sides of the Crawford Basin. The distances of the nearest license boundaries of the CPF, TCEA and NTEA sites to the nearest MEA license boundary are 6, 9.1

and 12.4 miles, respectively. Therefore, fugitive dust emissions from the MEA site are not expected to contribute to cumulative impacts in the Crawford Basin area, nor or the NTEA, TCEA, and CPF emissions expected to impact the MEA area.

Along with other past, present, and RFFAs, the combined emissions of the proposed expansion areas and the existing operation are not anticipated to jeopardize NAAQS attainment status in the region or impair visibility within any federally mandated PSD Class I area. Consequently, implementation of the proposed expansion projects would result in small cumulative effects on air quality when considered with other past, present, and RFFAs in the vicinity.

4.14.3.9 Noise

Agricultural activities, vehicular traffic, and heavy train traffic in the vicinity of the expansion areas contribute to regional noise effects. Under implementation of the proposed expansion projects, the sources of noise would be widely dispersed and barely perceptible over the background noise. Implementation of the proposed expansion projects would result in small cumulative effects on noise when considered with other past, present, and RFFAs in the vicinity because of the rural nature of the area.

4.14.3.10 Historic and Cultural

The cumulative effects area for cultural resources is defined as each of the expansion areas (NTEA, TCEA, and MEA) and a 1-mile radius around each of these expansion areas. No traditional cultural areas or historic properties have been identified in the general area that would merit consideration of a larger area of potential effects. Records searches have been completed for each of these cumulative effects areas, and complete intensive cultural resource inventories have been completed for each of the expansion areas. A variety of potentially important prehistoric and historic resources are present in the general area, including Fort Robinson State Historic Park north of the TCEA. There are historic properties within the Fort Robinson State Historic Park near the TCEA. However, sites within the park are protected and would not be adversely affected. One previously reported historic structure in the MEA is recommended potentially eligible for the NRHP and is therefore a historic property. This historic property would be avoided. The project would have no effect to historic properties. Therefore, the project would not contribute to cumulative adverse effects to historic properties in combination with past, present, and RFFAs.

4.14.3.11 Visual/Scenic

Other than public roads and the existing Crow Butte Operation, there are no contributions to cumulative visual resource effects from past, present, and RFFAs. The structures within the proposed expansion areas would be visible from public roads and residences near the expansion areas; however, contrasts would be low to moderate. The TCEA is located in scenic landscape of the Pine Ridge area of northwestern Nebraska and is visible from sensitive viewing areas. Sensitive viewing areas in the TCEA include Four Mile Road, the primary transportation route through the TCEA, and rural residences. Fort Robinson State Park (Park), which is located to the north of the TCEA, is also a sensitive viewing area because of the potential visibility of proposed facilities to Park visitors. The lines and textural contrasts of the well houses, the satellite plant, and appurtenance facilities would be obvious to viewers at the sensitive viewing areas, but would be subordinate to the rural landscape.

The visual/scenic effects of the proposed expansion projects would be minimal because the expansion areas are dispersed, and the rolling terrain restricts or prevents simultaneous line of expansion area viewing of multiple facilities. Wellhead covers would be visually subordinate to the landscape in the foreground-middleground distance zone. The buildings at the satellite plants would be painted to harmonize with the surrounding soil and vegetation cover. With implementation of mitigation measures, such as aligning roads with existing topographic contours and avoiding straights lines, visual effects would be minimized.

Over the long term, the VRM Class III objectives would be met by the proposed project facilities within the expansion areas. Hence, implementation of the proposed expansion projects would result in a small incremental effect visual/scenic resources.

4.14.3.12 Socioeconomics

Total employment in Dawes County in 2010 was 5,691 (BEA 2011). CBR currently employs a workforce of approximately 68 employees and two contractors with 14 employees. CBR currently provides approximately 1.5 percent of all employment in Dawes County. CBR payroll represents about 4 percent of the total Dawes County wage and salary payments. The majority of CBR's employees have been hired from the surrounding communities.

When all three expansion areas and the Crow Butte Operation are operational, the combined total number of employees would increase by fewer than 30 workers compared to current staff. During construction, CBR expects to supplement the existing workforce for the proposed expansion project with an additional 10 to 12 full-time employees, four to seven full-time contractor employees, and 10 to 15 part-time employees and short-term contractors. The full- and part-time employees would be needed for operations at each of the expansion areas and to fill 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. Because skills and services required for the proposed expansion projects would be available in the existing local labor force, the proposed project is not anticipated to require migration of additional workers into the nearby City of Crawford and City of Chadron, or Dawes County. It is anticipated that the workforce and contractors required for the proposed project would result in nominal effects on local services because the total CBR employment would continue to represent approximately 4 percent of the employment in Dawes County.

Monetary benefits would continue to accrue to the community from the presence of the existing Crow Butte Operation. Continued operation of the project simultaneously with the expansion areas would provide significant tax revenues to Dawes County similar to current conditions. In addition, mineral royalty payments accrue to local landowners, most of whom are residents of Dawes County. Future tax revenues depend on uranium prices, which cannot be predicted with accuracy; however, these taxes also somewhat depend on the number of pounds of uranium produced by CBR.

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. Against these monetary benefits are the monetary costs to the communities near the project, such as those for county road maintenance. The current mine operation has not resulted in any significant effect 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.

No adverse environmental impacts would occur to the local population from proposed project activities. Hence, construction and implementation of the proposed expansion areas would have no disproportionate adverse impacts to minority populations or people living below the poverty level.

CBR currently provides a positive economic impact to the local Dawes County economy. Development of the proposed expansion projects would have a positive impact on the local economy. Transition from operations at the current permitted CBR facilities to the proposed expansion areas would allow the uninterrupted continuation of these contributions towards the funding of Dawes County government subdivisions. The proposed expansion projects would result in beneficial socioeconomic effects to county revenues and local businesses similar to current conditions. Implementation of the proposed expansion projects would result in a small incremental effect on socioeconomics when considered with all the other past, present, and RFFAs in the vicinity.

4.14.3.13 Nonradiological Health

Over the long term, regional population increases agricultural activities would continue to generate wastes with a proportional potential for releases of non-radiological waste materials. The proposed facilities would be designed and constructed to minimize the potential for release of non-radiological wastes. Because production rates would continue similar to current levels, the amounts of nonradiological waste materials generated would approximate current conditions, and the risk of health or environmental effects would be similar to existing conditions. With implementation of the SPCC Plans and other standard operational procedures, the proposed expansion projects would not affect non-radiological health; therefore, there would be no cumulative effects.

4.14.3.14 Radiological Health

For residents in the vicinity of the current Crow Butte Operation and the proposed expansion areas, the cumulative TEDE for all simultaneous operations was presented in **Table 4.12-1** of the TCEA application. **Table 4.12-1** demonstrates that the annual dose limit of 100 mRem/year found at 10 CFR §20.1301 would be attained. The MEA is sufficiently distant that it would contribute only 0.3 mRem/year under typical operating conditions in the vicinity of the City of Crawford. The highest dose rate at cities and towns within 50 miles of the MEA was 0.5 mRem/yr at the Town of Marsland, which is located approximately 4.6 miles (7.4 km) from the MEA satellite facility (centerpoint of Town of Marsland to centerpoint of MEA satellite building).

On October 17, 2006, CBR submitted a license amendment request to the NRC requesting an increase in the licensed flow at the CPF. License Condition 10.5 of SUA-1534 limited current operation to an annual facility throughput of 5,000 gpm exclusive of restoration flow. CBR requested an amendment to this license condition to increase production and assist restoration efforts. The production increase was to be accomplished by expanding the existing facility and mining existing wellfields to lower levels of soluble uranium. CBR requested approval to increase the annual facility throughput to 9,000 gpm exclusive of restoration flow. The amendment request did not change the annual licensed production rate of 2,000,000 pounds of U_3O_8 per year. NRC issued the license amendment on November 30, 2007.

The only environmental effect of the increased flowrate at the current operation is a corresponding increase in the emission of radon-222 from the current operation. The amendment estimated a 22 percent increase in the maximum public dose, and that the maximum public dose would remain well below the limit found in 10 CFR § 20.1301. Implementation of the proposed expansion projects would result in a small incremental effect on radiological health when considered with all the other past, present, and RFFAs in the vicinity. Implementation of the proposed expansion projects would result in a small incremental effect on radiological health when considered with other past, present, and RFFAs.

4.14.3.15 Waste Management

Over the long term, regional population increases would result in generation of additional waste loading on disposal facilities; however, the capacities of local and remote waste disposal facilities are anticipated to remain adequate for the life of the project. Under implementation of the proposed project, relatively small quantities of solid wastes and no significant health or environmental effects are anticipated. Because production rates would remain similar to current levels, the amount of wastes generated would approximate current conditions. When considered with other past, present, and RFFAs, implementation of the proposed expansion projects would result in small incremental effects associated with non-radiological health.

4.14.3.16 Mineral Resource Recovery

The only mineral known to be present in recoverable amounts that is economical for the proposed expansion areas and the CPF is uranium.

Local or regional gas and oil exploration and production operations are not expected to generate cumulative impacts in associated with the development of the proposed expansion areas. Historically, there have been approximately 137 oil and gas exploration wells, with more than 100 drilled in the 1950s through the 1970s, completed in Dawes County (NOGCC 2013a). All of these wells were abandoned, most recorded as dry holes. A total of 15 plugged and abandoned oil and gas exploration wells are located within the AORs of the MEA, NTEA, and TCEA. These wells were drilled between 1952 and 1981.

According to the NOGCC, there has never been any oil and gas production in Dawes County (NOGCC 2013b). There are no current applications for permits to drill in Dawes County (NOGCC 2013c). Two wells are currently producing in Sioux County, but are located at a significant distance southwest of MEA in Section 8 Township 25 North, Range 55 West and Section 11 Township 25 North, Range 56 West (NOGCC 2013a). For the months January through October 2012 and November through December 2011, there were no drilling permits issued for Dawes, Sheridan, or Box Butte Counties (NOGCC 2013d). There were four drilling permits issued for Sioux County, primarily in the southern part of the county. NOGCC annual production records for 2005 through 2012 indicated production for Sioux County, but no oil and gas production for Dawes, Box Butte, and Sheridan Counties (NOGCC 2013c).

The only non-fuel mineral produced in Dawes County is sand and gravel. The state's coal resources are insignificant and not economical to mine (NEO 2013); therefore, coal is not produced anywhere in Nebraska. Consequently, economical viable coal beds are not expected to be encountered during drilling within the MEA. Based on the above findings, it is concluded that there will be no cumulative impacts on other mineral resources underlying the proposed expansion areas.

CBR obtained surface and mineral leases from the appropriate landowners necessary to construct and operate the proposed ISR facilities. Uranium mineralization is limited to the basal sandstone of the Chadron Formation. There are no other uranium recovery facilities in Nebraska. Mineral resource recovery would remain similar to current conditions; therefore, implementation of the proposed expansion projects would result in no cumulative effects on mineral resource recovery.

Table 4.1-1 Acres Disturbed by MEA Satellite Facility, Mine Units, and Access Routes

Table 4.1-1 Estimated Acres Disturbed by Marsland Expansion Area Project Development

Disturbed Area	Type of Habitat Cover								Total
	Cultivated	Mixed Grass Prairie	Range Rehabilitation	Structure Biotype	Degraded Rangeland	Drainage	Deciduous Streambank Forest	Mixed Conifer	
	Acres								
Initial Acres Disturbed by MEA Satellite Facility, 11 Mine Units, Deep Disposal Well and Access Routes									
Mine Units (11)	71.7	343.7	6.9	8.9	143.6	7.2	0	5.6	587.6
SAT		1.8							1.8
Access Route to SAT		1.6				0.1			1.7
DDWs (6)[b]	0.20	~~0.5~~0.52				0.07			0.79~~0.5~~
INITIAL DISTURBED ACRES	**71.~~7~~9**	**~~347.6~~347.6**	**6.9**	**8.9**	**143.6**	**~~7.3~~7.4**	**0**	**5.6**	**~~591.6~~591.9**
Long-Term Acres Disturbed by Additional Site Operations									
All Additional Long-Term Activities [a]	**56.7**	**795.1**	**0.2**	**8.0**	**84.4**	**23.9**	**4.7**	**189.0**	**1,162.0**
TOTAL DISTURBED ACRES	**128.46**	**~~1142.7~~1,142.7**	**7.1**	**16.9**	**228.0**	**31.3~~2~~**	**4.7**	**194.6**	**~~1,753.6~~1,753.9**

SAT = Satellite Facility

[a] Multiple new activities such as roadways, exploration/delineation drilling, new and expanded MUs, wellhouses, and underground piping.

[b] The estimated disturbance area for each of six DDWs (~0.5 acre for a total of 3 acres) overlaps areas to be disturbed by MU development; this overlapped acreage of the DDWs within the MUs is not included in the estimated DDW disturbance acres since the disturbed acreage has already been addressed.

Table 4.4-1 Crow Butte Resources Excursion Summary

Table 4.4-1 Crow Butte Resources Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
SM4-5	January 25, 1995	March 9, 1995	Poor well development
SM4-2	April 2, 1995	March 13, 1996	Poor well development
SM4-7	December 27, 1995	March 13, 1996	Poor well development
I-196	March 29, 1996	August 19, 1999	Casing leak
I-752	November 8, 1996	May 7, 1997	Casing leak
SM6-26	March 19, 1998	No record available	High water table
CM6-6	July 1, 1999	September 23, 1999	Excursion of mining solutions
I-567	September 20, 1999	October 12, 1999	Casing leak
PR-15	January 13, 2000	March 23, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM6-18	March 6, 2000	April 11, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
IJ-13	April 20, 2000	July 20, 2000	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
SM7-23	April 27, 2000	January 13, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	May 25, 2000	June 22, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-13	May 25, 2000	July 20, 2000	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-12	September 8, 2000	November 2, 2000	Surface leak
SM6-13	March 1, 2001	April 12, 2001	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM7-23	December 4, 2001	January 9, 2004	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM5-11	September 10, 2002	June 3, 2003	Excursion of mining solutions
CM6-7	April 4, 2002	April 25, 2002	Excursion of mining solutions
PR-8	December 23, 2003	July 27, 2010	Mine Unit 1 interior monitor well affected by adjacent groundwater restoration (unrelated to mining activities)
CM5-19	May 2, 2005	July 26, 2005	Excursion of mining solutions
SM6-28	June 16, 2005	July 5, 2005	High water table due to heavy spring rains (unrelated to mining activities)
SM6-12	June 27, 2005	July 26, 2005	High water table due to heavy spring rains (unrelated to mining activities)
CM9-16	August 4, 2005	November 8, 2005	Excursion of mining solutions
CM8-21	January 18, 2006	April 4, 2006	Excursion of mining solutions
PR-15	September 26, 2006	February 4, 2011	See IJ-13 and PR-8
CM9-5	May 15, 2008	June 24, 2008	Excursion of mining solutions

Table 4.4-1 Crow Butte Resources Excursion Summary

Monitor Well ID	Date On Excursion	Date Off Excursion	Causal Factor(s)
CM9-3	May 30, 2008	July 15, 2008	Excursion of mining solutions
SM6-20	April 27, 2009	August 25, 2009	Excursion of mining solutions
CM9-4	June 11, 2009	July 21, 2009	Excursion of mining solutions
SM6-20	March 16, 2010	July 26, 2011	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-6	April 12, 2010	August 31, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-23	June 16, 2010	July 29, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-28	June 16, 2010	July 29, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-28	June 16, 2010	July 29, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM6-21	June 22, 2010	August 10, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-5	June 22, 2010	August 3, 2010	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
CM8-12	July 8, 2010	August 19, 2010	Excursion of mining solutions
CM-8	March 15, 2011	June 28, 2011	Excursion of mining solutions
SM6-20	May 23, 2011	July 26, 2011	Excursion of mining solutions
SM8-6	May 24, 2011	August 23, 2011	Excursion of mining solutions
SM6-28	May 26, 2011	July 20, 2011	Natural fluctuation of shallow groundwater quality (unrelated to mining activities)
SM8-28	May 26, 2011	July 20, 2011	Excursion of mining solutions
IJ13P	October 4, 2011	February 24, 2012	Excursion of mining solutions

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

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

Type of Taxes	2010	2009	2008	2007	2006	2005
Property Taxes	997,000	914,000	1,120,000	1,102,000	627,000	351,000
Sales and Use Taxes	83,000	136,000	140,000	90,000	238,000	185,000
Severance Taxes	292,000	403,000	512,000	1,066,000	545,000	338,000
Total	**1,372,000**	**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 MEA

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

Activity	Current Crow Butte Operation	Estimated Economic Impact due to Marsland Expansion Area
Employment		
Full Time Employees	68	+ 10 to 12
Full Time Contractor employees	14	+ 4 to 7
Part Time Employees and Short Term Contractors	3	+ 4 to 7**
CBR Payroll, 2010	$4,200,000	+ $400,000 to $480,000
Taxes		
Property Taxes	$997,000	-
Sales and Use Taxes	$83,000	-
Severance Taxes	$292,000	-
Total Taxes	$1,372,000	+ $0.95 million
Production Royalties		
Royalty Payments, 2010	$532,000	+ 325,000
Local Purchases		
Local Purchases, 2010	$4,332,000	+ $3,650,000 to $4,350,000
Total Direct Economic Impacts	**$10,435,000**	**+ $5,325,000 to $6,105,000**

**All construction workers

Table 4.12-1 Radiation Dose Rates to Receptors From MEA only and Cumulative Dose Rates

Table 4.12-1 Radiation Dose Rates to Receptors From MEA Only and Cumulative Dose Rates

Receptor No.	Description	Distance from MEA Satellite Facility (km)	Radiation Dose Rates (mrem/yr)[a]		
			MEA Only	Nearby Existing and Proposed ISR Operations	MEA plus Nearby Existing and Proposed ISR operations
1	Alliance	54.4	0.3	0.7	1.0
2	Berea	39.1	0.5	0.9	1.4
3	Chadron	42.2	0.3	0.9	1.2
4	Clinton	79.9	0.1	0.3	0.4
5	Crawford	24.1	0.5	5.5	6.0
6	Harrison	55.4	0.2	0.7	0.9
7	Hay Springs	50.7	0..2	0.5	0.7
8	Hemingford	24.9	1.0	1.4	2.4
9	Marsland	7.2	1.0	2.2	3.2
10	Mitchell	77.2	0.1	0.3	0.4
11	Oelrichs	75.5	0.2	0.6	0.8
12	Rushville	69.6	0.2	0.4	0.6
13	Scottsbluff	77.9	0.1	0.5	0.6
14	Van Tassell	70.7	0.2	0.5	0.7
15	Whitney	31.4	0.4	1.8	2.2
16	Residence 1	1.0	17.3	3.4	20.7
17	Residence 2	1.0	22.3	3.1	25.4
18	Residence 3	2.2	5.1	3.0	8.1
19	Residence 4	3.5	3.6	2.6	6.2
20	Residence 5	4.8	4.1	2.3	6.4
21	Residence 6	5.0	3.6	4.2	7.8
22	Residence 7	4.2	5.5	3.1	8.6
23	Residence 8	6.5	1.9	1.9	3.8
24	Unoccupied 1	2.1	29.0	3.8	32.8
25	Unoccupied 2	3.3	7.5	3.2	10.7
26	East Boundary	1.4	13.5	3.1	16.6

Table 4.12-1 Radiation Dose Rates to Receptors From MEA Only and Cumulative Dose Rates

Receptor No.	Description	Distance from MEA Satellite Facility (km)	Radiation Dose Rates (mrem/yr)[a]		
			MEA Only	Nearby Existing and Proposed ISR Operations	MEA plus Nearby Existing and Proposed ISR operations
27	South Boundary	0.5	61.4	3.3	64.7
28	West Boundary	0.7	44.6	3.6	48.2
29	Miniature	79.1	0.1	0.5	0.6
30	North Boundary #1	5.2	5.0	4.5	9.5
31	North Boundary #2	3.4	11.4	3.9	15.3

[a] Wastewater flow rate of 315 gallons per minute
mrem/yr = millirems per year
MU = Mine Unit
km = kilometer

Table 4.12-2 Public and Occupational Doses for Marsland Expansion Area

Table 4.12-2 Public and Occupational Doses for Marsland Expansion Area

Radon Sources Distribution	Public Dose/Deliveries	Occupational
Location of Dose	**mRem/yr from 10 hrs/month Onsite**	**mRem/yr from 2,000 hrs/yr Onsite**
North Boundary #1	0.03	2.2
North Boundary #2	0.05	3.5
East Boundary	0.05	3.8
South Boundary	0.21	14.8
West Boundary	0.15	11.0
MU-1	--	25.9
MU-2	--	42.6
MU-3	--	32.3
MU-4	--	36.8
MU-5	--	25.8
Satellite	0.43	31.3
Average		**20.9**

Notes:
mRem/yr = millirems per year

Table 4.14-1 Combined Effects of North Trend, Three Crow and Marsland Expansion Areas

Table 4.14-1 Combined Effects of North Trend, Three Crow and Marsland Expansion Areas

Effect of Operations	Individual Effects	Combined Effects
Land Surface	Minimal temporary effects in wellfield areas, significant surface and subsurface disturbance confined to the 12- to 30-acre footprints of the satellite plants and appurtenance facilities.	Late in the project life, approximately 58 acres of long-term disturbance would result for the footprint of the satellite buildings and associated facilities.
Land Use	Loss of crop and cattle production on 1,310 acres of the NTEA, on 671 acres of the TCEA, and on 562 acres of the MEA.	Late in the project life, when all three expansion areas and the existing operation are operated simultaneously, crop production and cattle production would be reduced by a total of approximately 2,553 acres (for 11 MUs). This represents approximately 0.003 percent of the total agricultural land in Dawes County.
Transportation	For each expansion area minimal effect on current traffic levels. Estimated additional heavy truck traffic of 2,600 trips per year; addition resin truck traffic of 730 trips per year; and an 10 to 20 additional vehicle trips per day.	Late in the project life, when all three expansion areas and the existing operation are operated simultaneously, the peak heavy truck would increase for the proposed satellite facilities to approximately 7,800 delivery heavy trucks per year and 2,190 resin trucks two week.
Geology and Soil	No geologic effects. Soil effects will be minimal because BMPs will be implemented.	No geologic effects. Soil effects will be minimal because BMPs will be implemented.
Surface Water	Surface water effects will be minimal because BMPs will be implemented to prevent erosion and control sedimentation.	Surface water effects will be minimal because BMPs will be implemented to prevent erosion and control sedimentation.
Groundwater	Consumption of Chadron groundwater for control of mining solutions and restoration (estimated at 315 gpm for MEA, __ gpm for TCEA, and __gpm for NTEA.	Late in the project life, when all three expansion areas and the existing operation are operated simultaneously,, additional widely separated consumption of Chadron groundwater would occur (800 to 1,000 gpm).
Ecological	No substantive impairment of ecological stability or diminishing of biological diversity.	The NTEA and TCEA are predominantly used as cropland. The MEA is primarily open rangeland and is some distance away. As such no increased impairment of ecological stability or biological diversity is anticipated on a cumulative basis.
Air Quality	Additional uncontrolled/controlled dust emissions of 14.3/12.9 tons per year total for the NTEA, 31.5/28.3 tons per year total for the TCEA and 44/40 tons per year total for the MEA due to vehicle traffic on unpaved and paved roads. Control values based on 10 percent control efficiency.	Late in the project life, when all three expansion areas and the existing operation are operated simultaneously, the maximum cumulative dust emissions would be dispersed and less than 90 tons per year uncontrolled (80 tons per year controlled [10 percent]). The cumulative dust emissions would not jeopardize NAAQS attainment status in the region.
Noise	Barely perceptible increase over background noise levels in the area.	On a cumulative basis, the sources of noise would be widely dispersed and barely perceptible over the background noise, especially the heavy train traffic in the vicinity of the expansion areas.

Table 4.14-1 Combined Effects of North Trend, Three Crow and Marsland Expansion Areas

Effect of Operations	Individual Effects	Combined Effects
Historic and Cultural	None because the proposed projects would avoid known sites.	None because the proposed projects would avoid known sites.
Visual /Scenic	Moderate effect; noticeable minor industrial component in sensitive viewing areas.	On a cumulative basis the visual/scenic effects would not increase as the expansion areas are dispersed and the rolling terrain restricts or prevents simultaneous line of expansion area viewing of multiple facilities.
Socioeconomic	Extension of the current annual direct economic effect of $10.4M plus the addition of $5.3M to $6.1M annual direct economic effect to the local area.	Late in the project life, when all three expansion areas and the existing operation are operated simultaneously, peak employment would increase slightly above the estimates provided for each individual expansion facility. The cumulative level of employment would be satisfied locally with only nominal effect on local services.
Non-radiological Health	None because non-radiological health effects will continue to be minimize similar to current conditions.	None because non-radiological health effects will continue to be minimize similar to current conditions.
Radiological Health	The Total Effective Dose Equivalent (TEDE) for the highest exposure near the NTEA is 31.7 mrem per year. The TEDE for the highest exposure near the TCEA is 32.3. The TEDE for the highest exposure near MEA is 79.5. All of these exposures are less than the annual dose limit of 100mrem/year found at 10 CFR §20.1301.	For residents in the vicinity of the current Crow Butte Operation, the NTEA and the TCEA, the cumulative TEDE for all simultaneous operations was presented in **Table 4.12-1** of the TCEA application**. Table 4.12-1** demonstrates that the annual dose limit of 100mrem/year found at 10 CFR §20.1301 would be attained. Marsland is sufficiently distant that it would contribute only 0.5mrem/year in the vicinity of Crawford.
Waste Management	Generation of additional liquid and solid waste for proper disposal	On a cumulative basis, the local and remote waste disposal capacity would remain adequate.
Mineral Resource Recovery	None because mineral recover recovery will continue similar to current conditions.	None because mineral recover recovery will continue similar to current conditions.

Table 4.14-2 Unavoidable Combined Environmental Effects of North Trend, Three Crow and Marsland Expansion Areas

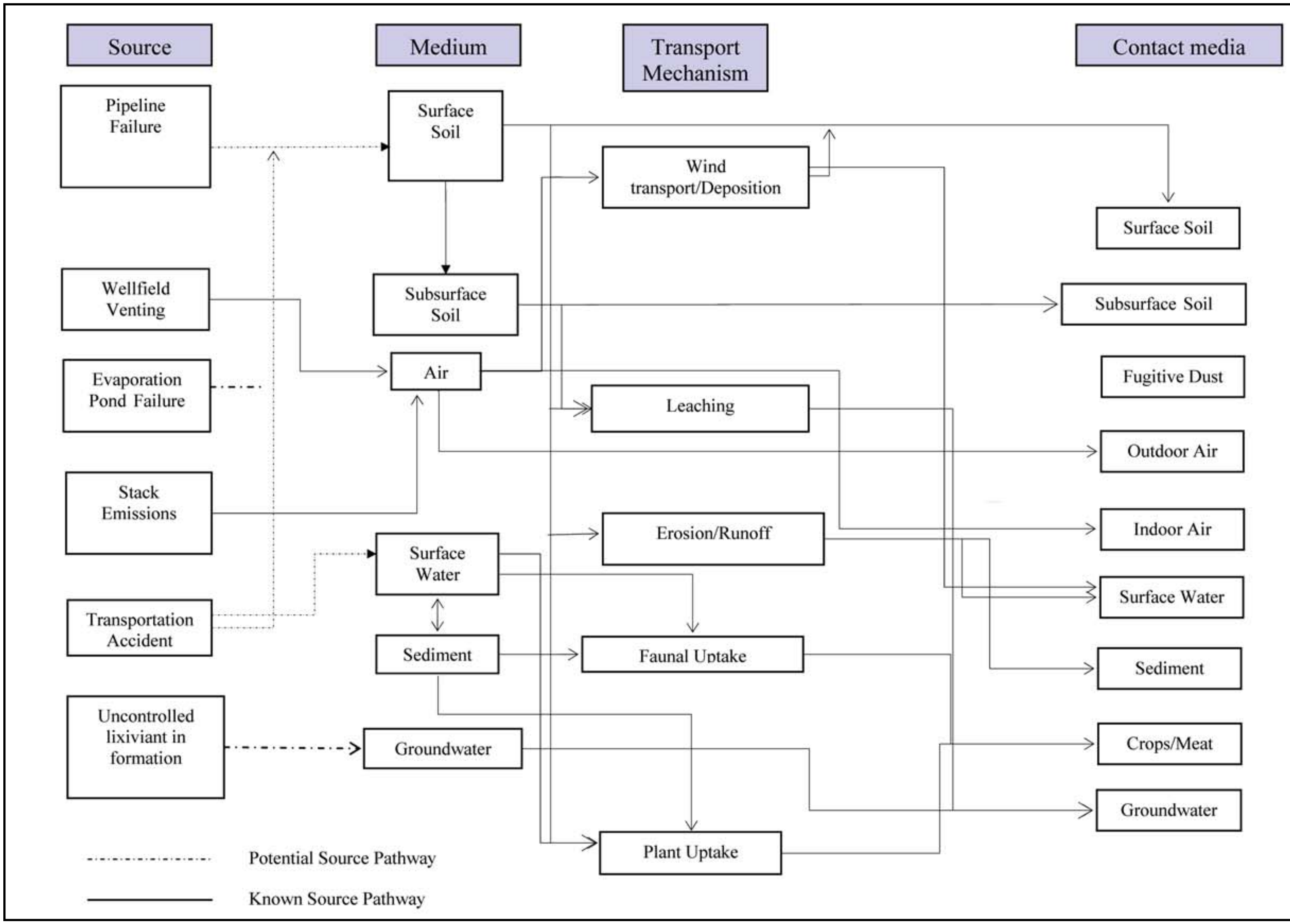
Table 4.14-2 Unavoidable Combined Environmental Effects of North Trend, Three Crow and Marsland Expansion Areas

Effect	Estimated Combined Effects	Mitigation Measures
Use of Natural Resources		
Temporary Land Surface (acres)	Significant land surface effects to approximately 58 acres for the satellite plants; minimal disturbance to remaining wellfield acreage affected 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	Restriction of agricultural use of proposed expansion areas; restricted access for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Lost cattle production ($/yr.)	Up to $42,222	Compensation to landowners through surface leases and/or mineral royalties.
Lost crop production ($/yr)	Up to $51,200	Compensation to landowners through surface leases and/or mineral royalties.
Groundwater consumption in basal sandstone of the Chadron Formation (net gpm)	800 to 1,000	None
Groundwater quality effects	Temporary effects to groundwater quality in the basal sandstone of the Chadron Formation mining zone.	Proven groundwater restoration following mining to return Chadron groundwater quality to baseline or pre-operational water uses.
Visual and scenic effects	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 of expansion area roads to follow topography; removal of construction debris.
Emissions		
Dust emissions (tons/yr.)	90 TPY Uncontrolled 80 TPY Controlled (10 percent) For Unpaved Roads: Offsite: 55.5 TPY Uncontrolled 49.9 TPY Controlled Onsite: 33.5 Uncontrolled 30.2 Controlled	Dust control measures implemented where appropriate.
Radiological		
Additional maximum predicted dose (mrem/yr.)	32.3 (TCEA nearby resident) 20.9 (MEA nearby resident)	None
Highest dose rate at cities and towns within an 80 km radius of the combined Crow Butte, NTEA and TCEA at Crawford, NE (m/rem/yr)	2.6	None
Highest dose rate at cities and towns within an 80 km radius of the MEA at Marsland and Hemmingford, NE (m/rem/yr)	0.9	None

Table 4.14-2 Unavoidable Combined Environmental Effects of North Trend, Three Crow and Marsland Expansion Areas

Effect	Estimated Combined Effects	Mitigation Measures
Socioeconomic		
Employment		
Maximum additional full time employment	15 to 18	None
Additional contractor employment	6 to 10	None
Part time and contractor employment (during expansion area construction)	15 to 22	None
Additional CBR payroll ($/yr.)	$600,000 to $720,000	None
Taxes Paid ($/yr.)	$1,000,000 to $1,200,000	None
Local purchases	$3,650,000 to $4,350,000	None
Waste Management		
Wastewater (gpm)	150	None
Solid waste produced (yd^3/yr.)	2100	None
11(e)2 byproduct waste produced (yd^3/yr.)	180	None

Figure 4.12-1 Marsland Human Exposure Pathways for Known and Potential Sources of Radiological Emissions



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
MARSLAND
HUMAN EXPOSURE PATHWAYS FOR KNOWN AND POTENTIAL SOURCES OF RADIOLOGICAL EMISSIONS

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

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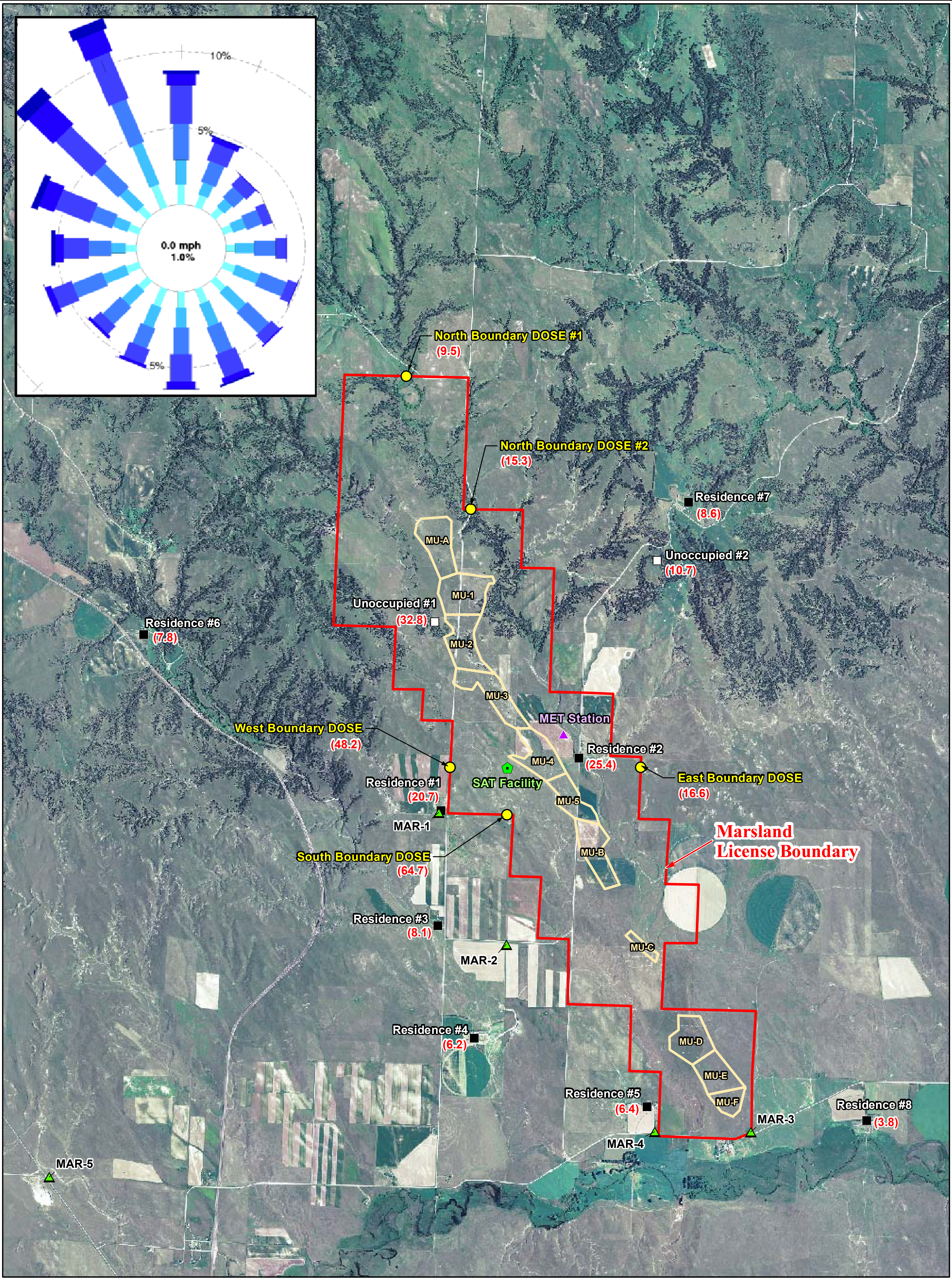
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Fig_7_3-1 Human Exposure Pathways.ai @ 01/08/2010

Figure 4.12-2 MILDOS Receptors Residences and Designated MEA License Boundary Locations

Path: K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 4_12-2_MILDOS Receptors - Residences and Designated MEA License Boundary Locations_11x17.mxd | Date: 10/7/2013 | User: jchen Formatted in ER 4.12-2.ai



LEGEND

- Air Sample Station
- Boundary Dose Point
- Residence (Occupiable)
- Unoccupied Structure (Unoccupiable)
- Proposed Satellite Plant Location
- MEA Met Station
- Project Boundary
- Mine Unit
- (3.8) MEA Mildos Estimated Radiation Dose Rate (in mrem/yr)

MEA = Marsland Expansion Area
mrem = millirems per year

N

0 2,000 4,000
Feet

PROJECTION: NAD1927,
STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

CROW BUTTE RESOURCES, INC.

FIGURE 4.12-2
MILDOS RECEPTORS
RESIDENCES AND DESIGNATED MEA
LICENSE BOUNDARY LOCATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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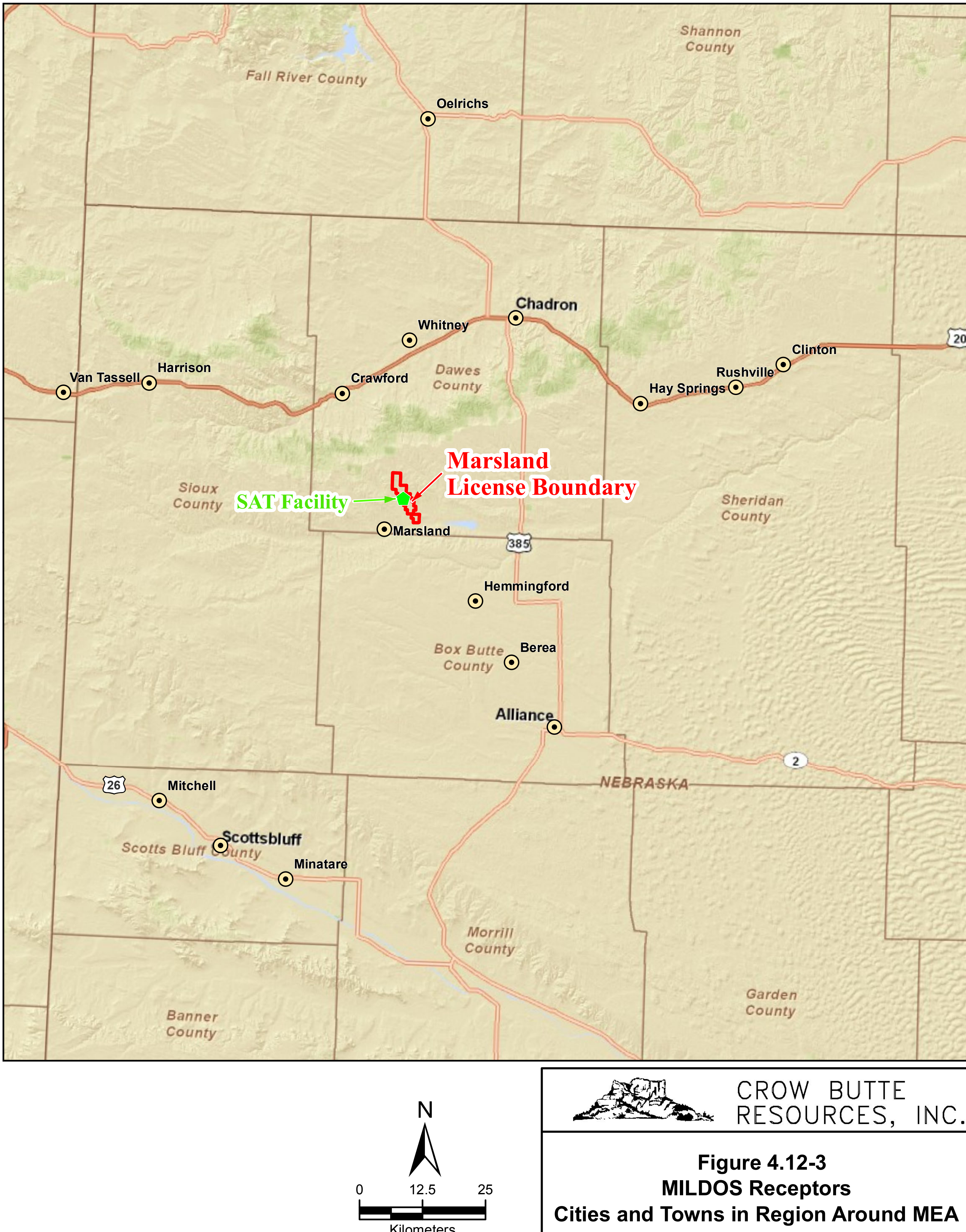
Figure 4.12-3 MILDOS Receptors Cities and Towns in Region around MEA



PROJECTION: NAD 1927,
STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED
BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

Figure 4.12-3
MILDOS Receptors
Cities and Towns in Region Around MEA

PROJECT: CO001636 MAPPED BY: BB CHECKED BY: J. CEARLEY

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5 MITIGATION MEASURES

5.1 Land Use Impact Mitigation Measures

The following section addresses the methods for final decommissioning of disturbed lands including wellfields, satellite facility areas, and diversion ditches that will be used on the Crow Butte project sites, including the MEA. 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 the wellfield and process facilities will be scheduled after agency approval of groundwater restoration. 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 5.1.3.1.
- Determine appropriate cleanup criteria for structures (Section 5.1.4) and soils (Section 5.1.5).
- Conduct radiological surveys and sampling of all facilities, process-related equipment, and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.
- Remove from the site all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocate to an operational portion of the mining operation as discussed in Section 5.1.4.
- Decontaminate 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 generally describe the planned decommissioning activities and procedures for the CBR facilities. These activities and procedures will apply to the MEA 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 final decommissioning. As required by 10 CFR 40.36 (f), records important to MEA decommissioning will be maintained in the office of the on-site RSO. 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 MEA will be the satellite facilities (uranium recovery building, fuel and chemical storage, shop, office, rest rooms, and wellfield production areas, and DDWs). Surface disturbances also occur during well drilling, 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 pre-mining 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 to re-establish original slope and topography and present a natural appearance. Surface reclamation efforts will strive to limit soil erosion by wind, water, and sedimentation and to re-establish natural trough drainage patterns.

The following sections provide reclamation procedures for the facility sites, wellfield production units, and access and haul roads. Reclamation timelines 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 7.2.9 and include all activities 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 following 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 building[s]), DDWs, and any other areas where topsoil is removed for purpose of site development. 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 wellfield, which are determined during final wellfield construction.

As described in Section 3.3.1.6, topsoil thickness varies within the MEA. Topsoil is usually thickest in and along drainages where material has been deposited and deep soils have developed. Therefore, topsoil stripping depths may vary depending on location and the type of structure being constructed. In cases where it is necessary to strip topsoil in relatively large areas, such as a major road or building site, field mapping and Soil Conservation Service Soil Surveys will be employed 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 perimeters 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 the mud pit is no longer needed, all subsoil is replaced and topsoil is applied. Mud pits generally remain open for a short time. The success of revegetation efforts at the current site show that these procedures adequately protect topsoil and result in vigorous vegetation growth.

5.1.1.2 Contouring of Affected Areas

Due to the relatively minor nature of disturbances created by ISR mining, there are only a few areas where subsoil and geologic materials are removed, causing significant topographic changes that need backfilling and recontouring. Generally, solar evaporation pond construction results in redistribution of sufficient amounts of subsurface materials, which requires replacement and contour blending during reclamation. This is usually one of the major surface disturbances at a uranium in-situ facility. However, no evaporation ponds will be constructed for use at the MEA project site. Therefore, the existing contours at Marsland 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 be 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 re-establishment of drainage patterns, will be accomplished by returning the earthen materials moved during construction to their approximate original locations.

Drainage channels that have been modified by the mine plan for operational purposes such as road crossings will be re-established by removing fill materials and culverts and reshaping to as close to pre-operational conditions as practical. Surface drainage of disturbed areas located on terrain with varying degrees of slope will be accomplished by final grading and contouring appropriate to each location to allow for controlled surface runoff 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 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 5.1.4, 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 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 to establish adequate drainage, and the final prepared surface will be left in a roughened condition.

5.1.3 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. Surfaces will be prepared as needed 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.
- Buried well field piping will be removed.
- 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 contaminated materials will be acid washed or decontaminated with other methods until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at an NRC-licensed disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence at the CPF and at the MEA. 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.

5.1.3.1 Well Plugging and Abandonment

Cased Mining and Restoration Wells

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 to protect the groundwater supply 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. That formation can be used to adjust the amount of bentonite chips needed to plug the well screens and to calculate the minimum weight (lbs/gallon) of abandonment mud used to fill the hole to the surface and keep formation and mining pressures from allowing water to rise in the borehole. A pre-packaged bentonite-filled tube is currently used for plugging 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 descend into the screens. The drill rig then trips the 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 an appropriate abandonment mud is mixed. If the weight of the abandonment mud needs to be increased, barite may be added to increase the weight. Likewise, an appropriate drilling additive may be added to improve the ability of the abandonment mud to carry the barite. In situations where it appears that the operating pressure and formation pressure are great enough to impede mixing of 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, abandonment fluids will be added.

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

- A mechanical plug may be placed above the screened interval.
- Thirty to 50 feet of coarse bentonite chips will be added to provide a grout seal.
- 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 NDNR also requires filing a well abandonment notice for all registered wells.

Exploratory Holes

Exploratory holes (including core holes) are plugged and abandoned in compliance with the State of Nebraska Title 135 Mineral Exploration Permit that requires NDEQ approval. Abandonment procedures described above apply to cased wells but not to uncased exploratory holes.

The Mineral Exploration Permit allows for exploratory holes within the boundaries of the permit, and includes a surety bond to cover abandonment and reclamation costs in the event that the permit holder does not complete the abandonment and reclamation.

In summary the permit requires:

- At final drill depth, the TD viscosity is measured and recorded using a Marsh Funnel.
- Circulation of the drill fluid continues while abandonment mud is mixed through the jet mixer.
- Mixing continues until a measured Marsh Funnel viscosity greater than 60 seconds or 20 seconds over the TD viscosity, whichever is greater, is achieved and circulation continues for 15 to 30 minutes.
- The hole is then filled with abandonment mud from the surface to replace the volume displaced by the drill pipe.
- A cement plug of approximately 5 feet in length is placed near the ground surface.
- The drill pits are filled with the soil excavated during construction, taking care to replace the topsoil.
- Settling of the soil in the drill pit is allowed prior to final reclamation smoothing and reseeding of the drill site.

5.1.3.2 Buried Trunklines, Pipes, and Equipment

Buried process-related piping, such as injection and production lines, will be removed from the MU 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.

5.1.4 Removal and Disposal of Structures, Waste Materials, and Equipment

5.1.4.1 Preliminary Radiological Surveys and Contamination Control

Prior to decommissioning the satellite building, 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 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 water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

5.1.4.2 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, and other components, 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
- 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.

Building Materials, Equipment, and Piping to be Released for Unrestricted Use

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/100 cm^2
- Average total of 5,000 dpm/100 cm^2 over an area no greater than 1 m^2
- 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 collected 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 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, and other components with water or acid to reduce interior contamination as necessary for safe handling.

- Survey the exterior surfaces of process equipment for contamination. If the surfaces are found to be contaminated, the equipment will be washed down and decontaminated to permit safe handling.
- Disassemble the equipment only to the degree necessary for transportation. All openings, pipe fittings, vents, and other components 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 measuring 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, the equipment will be resurveyed, and documentation of the final survey will be 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 confirm 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 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.

These areas will be decontaminated as necessary to meet the standards for unrestricted use.

5.1.4.3 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 has a contractual agreement with DUSA for the disposal of 11e.(2) byproduct materials at DUSA's White Mesa Mill site located near Blanding, Utah (CBR and DUSA 2010). The White Mesa Mill is licensed by the NRC to allow the disposal of byproduct material generated as a result of operations at a licensed uranium ISR facility by placement of the byproduct material in the White Mesa Mill's tailings impoundment. For this agreement, the maximum annual volume for disposal is 3,823 m^3 (5,000 yds) of byproduct, which is a common maximum volume for many other agreements with the White Mesa Mill. Unless terminated by either party, the contract shall be automatically renewed each year for a maximum of four additional periods (i.e., up to June 30, 2015 at the latest). At the end of this period, Cameco can seek renewal for a designated period of time. Should Cameco contract with a new disposal facility, Cameco will notify the NRC in accordance with License Condition 9 of 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 DOT Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

5.1.5 Methodologies for Conducting Post-Reclamation and Decommissioning Radiological Surveys

As discussed in introductory paragraphs of Section 5.1 and Sections 5.1.1 through 5.1.3, survey areas will include areas expected to exhibit higher levels of contamination than surrounding areas, including diversion ditches, any surface impoundments, wellfield surfaces (particularly those areas where spills or leaks may have occurred), and structures in process and storage areas, areas around the deep disposal wells, and on-site transportation routes for contaminated material and equipment.

5.1.5.1 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 ALARA 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 more than 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 a maximum of 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 because 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 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.

5.1.5.2 Excavation Control Monitoring

CBR will use 17,900 counts per minute (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 global positioning system (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 until 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 radium-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 because the contaminated areas were small in size. The measured gamma emission rate per unit radium-226 concentration from small areas is normally lower than that which would be measured using large areas, such as a 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 CPM action level. It does, however, allow for a revision of the number should it later be determined not appropriate.

5.1.5.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to 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 will be analyzed at an off-site analytical 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 next 10 percent of grid blocks 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 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 NRC-approved statistical test will be conducted to demonstrate that the survey method provides for a 95-percent confidence level that cleanup guidelines have been met, as per acceptance criteria 6.4.3 of NUREG-1569 (NRC 2003). An appropriate statistical test for analysis of the survey data as described in NUREG-1575 (Multi Agency Radiation Survey and Site Investigation Manual) will be employed (NRC 2000). If the mean of the sample concentrations is lower than the criterion but the data fail the statistical test, CBR will follow procedures similar to those recommended in NUREG-1575.

5.1.5.4 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 analysis of radium-226 and natural uranium over surveying to verify cleanup of subsurface excavations. The protocols are summarized in site procedures.

5.1.5.5 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 analysis of radium-226 and uranium over surveying to verify cleanup of ditches and impoundments. Surveying is applicable in larger impoundments; however, the effects of geometry are not as pronounced, particularly in areas not influenced by adjacent walls.

5.1.5.6 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, SOPs, sample receipt, handling, 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 defined by 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 MEA may result in the degradation of public road surfaces, particularly local gravel roads maintained by Dawes County. These impacts are expected to be minimal because 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 by providing 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, including the MEA operations.

5.3 Soils Impact Mitigation Measures

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 reduce the effects to soil resources at the MEA 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.
- Do not direct surface drainage over the unprotected face of the fill.
- Employ appropriately designed and implemented special sediment controls for operations and disturbance on slopes greater than 40 percent.
- Avoid continuous disturbance that provides continuous conduit for routing sediment to streams.
- Inspect and maintain all erosion control structures.
- Repair significant erosion features, clogged culverts, and other hydrological controls in a timely manner.
- If BMPs do not result in compliance with applicable standards, modify or improve such BMPs to meet the controlling standard of surface water quality.

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 the site of salvage to concurrent reclamation sites.
- Avoid excessive compaction of topsoil and overburden used as plant growth medium by limiting the number of vehicle passes and handling soil while saturated and scarifying compacted soils.
- Time topsoil redistribution so seeding or other protective measures can be immediately 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 stable cut and fill slopes.
- 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.

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, and other techniques.
- 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.
- Concurrently reclaim regraded material to minimize surface runoff.

Implementation of the above BMPs, SPCCs, and 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 groundwater in the mining zone to suitability for pre-mining uses. 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

Based on regional deposition, the MEA ore body is expected to be similar mineralogically and geochemically to that of the ore body at the CPF. The ore bodies in the two areas are within the same geologic unit (the basal sandstone of the Chadron Formation) and have the same mineralization source. The sites are separated by only a few miles, and the cause of mineral deposition in the two areas appears to be similar. Neither site is anticipated to be significantly affected by recharge or other processes.

The uranium deposit in the MEA is similar to that found in the CPF license area. It is a roll front deposit in fluvial sandstone similar to those in 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 from either the feldspar or volcanic ash content of the basal sandstone of the Chadron Formation. The source of the uranium could also be volcanic ash of the Chadron Formation which overlays the basal sandstone of the Chadron Formation. 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 basal sandstone of the Chadron Formation. The basal sandstone of the Chadron Formation 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. More detailed discussions of the geochemical description of the mineralized zone are presented in Section 3.3.1.2.

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 basal sandstone of the Chadron Formation 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.

Because the deposition of the uranium was controlled between clay beds within the basal sandstone of the Chadron Formation, the mining solutions will be 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 (g/L) 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 MEA 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 basal sandstone of the Chadron Formation and the ore, magnesium and potassium in solution have no impact. The limited solubility of $CaCO_3$, and to a lesser degree, calcium sulfate, may increase 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 (meq) of calcium per 100 grams of ore. This equates roughly to 0.5 pound of calcium or about 1.2 pounds of $CaCO_3$ per ton of ore that could potentially precipitate. Not all of this calcium, however, will be realized because laboratory testing is run in a manner that indicates 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 are 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. There is some uncertainty 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 observed in the system. As a first approximation, the proportion of calcium precipitation occurring aboveground 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 aboveground, as is the case for most ISR operations including those projected for the MEA, then more of the calcium will precipitate underground than aboveground. The calcium precipitation is a function of turbulence in the solution, changes in dissolved 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 approximately 0.15 percent 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 MEA wastewater system (i.e., wastewater tanks located in the satellite building) and periodically acid cleaned, if necessary, to remove precipitated $CaCO_3$ from the filter housing or filter media.
- The solution bleed (approximately 0.5 to 1.0 percent) will be taken to create overproduction, and a hydrologic sink in the mining area eliminates some calcium from the system.

Should precipitation of $CaCO_3$ 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 $CaCO_3$ or particulate $CaCO_3$ is collected and placed into the waste disposal system. Upon decommissioning, $CaCO_3$ from the facility equipment tank residues will be disposed of in either a licensed tailings pond or a commercial disposal site.

The other possible precipitating species 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 basal sandstone of the Chadron Formation, 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 basal sandstone of the Chadron Formation are H_2S 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 oxidized along with the uranium will be solubilized by the lixiviant, recovered with the uranium, and could potentially contaminate the precipitated yellowcake product. H_2O_2 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 MEA, these sulfur species are completely oxidized to sulfate, which poses no problems.

Organics

Organic materials are generally not present in the MEA 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 an MU average as determined by the baseline water quality sampling program. This sampling program is performed for each MU before mining operations commence. Should restoration efforts be unable to achieve baseline conditions after diligent application of the 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 ISR mining. These secondary restoration values are approved by the NDEQ in the individual Notice of Intent (NOI) for each MU 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 ISR licenses of the NRC and its Agreement States. The EPA regulations issued under UMTRCA authority provide the principal standards for uranium ISR operations and groundwater protection, while the UIC regulations are considered additional requirements for ISR 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 ISR 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, at the point of compliance (mining zone after restoration), the concentration of hazardous constituent must not exceed:

5B(5)—At the point of compliance, the concentration of a hazardous constituent must not exceed—

(a) The NRC-approved background concentration of that constituent in the groundwater

(b) The respective value given in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed

or

(c) An alternate concentration limit established by the NRC.

CBR will comply with these provisions in terms of groundwater restoration limits.

Establishment of Baseline Water Quality

In addition to pre-operational baseline groundwater monitoring, baseline groundwater quality is determined before mining in each MU by assigning and evaluating groundwater quality in “baseline restoration wells”. A minimum of one baseline restoration well for each 4 acres, but not fewer than six wells total for each MU, are sampled to establish the MU baseline water quality. A minimum of four samples are 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**.

Tables 3.4-9 through **3.4-11** contain the restoration tables for MUs 1 through 3 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 MU in the NOI.

Establishment of Restoration Goals

The baseline data are used to establish the restoration standards for each MU. As previously noted, the primary goal of restoration is to return the MU to PPMP water quality condition on an

MU average. Because ISR 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 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. The NDEQ restoration values are established for each MU and are approved with the NOI to operate submittals according to the following analyses:

- For parameters that have numerical groundwater standards established in Title 118, the restoration goal is based on the Title 1118 Maximum Contaminant Level (MCL).
- If the baseline concentration exceeds the applicable MCL as noted above, the standard is set as the MU 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 PPMP sampling data. Normal statistical procedures will be used to obtain the average.
- The restoration values for the major cations (calcium, magnesium, potassium, and sodium) 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 MU average plus one standard deviation.

The current NDEQ restoration standards are listed in **Table 5.4-1**.

It is anticipated that the Class III UIC Permit issued for the MEA will have similar requirements. Under the provisions of the performance-based license, the CBR Safety and Environmental Review Panel (SERP) reviews and approves the establishment of restoration standards using the review procedures discussed in Section 5. **Table 5.4-1** lists the 27 parameters used at the Crow Butte 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 MU is based on the current Title 118 standard at the time the NOI is approved by the NDEQ.

Proposals for Alternate Concentration Limits (ACLs) will include consideration of factors listed under Criterion 5B(6) of 10 CFR Part 40, Appendix A and approval by NRC pursuant to Criterion 5B(5)(c).

5.4.1.4 Groundwater Restoration Methods

Introduction

Restoration activities in the current 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**, MUs 2 through 6 are currently undergoing restoration, with MU 2 undergoing stability monitoring following active restoration. MU 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 MU 1 at CBR. This approval was the culmination of 3 years of agency reviews including a license amendment to accept the NDEQ restoration standards as the approved secondary goals. MU 1 consisted of 40 patterns installed in 9.3 acres immediately adjacent to the

CPF. Included within the boundaries of MU 1 were five wells originally mined beginning in 1986 as part of the R&D pilot plant operation. Commercial mining activities began in 1991 and were completed in 1994. MU 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 any time 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 Na_2S are discussed in Section 1.3.2.7. Instructions and safety precautions on the use of sodium sulfide are included in SHEQMS Volume III Operating Manual (Restoration Reductant [Sodium Sulfide]).

Although CBR's CSA Class III UIC Permit requires a minimum of 6 months for stability monitoring of an MU to demonstrate the success of restoration (stabilization), for this license, the specified ore zone monitoring wells will be sampled at a frequency of once each quarter. The quarterly monitoring will continue until the data from the most recent four consecutive quarters indicate no statistically significant increasing trend for all constituents of concern. At that point, stabilization will be deemed complete subject to approval.

Throughout restoration and stabilization, excursion monitoring consistent with Section 6.2.2.1 will continue until NRC determines that groundwater stabilization has been demonstrated. Stability monitoring may continue beyond the 6-month period as necessary. Stability monitoring will conclude, instead, when stabilization samples show that restoration goals on an MU average for monitored constituents are met and there is no significant increasing trend for a minimum of four quarters. At the end of the stabilization period, when restoration parameters have been achieved and there are no significant increasing trends for any of the restoration parameters, a request would be made to the appropriate regulatory agencies that the wellfield be deemed restored.. A cone of depression (inward hydraulic gradient) is not maintained during stabilization.

During mining until the start of stabilization, an overall hydrologic bleed will be maintained within the perimeter monitor well ring 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 3.4-12** 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 control of the mining fluid. Vertical migration of fluids is less of a concern than lateral migration due to the underlying and overlying aquitards. 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.

Crow Butte initiated a bioremediation pilot study in MU 4 at the existing CPF on December 17, 2008. If CBR decides to employ this type of remediation in the future, 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: three pore volumes through IX treatment, six pore volumes through the RO, and two pore volumes of recirculation (total of 11 pore volumes for restoration). 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.

Because the final layout of the MUs has not been defined, an assumed pore volume for the MUs will be calculated as per the following:

Pore Volume (PV) = area x thickness x porosity x flare factor x 7.48 gal/ft^3

The calculated pore volume will be based on the square footage of the potential wellfield area, average under-ream interval of approximately 25 feet, an assumed 29 percent open pore space value, and an assumed flare factor of 20 percent. As additional drilling is performed, these values may be refined for use in calculating surety. All of these values are based upon experience at the CPF.

Geology and hydrology at the CPF is very similar to that of Marsland. Because there are fewer stacked roll fronts at Marsland, Cameco expects an under-ream interval closer to 20 feet. The 29 percent assumed open pore space value remains valid at Marsland.

NUREG-1569 indicates that, for surety purposes, the licensee should include the flare factor in its calculation of the number of pore volumes necessary for groundwater restoration (NRC 2003). The flare factor is defined by the NRC *as a proportionality factor designed to estimate the amount of aquifer water outside of the pore volume that has been impacted by lixiviant flow during the extraction process*. The flare factor is usually expressed as a horizontal and vertical component to account for differences between the horizontal and vertical hydraulic conductivity of an aquifer material (NRC 2003). At the MEA, little vertical flare is expected by virtue of the consistent overlying clay breaks and the underlying Pierre Shale.

The horizontal and vertical flares are typically expressed as a multiple of the calculated pore volume. However, R/CR-6870 states that there are zones with low permeabilities that have proven to be more of a concern than in a wellfield where the balance is maintained. As in the case of the current CBR operations, a wellfield at MEA will be balanced on an individual pattern basis. Within the uranium ISR industry, this is the most effective way to mine an in-situ wellfield and restore groundwater (Powertech 2009). During operations, CBR will balance the MEA individual wells daily, a method that will reduce the pore volumes for restoration and minimize excursions beyond the flare zone.

Acceptance Criteria 2 in Section 6.1.3 of RG-1569 (NRC 2003) states, “Specific flare factors approved in the past vary from 20 to 80 percent and are typically based on experience from research and development pilot demonstrations." CBR's technical basis for the proposed 20 percent flare factor is the limited vertical flare and operational experience and hydrological modeling at the CPF. Given the similar operating approach and similar geology and hydrology, the NRC 2011 determination of 20 percent as an acceptable flare at the CPF is also appropriate for calculating pore volume at the MEA (NRC 2012; ML110320362)

As an example for use in the license application surety calculation, the calculated pore volume for a 75-acre MEA wellfield will be approximately 177,193,095 gallons. A 75-acre wellfield is the maximum area allowed by the State of Nebraska. In fact, the wellfields at the CPF average 50 to 60 acres and similar, smaller wellfields are expected at the MEA. This is based on a calculated square footage (75 acres = 3,267,000 ft^2) of the example wellfield, an average under-ream interval of 25 feet an estimated 29 percent open pore space value, and a 20 percent flare factor. As noted earlier, this example calculation overestimates both the area and the under-ream interval, so that surety calculations for wellfields will be based upon the actual area and under-ream interval.

Groundwater Transfer

During groundwater transfer, water may be transferred between the MU commencing restoration and an MU commencing mining operations. The higher TDS water from the MU in restoration is recovered and injected into the MU commencing mining. The direct transfer of water will lower the TDS in the MU 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 MUs 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 MU must be ready to commence mining. If an MU is not available to accept transferred water, groundwater sweep, or other activity will be employed 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 MU, which sweeps the affected portion of the aquifer. The cleaner baseline quality water has lower ion concentrations that 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 MU. The number of pore volumes transferred during groundwater sweep, if any, is dependent upon the presence of other active MUs along the MU boundary, the capacity of the wastewater disposal system, and the success of the groundwater transfer step in lowering TDS.

Groundwater Treatment

Following groundwater sweep, water will be pumped from production wells to treatment equipment and then re-injected into the wellfield. IX, RO, and/or Electro Dialysis Reversal treatment equipment is generally used during this stage, as shown on the generalized restoration flow sheet on **Figure 5.4-1**.

Water recovered from restoration that contains 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 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 an RO unit: 1) reduces the TDS 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 wide difference in ion concentration.

The RO unit contains membranes that pass about 60 to 75 percent of the water, 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 DDWs. 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 O_2 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. H_2S, Na_2S, or a similar compound will be added as a reductant. CBR typically uses Na_2S due to the chemical safety issues associated with proper handling of H_2S. A comprehensive safety plan regarding reductant use is implemented.

The number of pore volumes treated and re-injected during the groundwater treatment stage will depend on the efficiency of the RO in removing TDS and the reductant in lowering the uranium and trace element concentrations.

Wellfield Recirculation

Wellfield recirculation may be initiated at the completion of the groundwater treatment stage. To homogenize the aquifer, solutions may be recirculated by pumping from the production wells and re-injecting the recovered solution into injection wells.

The sequence of the activities will be determined by CBR based on operating experience and wastewater 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 MU has achieved the restoration values, on an MU 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 BPT 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, all groundwater extraction and injection ceases, and no inward hydraulic gradient is maintained. Only stability monitoring (sampling) occurs.

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**. A cone of depression (inward hydraulic gradient) is not maintained during stabilization.

Although CBR's CSA Class III UIC Permit requires one sample per month for a minimum of 6 months for stability monitoring of an MU to demonstrate the success of restoration (stabilization), for CPF's NRC license, the specified ore zone monitoring wells will be sampled at a frequency of once each quarter. The quarterly monitoring will continue until the data from the most recent four consecutive quarters indicate no statistically significant increasing trend for all constituents of concern at which point will be deemed complete, subject to approval.

Throughout restoration and stabilization, excursion monitoring, consistent with Section 6.2.2.1, will continue until NRC determines that groundwater stabilization has been demonstrated.

The sampling frequency will be one sample every other month for four quarters, and if the six samples show that the restoration values for all wells are maintained during the stabilization period with no significant increasing trends, restoration shall be deemed complete.

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. In the unlikely event that a well goes on excursion during restoration, the process described in Section 5.7.8.3 of RG-1569 will be followed. Excursion monitoring operational procedures will include corrective action and notification plans in the event of an excursion. The NRC will be notified within 24 hours by telephone and within 7 days in writing from the time an excursion is verified. A written report describing the excursion event, corrective actions taken, and the corrective action results will be submitted to the NRC within 60 days of the excursion confirmation. If any of the wells are still on excursion status when the report is submitted, the report will also contain a timeline for submittal of future reports describing the excursion event, corrective actions taken, and results obtained. In the event of a vertical excursion, the report will contain a projected completion date for the extent of the vertical excursion.

Upon completion of restoration activities and before stabilization, all designated restoration wells in the MU 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. Groundwater restoration standards for the current CBR operations are established by the NDEQ, with concurrence of the NRC and EPA. This process will be adhered to for the MEA project.

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 MU and do not exhibit significant increasing trends, CBR would request that the MU be declared restored. Following agency approval, wells will be reclaimed, plugged, and abandoned as described in Section 6.2.3. CBR will not remove production or monitoring wells until the stability monitoring is concluded and agency approval is granted. In this way, these wells could be used to correct any excursion.

5.4.2 Surface Water Quality Impact Mitigation Measures

Surface water impacts due to stormwater runoff events are a possibility during all phases of the construction, operation, and reclamation of the proposed MEA project. Impacts include increased sedimentation and changes to the water quality of stormwater and snowmelt runoff discharging to ephemeral drainages and eventually the Niobrara River. Due to the minimal amounts of flows in the ephemeral drainages located on the MEA project site, and mitigation measures to be taken to minimize increased sedimentation and contamination of stormwater runoff, the potential for impacted stormwater runoff reaching the Niobrara River is expected to be rare.

Potential impacts associated with stormwater and snowmelt runoff are discussed in Sections 4.4.1 and 4.4.2, 4.3.1.1, and 5.3. Steps to be taken to minimize impacts to surface water include the following:

- Construction site planning and management (sequencing of construction, inspect and maintain BMPs, and runoff and sediment control features);
- Erosion control (use of erosion and stormwater and snowmelt runoff control features such as mulching, riprap, seeding, sodding, soil retention, and temporary slope drain);
- Runoff Control (diversion channels, grading to have areas sloped to minimize erosion, grass-lined channels, and permanent slope diversions);
- Sediment Control (silt fences, hay bales, mulching, fiber rolls, sediment basins, sediment traps, storm drain inlet protection, and vegetated buffers);
- Minimize the amount of disturbance to surface areas, drainage channels, and natural vegetation, which will help to minimize erosion and runoff impacts;
- To the extent possible, maintain natural contours, stabilize slopes, and minimize the amount of off-road travel with vehicles;
- Employ existing spill cleanup and remediation procedures to address any spills of materials that could adversely impact the quality of any stormwater and snowmelt runoff;

- Provide berms and/or curbing for storage of fuels, hazardous materials, and chemicals that minimize the potential for any releases of spilled materials;
- As required, prepare and implement a SWPPP that meets applicable regulatory requirements;
- Use assessment of flooding and erosion potential studies in locating and protecting surface facilities from potential flooding events;
- Train contractors and employees in the handling, storage, distribution, and use of hazardous materials.

5.5 Air Quality Impact Mitigation Measures

Operational activities within the MEA 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 suspended particulates. Speed limits at the current operation are 25 mph or less. Similar controls will be implemented at the MEA.

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.) to unpaved county roads are costly, but will be used as necessary. 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. CBR will work with the county for similar assistance needs.

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 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)
- 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.

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Table 5.1-1 Soil Cleanup Criteria and Goals

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

pCi/gm – picocuries per gram

Table 5.4-1 NDEQ Groundwater Restoration Standards

Table 5.4-1 NRC and 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: NDEQ 2006)
Source: NRC UMTRCA Groundwater Protection Standards (Criterion 5B (5) of 10 CFR Part 40, Appendix A of UMTRCA

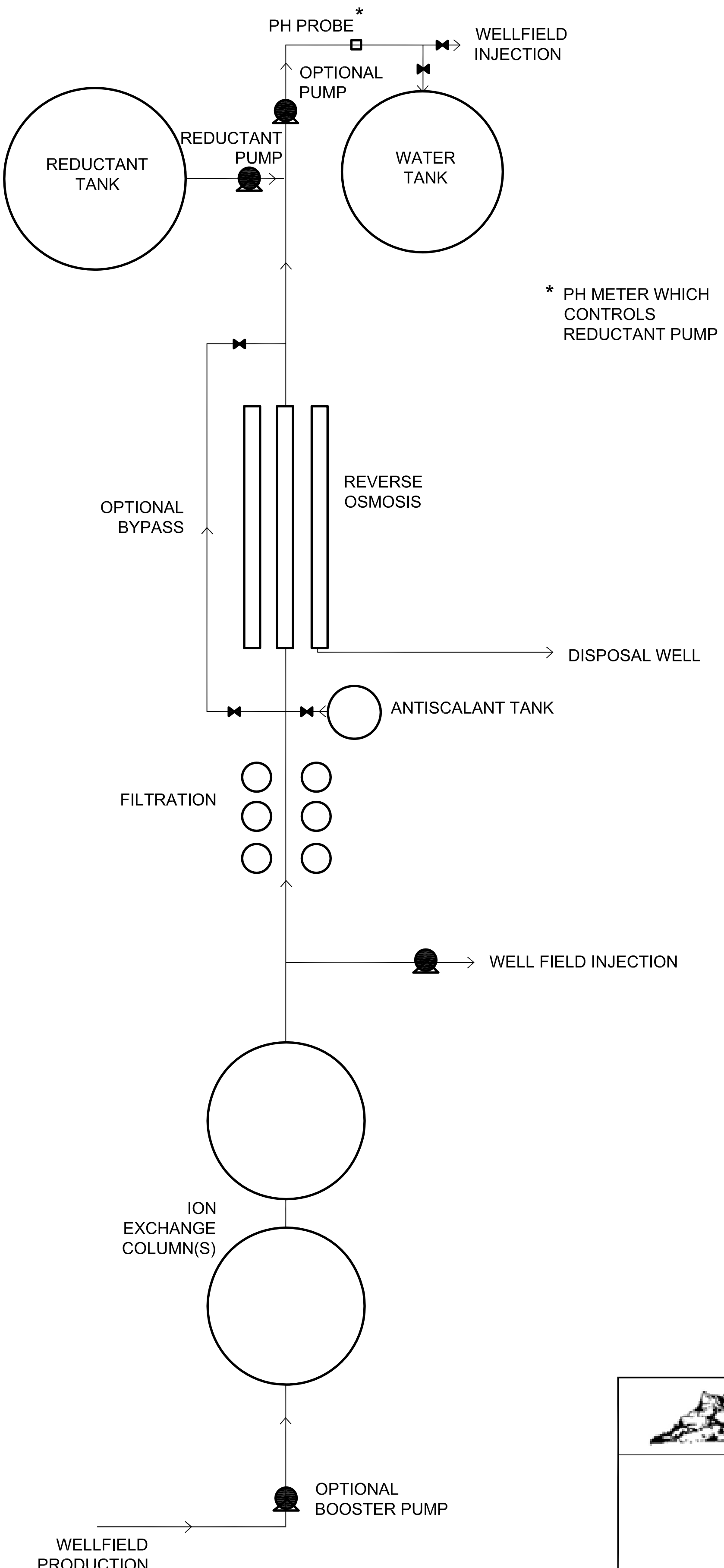
Table 5.4-2 Typical Reverse Osmosis Membrane Technology

Table 5.4-2 Typical Reverse Osmosis Membrane Rejection

Name	Symbol	Percent Rejection
Cations		
Aluminum	Al^{+3}	99+
Ammonium	NH_4^{+1}	88-95
Cadmium	Cd^{+2}	96-98
Calcium	Ca^{+2}	96-98
Copper	Cu^{+2}	98-99
Hardness	Ca and Mg	96-98
Iron	Fe^{+2}	98-99
Magnesium	Mg^{+2}	96-98
Manganese	Mn^{+2}	98-99
Mercury	Hg^{+2}	96-98
Nickel	Ni^{+2}	98-99
Potassium	K^{+1}	94-96
Silver	Ag^{+1}	94-96
Sodium	Na^{+}	94-96
Strontium	Sr^{+2}	96-99
Zinc	Zn^{+2}	98-99
Anions		
Bicarbonate	HCO_3^{-1}	95-96
Borate	$B_4O_7^{-2}$	35-70
Bromide	Br^{-1}	94-96
Chloride	Cl^{-1}	94-95
Chromate	CrO_4^{-2}	90-98
Cyanide	CN^{-1}	90-95
Ferrocyanide	$Fe(CN)_6^{-3}$	99+
Fluoride	F^{-1}	94-96
Nitrate	NO_3^{-1}	95
Phosphate	PO_4^{-3}	99+
Silicate	SiO_2^{-1}	80-95
Sulfate	SO_4^{-2}	99+
Sulfite	SO_3^{-2}	98-99
Thiosulfate	$S_7O_3^{-2}$	99+

Source: Osmonics, Inc.

Figure 5.4-1 Restoration Process Flow Diagram



CROW BUTTE RESOURCES, INC.

FIGURE 5.4-1
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_Projects\CO001636_Marsland\1_ACAD\RestorationProcessRevised.dwg LAYOUT: TR DATE/TIME: 3/16/2012 2:24 AM

6 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

This section discusses the environmental sampling program that CBR has implemented to assess preoperational and operational radiological and non-radiological conditions in the vicinity of the MEA.

6.1 Preoperational/Preconstruction Environmental Monitoring Program

CBR is in the process of completing the remaining sampling task of the conducting a PPMP in support of the MEA application, following the criteria outlined in RG 4.14 (NRC 1980). PPMP was delayed in order to allow for the completion of 1 year of on-site meteorological data collection. The MET data were needed for the proper location of the air and other environmental sampling locations and for completion of the MILDOS calculations. At the time of this application, a considerable amount of the PPMP has been completed, with at least 1 year of data collected for the following:

- Air particulate monitoring
- Radon gas
- Ore zone groundwater monitoring (CBR MWs in the basal sandstone of the Chadron Formation)
- Non-ore zone groundwater monitoring (CBR monitoring wells in the Brule Formation)
- Surface water (Niobrara River)
- Fish tissue samples in Niobrara River
- Sediment samples (ephemeral drainages and Niobrara River)

Remaining PPMP tasks are identified in **Figure 6.1-1**. These consist of additional surface water sampling of ephemeral drainages (as available), sediment samples for the Niobrara River during the dry season, alternative soil sampling for vegetable food uptake calculations, forage sampling, and direct radiation sampling. Sediment samples of the Niobrara during the wet season were collected in March 2013 and the analytical data are pending. With the exception of remaining food sampling (livestock), sampling of the other tasks will be completed by the end of the third quarter 2013.

This section discusses the environmental sampling program that has been implemented to assess PPMP radiological background conditions in the vicinity of the MEA. The results of the PPMP, 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 satellite facility and associated operations. The operational monitoring program is discussed in Section 6.2.

The results of the MEA preoperational radiological monitoring are organized by environmental medium to allow ready comparison of monitoring data collected during preoperational, operational, and post-operational monitoring periods. A discussion of the scope of the monitoring program precedes the presentation of the data.

6.1.1 **Baseline Air Monitoring**

6.1.1.1 Selection of Air Monitoring Stations

Figure 6.1-2 shows the locations of the air monitoring stations, with two at nearby occupiable structures, one located inside the license boundary, and the satellite facility. **Figures 3.1-2 and 4.12-2** depict all of the residences within the vicinity of the MEA license boundary and the estimated dose predicted by MILDOS modeling.

In accordance with these criteria, **Figure 6.1-2** shows three sampling sites at the project boundary (Sites MAR-1, MAR-4, and MAR-3). One of these (Site MAR-1) also coincides with the nearest, and most likely to be impacted, occupiable structure. A fourth sampling site (Site MAR-5) is intended to represent background conditions. Because the on-site wind rose indicates northeasterly winds to be the least frequent, this background monitoring site is located southwest of the project boundary at a distance of approximately 4 miles (6.4 km). A summary of monitor locations and elevations for each of the monitors is shown in **Table 6.1-1**.

Site MAR-2 is directly south of the proposed mill and slightly outside the project boundary. Sites MAR-3 and MAR-4 on the southernmost boundary of the project combine with Site MAR-2 to represent prominent downwind locations. The on-site wind rose shows north-northwesterly, northwesterly, and northerly winds to be the most frequent, accounting for more than 25 percent of the time. Hence, these three monitoring sites are located south-southeast, southeast, and south of the proposed milling operation. The wind roses are shown in **Figures 3.6-20** and **3.6-21**.

The wind rose was developed from data generated at an MEA on-site MET station. The MET monitoring station monitored temperature, precipitation, evaporation, wind speed and direction, and the standard deviation of the wind direction. The local meteorological station was operated from August 28, 2010 through August 29, 2011. Joint frequency data were compiled from this information. Further information on meteorological conditions is provided in Section 3.6.

6.1.1.2 Air Particulate Monitoring Program

RG 4.14 recommends that a total of five particulate monitoring stations be established as discussed above in Section 6.1.1.1. The locations of the air particulate samplers are shown on **Figure 6.1.2**. There are no operations at the satellite facility that could cause a significant release of airborne particulate radionuclides (e.g., lack of yellowcake drying). Therefore, radiologically contaminated air particulates are expected to be minimal.

The air monitoring program will be conducted and data submitted to the NRC for an acceptance review per the timeline on **Figure 6.1-1**. The results of the air monitoring data at sampling sites MAR-1 through MAR-5 for the fourth quarter of 2011 through the fourth quarter 2012 are presented in **Table 6.1-2**. The results are summarized as follows:

- Lead-210 measurements were a consistent 2E-14 µCi/ml at all monitor sites (reporting limit of 2E-15 µCi/ml) for all quarters except for the second quarter of 2012, where the lead level was 1E-14 µCi/ml (reporting limit of 2E-15 µCi/ml).
- Radium-226 levels at all monitor sites for all quarters exhibited a level at or less than 1E-16 µCi/ml (reporting limit of 1E-16 µCi/ml), except for the third quarter of 2012 where the radium-226 µCi/ml level was 5E-10 µCi/ml.

- Thorium-230 levels at monitor sites M-1 through M-4 for all quarters were at or less than 1E-16 µCi/ml, while the thorium-230 level at M-3 was 2E-16 µCi/ml (reporting limit of 1E-16 µCi/ml).
- Uranium levels at all monitor sites for all quarters were measured at <1E-16 µCi/ml (reporting limit of 1E-16 µCi/ml), with the exception of the first quarter of 2012, where levels of 3E-16 µCi/ml (reporting limit of 1E-16 µCi/ml) were measured at MA-2, MA-3, and MA-4, with MA-5 exhibiting a level of 2E-16 µCi/ml (reporting limit of 1E-16 µCi/ml).

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 F&J Portable DF-75L-BL-AC brushless powered air sampler, 60 liter/min, 24 voltage current direct (VCD). This is air particulate sampler runs on solar and battery power. The sampler has a filter holder and a set flowrate that is maintained automatically in case of dust loading. It does not require operator attention.

The sampler is placed in a protective enclosure (with an exhaust fan and temperature controller) that protects from the elements while allowing unimpeded sampling of the ambient air. The vendor provided CBR with an SOP for the F&J DF-75L-BL-AC that provides guidance in meeting NRC requirements (**Appendix I**).

Clean filters are installed in the filter holder at the beginning of each sampling period. The pump flowrate is adjusted as necessary. The filter replacement timeline is determined based on the dust loading at a particular location. In general, historical operations of samplers without automatic flowrate controllers at the CPF have shown that samplers can run for 1 to 2 weeks without a significant reduction in the flowrate due to dust loading.

The air sampler draws air and suspended particulate matter through a 47 mm collection filter at a known volumetric rate for a known period of time. The collected set of filters for each air sampling unit is sent for contract laboratory analysis at the end of each quarter 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. Filter sample replacement and additional handling procedures are described in the air sampler SOP.

The flowrate on the F&J portable sampler is calibrated at 6-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.

6.1.1.3 Radon Gas Monitoring Program

RG 4.14 recommends collection of radon gas samples at each of the air particulate monitoring stations (five or more sample points). Continuous samples or at least 1 week per month (at about the same time of the month) will be performed. Samples are analyzed for radon gas. The proposed PPMP and operational monitoring programs are shown in **Tables 6.1-41 and 6.1-42**.

Monitoring is being 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} mCi/ml) from RG 4.14 and to be consistent with the semiannual intervals approved by NRC for the current operational monitoring.

The PPMP and operational monitoring plan are designed to meet the criteria outlined in RG 4.14 (NRC 1980). Radon-222 monitoring for sampling sites MAR-1 through MAR-5 was conducted from the fourth quarter of 2011 through the fourth quarter of 2012 (**Table 6.1-3**). The gross count for the entire time period for all sampling points ranged from 43 to 362, with an average of 168. The gross count for sampling points MAR-1 through MAR-4 ranged from 43 to 362 (average of 163), compared to MAR-5 (background location) with a range of 70 to 255 (average of 191). The average radon concentration for the entire sampling period ranged from 0.07 to 1.6 x 109 µCi/ml (average of 0.5 µCi/ml). The average radon concentrations for sampling points MAR-1 through MAR-4 ranged from 0.07 to 1.6 µCi/ml (average of 0.5), as compared to MAR-5 (background location) with a range of 0.1 to 1.0 µCi/ml (average of 0.6 µCi/ml).

6.1.1.4 Quality of Air Measurements

The accuracy of monitoring data is critical to ensure that the preoperational air monitoring program precisely reflects air quality. RG 4.14 specifies the following LLDs for air measurements:

Radionuclide	Recommended LLD µCi/ml	Actual LLD µCi/ml
Natural Uranium	1 x 10^{-16}	1 x 10^{-16}
Thorium-230	1 x 10^{-16}	1 x 10^{-16}
Radium-226	1 x 10^{-16}	1 x 10^{-16}
Radon-222	2x 10^{-10}	0.2 x 10^{-9}
Lead-210	2 x 10^{-15}	2 x 10^{-15}

Note: µCi/ml – microCuries per milliliter

6.1.2 Baseline Groundwater Monitoring

This section discusses the results of the radiological and non-radiological analyses for private water supply wells with the MEA and CBR monitor wells installed within the MEA for purposes of assessing the MEA site. Groundwater quality in the vicinity near the MEA is generally poor (Engberg and Spalding 1978). Groundwater obtained from the basal sandstone of the Chadron Formation has a strong sulfur odor as a result of localized reducing conditions associated with the ore body.

Locations of all Arikaree Group, Brule Formation, and basal sandstone of the Chadron Formation monitoring wells in the vicinity of the MEA are shown on **Figures 3.4-6, 6.1-3, and 6.1-4**.

Water quality data for private water wells provided in this section are from March 25, 2011 to March 21, 2013. Groundwater samples for the CBR monitor wells were collected from March 4 to May 3, 2011 for the Brule Formation monitor wells and March 12 to August 20, 2012 for CBR basal sandstone of the Chadron Formation monitor wells.

In the March 2013 sampling event for the private water supply wells, there were a total of 45 water supply wells sampled. An additional 24 water supply wells could not be sampled for a variety of reasons, including wells being inoperable, power off, wells off for the season, windmill not working, and not in use. These wells are privately owned and in the control of the owners.

A summary of all private well groundwater quality data (radiological and non-radiological analytes) collected to date in the vicinity of the MEA, is presented in **Table 6.1-4.** The data are presented for the three water-bearing zones at the MEA: the Arikaree Group, Brule Formation, and basal sandstone of the Chadron Formation. Based on sampling to date, water quality results for all private water supply wells completed in the Arikaree and Brule Formations and MEA monitoring wells for the Brule Formation indicate that TDS ranged from 200 to 537 mg/L, while TDS for the basal sandstone of the Chadron Formation is generally higher than 1,000 mg/L (**Table 6.1-4**). Similarly, conductivity for the private wells and the Brule Formation monitor wells ranged from 241 to 763 micromhos per centimeter (µmhos/cm), while conductivity for the basal sandstone of the Chadron Formation is generally higher than 1,000 µmhos/cm. Major cations and anions for the private wells and monitor wells in the Brule Formation ranged from 2.75 to 6.87 meq/L, whereas cations and anions ranged from 13.85 to 25 meq/L for monitor wells completed in the basal sandstone of the Chadron Formation. This would be expected when compared to the concentrations of TDS.

6.1.2.1 Private Water Supply Wells

Preoperational baseline groundwater sampling and analyses of private wells are being carried out in two phases:

Phase 1

A select number of private water supply wells located within the MEA license boundary and less than 0.5 mile (0.8 km) from the license boundary were sampled in 2011 and analyzed for radiological and non-radiological parameters. The locations of these wells were based on placement around the license boundary and future MUs, with emphasis on downgradient locations. Within the license boundary, wells 705, 747, and 788 were monitored for three sampling events 2 weeks apart in 2011. Well 727 (within the license boundary) and wells 703, 723, 725, 741, 745, and 759 (less than 0.5 mile [0.8 km] outside of the license boundary) were sampled and analyzed for four quarters in 2011. The locations of these wells are shown on **Figures 3.4-6** and **6.1-5**.

Phase 2

Consistent with requirements of RG 4.14, a more comprehensive monitoring program for additional private wells located within 1.24 miles (2 km) of the MEA license boundary was implemented in the second quarter of 2012. An additional 47 private wells were added to the sampling program, resulting in a total of 57 monitor wells being sampled.

Private Wells Sampled in 2011	**Private Wells Sampled in 2012**
703, 705, 723, 725, 727, 741, 745, 747, 759, 788,	700, 702, 703, 704, 705, 706, 707, 714, 715, 716, 719, 720, 721, 722, 723, 725, 727, 728, 730, 731, 732, 733, 734, 735, 736, 737, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 750, 752, 753, 754, 755, 759, 760, 777, 788, 794, 795, 799, 802, 809, 810, 811, 815, 821, 836, 841, 845
Private Wells Sampled in 2013	
700, 702, 703, 704, 705, 706, 707, 714, 719, 720, 721, 722, 725, 727, 728, 734, 737, 739, 742, 743, 744, 745, 746, 747, 748, 750, 752, 753, 754 755, 760, 777, 788, 794, 795, 799, 802, 809, 810, 811, 815, 821, 836, 841, 845	

Whenever operational, all of the active private wells located within 1.24 miles (2 km) of the license boundary, where landowner access can be obtained, will be monitored quarterly (**Figures 3.4-6 and 6.1-5)**.

There were a total of 134 active and inactive private water supply wells within the license boundary and associated AOR identified during the water user survey. The number of wells and their general locations within the MEA project AOR can be broken down as follows:

> Located within License Boundary: 13 active and two inactive
>
> Located within 0.6-mile (1 km) radius of the License Boundary: 25 active and seven inactive
>
> Located between 0.6-mile (1 km) and 1.2-mile (2 km) radius of the License Boundary: 18 active and six inactive
>
> Located between 1.2-mile (2 km) radius and to 2.25-mile (3.62 km) AOR radius of the License Boundary: 54 active, eight inactive, and one unknown

The remainder of this section discusses the results of the radiological and non-radiological analyses for private water supply wells within the MEA. Other information on the selected wells, including formation, depth, and usage, is provided in **Appendix A**. Available well registration and well completion records are provided in **Appendices E-1** and **E-2**.

The radiological and non-radiological analytical results for the individual private wells are shown in **Tables 6.1-5** and **6.1-6,** respectively, and are summarized in **Table 6.1-4**.

The radiological analytical results for the Arikaree and Brule Formations were at levels that would be expected for background concentrations of the area.

Suspended uranium concentrations for the private wells completed in the Arikaree and Brule Formations were at a range of <0.0003 mg/L to 0.001 mg/L (average of 0.00021 mg/L), and dissolved uranium levels were 0.0028 to 0.0373 mg/L (average of 0.00745 pCi/L). Suspended uranium activity for the private wells ranged from <2.0E-10 to 0.4 µCi/L (average of 0.000151 µCi/mL), and dissolved uranium ranged from 3.8E-10 to 18.1 µCi/ml (average of 1.335 µCi/mL).

In comparison, the suspended uranium concentrations for the basal sandstone of the Chadron Formation monitor wells ranged from <0.0003 to 0.084 mg/L (average of 0.00354 mg/L) and dissolved uranium levels ranged from <0.0003 to 0.084 mg/L (average of 0.00942 mg/L).

Suspended radium-226 values for the private wells ranged from <0.06 to 0.2 pCi/L (average of 0.07 pCi/L) and dissolved radium-226 ranged from <0.1 to 9.5 pCi/L (average of 0.21 pCi/L). In comparison, suspended radium-226 values for the basal sandstone of the Chadron Formation monitor wells ranged from <0.1 to 45 pCi/L (average of 1.88 pCi/L) and dissolved radium-226 levels ranged from <0.1 to 390 pCi/L (average of 31.19 pCi/L).

The majority of the values for suspended and dissolved lead-210, polonium-210, and thorium-230 were below the reporting limit.

The concentration of dissolved uranium in the private wells completed in the Arikaree and Brule Formations within the NTEA, TCEA, and MEA compared as follows based on available data:

NTEA	<0.0003 to 0.05 mg/L
TCEA	0.004 to 0.04 mg/L
MEA	0.0028 to 0.0373 mg/L

Dissolved uranium values for the TCEA tended to be somewhat higher than those for the NTEA and MEA.

Concentrations of dissolved radium-226 from private wells in the NTEA, TCEA, and MEA compared as follows:

NTEA	<0.2 to 1.3 x 10^{-9} pCi/L
TCEA	0.006 to 1.5 pCi/L
MEA	<0.1 to 9.5 pCi/L

The non-radiological analytical results were at levels consistent with what would be expected for background concentrations of the area (**Tables 6.1-4** and **6.1-6**). Concentrations of the parameters for the private wells versus CBR monitor wells completed in the Brule Formation are comparable, with some parameters for the private wells having somewhat lower average values than for the CBR monitor wells (e.g., dissolved sodium, sulfate, chloride, and conductivity; **Table 6.1-4**). The average values for sodium and sulfate for the private wells versus CBR Brule monitor wells was 20 versus 77 mg/L and 10 versus 33 mg/L, respectively. The average values for sodium and sulfate for the Brule monitor wells versus CBR basal sandstone of the Chadron Formation monitor wells was 77 versus 408 mg/L and 33 versus 173 mg/L, respectively.

Overall, similar trends in the NTEA and TCEA were seen for the same MEA water-bearing units.

6.1.2.2 CBR Groundwater Monitor Wells

Water Level Measurements

- Arikaree Group and Brule Formation

Ten Arikaree Group monitoring wells (AOW-1 and AOW-3 through AOW-11) were installed in 2013. There are 11 active monitoring wells screened in the Brule Formation (BOW-2010-1,

BOW-2010-2, BOW-2010-3, BOW-2010-4A, BOW-2010-5, BOW-2010-6, BOW-2010-7, BOW-2010-8, BOW-2013-9, BOW-2013-10, and BOW-2013-11). Three of these wells (BOW-2013-9, BOW-2013-10, and BOW-2013-11) were screened in the Brule Formation in September 2013). These wells were installed in September 2013. The Walters Drillers Pond-720 (Walters-2) and Walters Drillers Pond-721 (Walters-1) wells have been employed as monitoring wells for the Brule Formation, but these wells will not be part of future monitoring specifically for the Brule Formation because they are screened across the Arikaree and Brule Formations. In September 2013, ten wells were screened in the Ariakaree Group. The primary purpose of the Arikaree and Brule monitor wells is to further the site-specific understanding of the hydrologic characteristics of the Arikaree Group and Brule Formation. Installation and subsequent monitoring of water levels and water quality are intended to provide more information about potentiometric surfaces of groundwater within aquifers and provide data by which the hydrologic connectivity between the aquifers, or lack thereof, can be determined. The locations of CBR's Arikaree and Brule monitor wells within the MEA are shown on **Figure 6.1-3**.

Well BOW-2010-4 is not being used for baseline monitoring, and plans are to abandon this well in the future. During reaming of this well for casing, the driller lost a bit that he was unable to retrieve. Unsuccessful attempts to convert the well to a shallow monitor well resulted in the well being considered unacceptable for baseline monitoring. A new replacement well (BOW-2010-4A) was drilled nearby. Well completion records for these monitoring wells are included in **Appendix E-2**.

Thirteen active monitoring wells are screened in the basal sandstone of the Chadron Formation (CPW-2010-1, CPW-2010-1A, Monitor-1, Monitor-2, Monitor-3, Monitor-4A, Monitor-5, Monitor-6, Monitor-7, Monitor-8, Monitor-9, Monitor-10, and Monitor-11**; Figures 3.4-6** and **6.1-4**). Well completion reports for these monitoring wells are included in **Appendix E-2**.

Water levels were measured for the Arikaree Group at ten monitoring wells on October 17, 2013 (**Table 6.1-7**). The static water level for wells screened in the Arikaree Group ranged from 19 to 149 feet bgs. Calculated groundwater elevations ranged from approximately 4,049 to 4,293 feet amsl. A potentiometric surface map and groundwater flow directions for the Arikaree Group for the October 17. 2013 event are depicted on **Figure 6.1-6**. Groundwater level data collected in October 2013 indicates that groundwater flow within the Arikaree Group is to the south-southeast toward the Niobrara River at an average lateral hydraulic gradient of approximately 0.009 ft/ft.

Water level measurements were collected for the Brule Formation monitoring wells on February 22, 2011 and again on October 17, 2013. Six monitoring wells were sampled on February 22, 2011 and 11 monitoring wells were sampled on October 17, 2013 (**Table 6.1-7**). The static water level for wells screened in the Brule Formation in the vicinity of the MEA typically ranges from approximately 37 to 155 feet btoc. Groundwater elevations measured during the two measurement events ranged from approximately 4,050 to 4,295 feet amsl. Potentiometric surface maps and groundwater flow directions for October 17, 2013 and February 22, 2011 events are depicted on **Figures 6.1-7a** and **6.1-7b,** respectively. Groundwater in the Brule Formation flows predominantly to the south-southeast across the entire MEA toward the Niobrara River drainage at a lateral hydraulic gradient of 0.011 ft/ft (Aqui-Ver 2011). Regional water level information for the Brule Formation is currently only available from the vicinity of the current production facility.

As shown on **Figures 6.1-6** and **6.1-7a**, October 2013 groundwater level data for the Arikaree Group and Brule Formation indicate potentiometric surfaces nearly equal in elevation. Particular care was taken during installation of monitoring wells to avoid screening individual wells within both the Arikaree Group and Brule Formation. Although the wells are screened at different intervals, nearby pairs of monitoring wells screened in the two units demonstrate groundwater elevations with differences of approximately 5 feet or less. While there is some minor variation between the two potentiometric surfaces, the similarity in groundwater elevations and shared south-southeast groundwater flow direction indicate significant hydraulic connectivity between the Arikaree Group and Brule Formation within the MEA. The shared hydraulic head between the two geologic units likely indicates that groundwater within the Brule Formation is not confined by overlying units and the Arikaree Group and Brule Formation function as a single hydrogeologic unit.

- Basal Sandstone of the Chadron Formation

Water levels were also measured on February 22, 2011 for the basal sandstone of the Chadron Formation at 12 monitoring wells and at 13 wells on October 17, 2013 (**Table 6.1-7**). The static water level for wells screened in the basal sandstone of the Chadron Formation in the vicinity of the MEA typically ranges from approximately 380 to 660 feet bgs. Groundwater elevations measured during the two measurement events ranged from approximately 3,695 to 3,717 feet amsl. A potentiometric surface map and groundwater flow directions for the October 17, 2013 event are depicted on **Figure 6.1-8a**. The locations of the Chadron wells measured are shown on **Figure 6.1-4**. Groundwater in the basal sandstone of the Chadron Formation flows predominantly to the northwest toward the White River drainage at a lateral hydraulic gradient of 0.0004 ft/ft (Aqui-Ver 2011). A minor variation in flow direction during the February 2011 event indicated localized westward flow in the vicinity of Monitor-10, but is not observed in the October 2013 data. Regional water level information for the basal sandstone of the Chadron Formation is currently only available from the vicinity of the current production facility.

- Risk Conclusions

Strong vertically downward gradients exist at all locations within the MEA, indicating minimal (if any) risk for potential impacts to the Arikaree Group and Brule Formation from the underlying basal sandstone of the Chadron Formation under natural conditions. Observed head differences between the two water-bearing zones at six well pairs (BOW-2010-1 and Monitor-3, BOW-2010-2 and Monitor-4A, BOW-2010-3 and Monitor-8, BOW-2010-4 and Monitor-10, BOW-2010-5 and Monitor-11, and BOW-2010-6 and Monitor-1) ranged from approximately 346 to 518 feet during the October 2013 measurement event.

Available groundwater data for the Arikaree Group and Brule Formation and basal sandstone of the Chadron Formation at the MEA do not indicate any documented flow rate variations or recharge issues that would impact groundwater quality as a result of ISR recovery operations in the basal sandstone of the Chadron Formation. There are no surface water ponds within the MEA license boundary and only limited, intermittent flow in ephemeral drainages. The Arikaree Group and Brule Formation, while considered to be overlying aquifers, are not exceptionally productive in the MEA area.

The presence of high-capacity irrigation wells both within and near the MEA that are screened within the Arikaree Group and Brule Formation will have a seasonal impact on those aquifers.

Agricultural wells near MEA are primarily used for irrigation water between mid-May and early August, with smaller volumes of water extraction lasting into September. These wells are metered, but data are collected annually; therefore, daily, weekly, and monthly extraction rates are unavailable. Estimated flow rates for wells provided by well users are provided in **Appendix A**.

CBR has installed additional monitoring wells within the Arikaree Group and Brule Formation located between the anticipated wellfield and the irrigation wells. The monitoring wells will be sampled seasonally to establish baseline data for both water quality and water levels. The fourth consecutive quarterly monitoring event will be completed in the summer of 2014. This sampling will allow for a full assessment of the impacts that the irrigation wells may have upon those aquifers within the MEA. **Figure 6.1-3** shows the locations of the Arikaree Group and Brule Formation monitoring wells.

Pumping test data show that the basal sandstone of the Chadron Formation is hydraulically isolated from the overlying Arikaree Group and Brule Formation aquifers due to the presence of several hundred feet of claystones, mudstones, and siltstones of the upper Chadron Formation and middle Chadron Formation. Estimated hydraulic conductivity data based on particle size distribution analysis of core samples from the upper confining zone discussed in Section 3.4.3.2 support the effectiveness of these confining units indicated by the pumping test. No agricultural wells are completed in the basal sandstone of the Chadron Formation. Groundwater extraction by agricultural wells completed in the Arikaree Group or Brule Formation will have no influence on the containment of production fluids within the basal sandstone of the Chadron Formation.

6.1.2.3 Groundwater Quality Data for Brule and Chadron Formations

This section does not include preoperational water quality monitoring results for the newly installed (September 2013) Arikaree Group monitoring wells or the new Brule Formation monitoring wells. The ten Arikaree Group monitoring wells and the 11 Brule Formation monitoring wells will be sampled monthly for a 12- month period, the results of which will serve as additional preoperational monitoring data. The first of four quarterly sampling rounds commenced in early November 2013. Submittal of the first quarter data is expected to occur in early 2014.

Three bi-weekly sampling events were conducted at ten Brule Formation monitoring wells (BOW-2010-1, BOW-2010-2, BOW-2010-3, BOW-2010-4A, BOW-2010-5, BOW-2010-6, BOW-2010-7, BOW-2010-8, Well 720 and Well 721). for March 9, March 24, and April 6, 2011. The analytical results are shown in **Tables 6.1-4, 6.1-8**, and **6.1-9**. Well 720 (Walters-1) and Well 721 (Walters-2; used for drilling makeup water) are screened across the Arikaree Group and Brule Formation. Therefore, these wells, previously used in 2011 as monitoring wells for the Brule Formation, have been removed from **Tables 6.1-8** and **6.1-9**, and the summary values in **Table 6.1-4** have been updated to reflect deletion of these data. These wells will not be part of future monitoring specifically for the Brule Formation. As stated above, the results of the sampling of newly installed Arikaree Group monitoring wells and the 11 Brule Formation monitoring wells will be reported in the future.

Bi-weekly sampling events were conducted in March and April 2011 at ten monitoring wells completed in the basal sandstone of the Chadron Formation (Monitor-1, Monitor-2, Monitor-4A, Monitor-5, Monitor-6, Monitor-7, Monitor-8, Monitor-9, Monitor-10, and Monitor-11). In addition, four quarterly sampling events were conducted for these wells in November 2011, and February, June, and August 2012. The analytical results are reported in **Tables 6.1-10** and **6.1-11**, with the summary of the data presented in **Table 6.1-4**.

The groundwater sampling results for radionuclides of the Brule and basal sandstone of the Chadron Formations are presented in **Tables 6.1-8** and **6.1-11**, respectively. Groundwater analytical laboratory reports are provided in **Appendix J**.

Dissolved concentrations of selected radionuclides appear to be largely absent from the Brule Formation, with the exceptions of uranium and radium-226. For the CBR Brule monitor wells, suspended uranium concentrations ranged from <0.0003 to 0.0017 mg/L (average of 0.00025 mg/L) and dissolved uranium concentrations ranged from 0.002 to 0.0095 mg/L (average of 0.0052 mg/L). For the basal sandstone of the Chadron Formation monitor wells, suspended uranium concentrations ranged from <0.0003 to 0.0843 mg/L (average of 0.00246 mg/L), and dissolved uranium levels ranged from <0.0003 to 0.084 mg/L (average of 0.00828 mg/L).

Suspended uranium activity for the Brule monitor wells ranged from <2.0E-10 to 1.2E-09 µCi/mL (average of 1.59E-10 µCi/mL), and dissolved uranium activity ranged from 1.3E-09 to 6.4E-09 µCi/mL (average of 3.8E-09 µCi/mL). For the basal sandstone of the Chadron Formation monitor wells, suspended uranium activity levels ranged from <2.0E-10 to 6.2 µCi/mL (average of 0.151 µCI/mL) and dissolved uranium levels ranged from <2.0E-10 to 6.2 µCi/mL (average of 3.87 E-10 µCi/mL).

For the Brule monitor wells, suspended radium-226 values ranged from <0.1 to 0.6 pCi/L (average of 0.14 pCi/L) and dissolved radium-226 ranged from <0.1 to 0.66 pCi/L (average 0.22 pCi/L). For the basal sandstone of the Chadron Formation monitor wells, suspended radium-226 values ranged from <0.1 to 45 pCi/L (average of 1.82 pCi/L) and dissolved radium-226 values ranged from <0.1 to 390 pCi/L (average of 30 pCi/L).

The concentrations of dissolved thorium-230 for the Brule Formation were below the RLs of 0.2 and 0.1 pCi/L at all locations, whereas dissolved thorium-230 for the basal sandstone of the Chadron Formation ranged up to 1.7 pCi/L; however, the majority of the sample results were below <0.1 and <0.2 pCi/L. As expected, suspended radionuclides were significantly higher in the wells of the basal sandstone of the Chadron Formation than in those of the Brule Formation.

Groundwater analytical laboratory reports are provided in **Appendix J**. **Tables 6.1-9 and 6.1-10** presents the sampling results for non-radiological analytes of the Brule Formation and basal sandstone of the Chadron Formation, respectively. TDS concentrations for the Brule Formation ranged from 200 to 537 mg/L (average of 320 mg/L), whereas TDS for the basal sandstone of the Chadron Formation ranged from 778 to 1,420 mg/L (average of 1,086 mg/L). Alkalinity for the Brule Formation ranged from 125 to 217 mg/L, while alkalinity in the basal sandstone of the Chadron Formation was consistently detected above 245 mg/L at all sampling locations. Conductivity for the Brule Formation was detected at up to 763 µmhos/cm, while conductivity for the basal sandstone of the Chadron Formation was detected at above 1,340 µmhos/cm at all sampling locations. Major ion concentrations for the Brule Formation ranged from 423 to 775 mg/L, while concentrations for the basal sandstone of the Chadron Formation ranged from 1,319 to 2,227 mg/L. Similar trends in relative concentrations for the MEA were observed in water quality sampling at the TCEA and NTEA for these two water-bearing zones. Groundwater analytical laboratory reports are provided in **Appendix J**.

In general, concentrations of TDS, specific conductance, and major ions in the basal sandstone of the Chadron Formation appear to be an order of magnitude larger than observed in the Brule Formation at the MEA. In addition, dissolved concentrations of selected radionuclides appear to be largely absent from the Brule Formation, with the exception of radium-226, which was detected at very low concentrations on the order of four magnitudes lower than dissolved concentrations measured in the basal sandstone of the Chadron Formation. To date, water quality sampling indicates that the Brule Formation and the basal sandstone of the Chadron Formation have unique geochemical signatures within the MEA.

6.1.2.4 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 RG 4.14.

The private laboratory employed by CBR, Energy Laboratories, Inc. (ELI), reported the lower limits of detection for the surface and groundwater analyses as Minimum Detectable Concentrations/Lower Limits of Detection (MDC/LLD) values. ELI stated in a letter dated April 23, 2012 (ELI 2012, **Appendix Q**) that the reported MDC/LLD values for the MEA samples were in compliance with RG 4.14, Section 5 “LLD”.

Radionuclide	MDC/LLD for Water	
	µCi/ml	pCi/L
Natural Uranium	2×10^{-10}	0.2
Thorium-230	2×10^{-10}	0.2
Radium-226	2×10^{-10}	0.2
Polonium-210	1×10^{-9}	1.0
Lead-210	1×10^{-9}	1.0

Source: ELI 2012 (Appendix Q)

Note: For analytes reported in two significant figures. MDC/LLD values rounded off to only one significant figure (e.g., 1.3 pCi/L = 1 pCi/L).

ELI met the criteria of the guidance suggested by the NRC when reasonably achievable by available conventional laboratory methodology. If for some reason the MDC/LLD was not met on the original analysis, the samples were recounted or re-analyzed until RG 4.14 MDC/LLDs were achieved. See **Appendix Q** for additional discussions by ELI of MDC/LLD reporting.

MDC levels for surface and groundwater radiological analytes are presented in the respective data tables of this document as well as in the individual Analytical Summary Reports of **Appendix J**.

6.1.3 Baseline Surface Water Monitoring

Surface water sampling in RG 4.14 calls for sampling of surface water passing through the project site or off-site 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 monthly with samples analyzed for suspended and dissolved natural uranium, radium-226, and thorium-230.

RG 4.14 also requires surface water sampling from each large on-site body of water or off-site impoundments subject to direct surface drainage from potentially contaminated areas that could be affected by a tailings impoundment failure. Grab samples are to be collected quarterly, 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.

Lack of water flow in ephemeral drainages in the MEA has prevented collection of surface water samples. Water samples were collected from the Niobrara River, which flows east-to-west to the south of the MEA license boundary (**Figure 3.4-4**). The results of this sampling program are discussed below. Historical water flow and water quality data were obtained from NDNR, NDEQ, and USGS databases (see discussions below). Water level measurements of the Box Butte Reservoir were obtained from the USBR (see discussions below).

6.1.3.1 NDNR Niobrara River Ambient Stream Monitoring Program

- Flow Measurements for Niobrara River

The NDNR maintains stream gaging stations on the Niobrara River and reports data on its web page (NDNR 2011). Flow data reported in this section are for the section of the Niobrara River close to the proposed MEA (**Figure 3.4-4**). The description of the stream gaging stations and their locations is presented in **Table 6.1-12**. A summary of the stream gaging measurements from 1999 through 2012 for the designated stream gaging stations are shown in **Table 6.1-13**. The sampling location at Agate is an exception, with data being available from 2006 through 2012. Monthly flow measurements for stream gaging stations in the upper reaches of the Niobrara River for each of the designated years are presented in **Table 6.1-14**. A graph of the average flow in cfs for the four Niobrara River stream gaging stations from 2006 through September 2012 is shown on **Figure 6.1-9**. As seen on **Figure 6.1-9**, flows for the gaging stations above the Niobrara River are fairly consistent over this time period. The year 2006 was used as the starting date because of the lack of flow data at the Agate gaging station prior to 2006.

In the Niobrara River west of Valentine, NE, which includes the area of the river in the vicinity of MEA, groundwater is the primary source of flow into the Niobrara River (Alexander et al. 2010). In this area of the river, the discharge of the river is steady and persistent, with overbank flooding being uncommon, except during winter ice jams (Shaffer 1975). As can be seen on **Figure 6.1-9**, the average flow of the Niobrara River at the Wyoming/Nebraska state line is consistently lower than the average flows at the gaging stations located at Agate and above the Box Butte Reservoir **Figure 6.1-9** clearly shows the time periods during which water is stored and released from Box Butte Reservoir. These data can be correlated with the flow data presented in **Table 6.1-14**. Peak discharge extremes and minimum discharge flows for the years 1999 through 2010 are presented in **Table 6.1-13**.

- Water Quality

The NDNR has not collected water quality on the Niobrara River in the area of the Marsland project since sampling was shared with the USGS prior to 1998 (Hayden pers. comm. 2011).

6.1.3.2 NDEQ Niobrara River Ambient Stream Monitoring Program

Water quality data for the NDEQ Niobrara River sampling stations were obtained from the NDEQ (Ihrie 2013a). Water quality data presented in this report are for the years 2003 through 2011, and consisted of major ions, physical properties, and metals, but no radiological analyses. Water samples were collected at a sampling station above the Niobrara River (NDEQ sample station SNI4NIOBR402/USGS 06454500) and a sampling point below Box Butte Reservoir (NDEQ sample station SNI4NIOBRA20/USGS 06455500) (**Figure 6.1-10**).

- NDEQ Water Quality Sampling for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402)

Monthly nonradiological water quality data from the sample location above Box Butte Reservoir (SNI4NIOBR402) are shown in **Tables 6.1-15** through **6.1-25**. A summary of the water quality data for 2003 through 2011 in **Tables 6.1-17** through **6.1-25** is presented in **Table 6.1-26**. Water quality samples were analyzed for eight major ions. The dominant cation at the sampling location above Box Butte Reservoir (SNI4IOBR402) was calcium (range of 42.82 to 58.20 mg/L), followed by sodium (range of 21.4 to 40.6 mg/L), magnesium (range of <0.15 to 11.5 mg/L), and chloride (range of 3.46 to 7.35 mg/L) (**Table 6.1-26**).

Nutrients such as nitrogen and phosphorus compounds occur naturally in surface water, but elevated concentrations may occur due to agricultural runoff and wastewater discharges and septic systems. There are at least two cattle feeding operations close to the stretch of the Niobrara River near the MEA project site (NDEQ 2005). Maximum values for nitrite plus nitrate, total ammonia nitrogen, and total kjeldahl nitrogen were all lower than 2 mg/L for the above-referenced NDEQ samples. Thirteen of 152 total phosphorus samples yielded concentrations higher than (maximum of 0.71 mg/L) the EPA recommendation of 0.1 mg/L for avoiding algal blooms.

The average of the dissolved O_2 readings was 8.55 mg/L, and ranged from 3.34 to 12.9 mg/L. There were only six readings below 6.0 mg/L and three between 6.1 and 6.3 mg/L, with 148 of the total samples being above 6.5 mg/L. Lower readings appeared to occur during low or high flows.

The NDEQ water quality standards state that, in order for water to support aquatic life, the pH S.U. should be maintained between 6.5 and 9.0, unless the pH values are outside this range due to natural conditions. One of 91 of the pH readings for the Niobrara River (9.92 S.U.) was outside the acceptable range of 6.5 to 9 S.U. The average of the pH values was 8.09 S.U. and ranged from 7.1 to a maximum value of 9.92 S.U. recorded on May 21, 2007.

Average temperature readings were 11.13 ^{o}C, ranging from -0.26 to 29.0 ^{o}C. Seasonal fluctuations indicate that water temperature is primarily dependent upon the ambient air temperatures.

Turbidity field measurements indicated an average of 27.7 nephelometric turbidity units (NTU), with a range of 0.29 to 233. The majority of the turbidity measurements were 30 NTU or less (103 of 139 readings [74 percent]). The majority of the turbidity measurements above 30 NTU were during periods of either high flow or low flow conditions. There were only 18 readings above 40 NTU.

Total suspended solids (TSS) measurements ranged from <5 to 297 mg/L, with an average of 24.7 mg/L. The maximum value of 297 mg/L was the only value to exceed 100 mg/L, and the cause of the exceptionally high value is unknown based on available information. Daily readings for the months before and after this high reading were 49.5 and 61 mg/L, respectively. TSS values of 103 of the total number of 138 samples (75 percent) analyzed were 30 mg/L or lower. Specific conductance values ranged from 100 to 539 µmhos/cm, with an average of 386 µmhos/cm. All 91 readings were 314 µmhos/cm and above except for two readings of 244 and 297 µmhos/cm.

The above-mentioned NDEQ water quality data support the classification of the Niobrara River by stream segment in the vicinity of the MEA project site. The Niobrara River segments provide a basic unit for assigning site-specific standards and for applying water quality management programs of the NDEQ. The NDEQ Water Quality Body ID N14-4000 is located to the south of the MEA (**Figure 3.4-3**). This segment is rated as Supported Beneficial Use for aquatic life, agricultural water supply, and aesthetics. However, this segment is classified as Impaired for recreational use due to the measured presence of E. coli (NDEQ 2010, 2005). As a result, the water body category for this segment of the Niobrara River has been established as Category 5 (waterbodies where one or more beneficial uses are determined to be impaired by one or more pollutants and all of the Total Maximum Daily Loads [TMDLs] have not been developed; NDEQ 2010). A TMDL is the maximum quantity of a pollutant a water body can receive and still meet its appropriate water quality criteria or goal (NDEQ 2010).

- NDEQ Water Quality Sampling for Niobrara River Below Box Butte Reservoir (SNI4NIOBRA20)

NDEQ water quality data were only available for 2008 for the Niobrara River below Box Butte Reservoir (SNI4NIOBRA20) (**Table 6.1-27**). The ranges for data available for the year 2008 are shown in **Table 6.1-28**. This sampling location is an NDEQ Basin Rotation site sampled as part of the 6-year Basin Rotation Cycle. There was no sampling at the site in 2009, 2010, 2011, and 2012 because sampling is only conducted every 6 years at Basin Rotation sites. Although scheduled for 2014, it may or may not be sampled in 2014, depending on site selections by the NDEQ for the Basin Rotation Cycle (Ihrie 2013b).

- Box Butte Reservoir

Box Butte Reservoir is rated as Supported Beneficial Use for recreation, agricultural water supply, and aesthetics, but Impaired Beneficial Use for aquatic life (NDEQ 2010). The impairment classification is due to a fish consumption advisory for northern pike because of elevated mercury levels identified in tissues. As a result, the water body category for this lake has been established as Category 5 (waterbodies where one or more beneficial uses are determined to be impaired by one or more pollutants and all of the TMDLs have not been developed; NDEQ 2010). The agencies assessment of Box Butte Reservoir in 2012 determined this water body is also impaired for pH (NDEQ 2012).

6.1.3.3 U.S. Bureau of Reclamation

The USBR monitors the contents of the Box Butte Reservoir daily (USBR 2013b). Measurements (acre-feet) for the reservoir from 2003 through September 2013 are shown in **Table 6.1-34.** The average value for the content of the reservoir was 9,627 acre-feet between 2003 and September 2013. The minimum and maximum values were 2,352 and 24,942 acre-feet, respectively (see summary values in **Table 6.1-35**). Since the 1950s, groundwater depletions of base flow and numerous farm conservation practices have greatly reduced inflow into the reservoir (USBR 2008).

Box Butte Reservoir is used as a source of irrigation water; consequently, the reservoir storage content (acre-feet) can vary considerably annually due to the use of the water for irrigation purposes downstream of the reservoir dam. Historically, the reservoir has experienced the highest reservoir elevations during the months of May and June, while September and October exhibit the lowest reservoir elevations following irrigation releases (USBR 2008). As seen in **Table 6.1-34**, the reservoir contained an average of 12,336 and 12,965 acre-feet in May and June 2013, respectively, whereas in August and September 2013, the reservoir contained an average of 6,541 and 5,295 acre-feet, respectively.

Under an agreement among the Mirage Flats Irrigation District, the NGPC, and the USBR, a minimum pool elevation is maintained at 3,978 acre-feet to support and maintain a viable fishery resource in the reservoir (USBR 2011a).

6.1.3.4 Crow Butte Sampling of the Niobrara River

CBR established two water quality sampling locations on the Niobrara River, with one sampling point (N-1) established upstream (west) of the MEA license boundary and one point (N-2) located downstream (east) of the license boundary (**Figure 3.4-4).** The downstream sampling point is located to assess potential impacts from either of the two ephemeral drainages that drain the MEA. Water quality and sediment samples are collected at N-1 and N-2.

Based on Requests for Additional Information (RAI) by the NRC and further discussions, CBR assessed the location of N-2 for the need to move the N-2 sampling point upstream closer to the MEA project site. Following discussions with, and concurrence by, the NRC, the downstream sampling location on the Niobrara River was moved approximately 2.3 river miles (3.7 km) upstream to the USGS/NDNR 06454500 and NDEQ SNI4NIOBR402 Gaging Station, which is referred to as the Niobrara River above Box Butte Reservoir for sampling purposes (**Figure 6.1-10**). N-1 and N-2 are located to detect potential impacts from either of the two major ephemeral drainages that drain the MEA site from northwest to southeast, and connect to the Niobrara River between N-1 and N-2.

CBR has collected samples for baseline water quality analysis for radiological and non-radiological parameters from January 2011 through March 2013, prior to the relocation of N-2. The objective was to collect 1 year of monthly data for the radiological parameters and quarterly data for non-radiological parameters. Fourteen months of sampling data (January 2011 through March 2012) are now available for dissolved radiological parameters (**Table 6.1-29**), 13 months of sampling data (January 2011 through May – March 2012 [excluding the month of April 2011 due to a commercial lab error]) for suspended radiological parameters (**Table 6.1-30**), and 7 months of sampling data (February 2011 through February 2012) (**Table 6.1-31**) for non-radiological parameters (major ions, physical properties, and dissolved metals). A summary of the baseline suspended and dissolved radiological parameters is presented in **Table 6.1-32**, and a summary of the baseline non-radiological parameters is shown in **Table 6.1-33**.

The results of the radiological analyses indicated that background levels are low, with the majority of the results at or below the R value (**Table 6.1-32**). The levels for dissolved uranium (as a metal) and uranium activity were all above the RL, except for the January 2012 measurements. The concentrations at N-1 and N-2 appear to be similar. The minimum and maximum radiological analytical results for N-1 and N-2 are summarized below.

Radiological Analyte Results for N-1 and N-2 Sample Points on Niobrara River				
	Dissolved Radiological Analyte		Suspended Radiological Analyte	
Analyte	Minimum	Maximum	Minimum	Maximum
Lead-210, pCi/L	< 0.6	50	< 0.5	< 2.1
Polonium-210, pCi/L	< 0.4	4.6	< 0.2	0.4
Radium-226, pCi/L	< 0.1	1.7	< 0.06	0.14
Thorium-230, pCi/L	< 0.1	< 0.8	< 0.04	0.2
Uranium Activity, µCi/ml	<2.0E-10	4.9E+00	< 2.0E-10	4.5E-09
Uranium, mg/L	<3.0E-04	1.04E-02	< 3.0E-04	6.6E-03

The analytical results, with RLs, for the non-radiological parameters, are presented in **Table 6.1-31**). A total of six quarterly samples have been collected. The analytical results for the major ions and physical parameters are summarized in **Table 6.1-33**, showing the minimum and maximum values. The results for N-1 and N-2 are similar, with the majority of the results for the dissolved metals at or below the RL. The surface water laboratory records are presented in **Appendix W-1** of the MEA Technical Report.

Future sampling at N-1and the relocated N-2 will be conducted for a 12-month period beginning in September, 2013. Preoperational monthly sampling and analysis will be conducted for suspended and dissolved natural uranium, radium-226, and thorium-230, with semi-annual sampling for suspended and dissolved lead-210 and polonium-210.

6.1.3.5 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 RG 4.14. See discussions in Section 6.1.2.4 for details regarding the reporting of lower limits of detection for surface water analyses.

6.1.4 **Baseline Vegetation, Food, and Fish Monitoring**

Reference is made in this section to “milling” or “mill site” as it applies to RG 4.14. The terms “milling” or “mill site” typically refer to a primary recovery method or facility used to extract uranium from mined operations (e.g., conventional milling). ISR facilities perform uranium “milling” under an expanded NRC definition of by-product material that includes discrete surface wastes resulting from uranium solution extraction processes. Therefore, references to “milling” or “mill site” in this section can be extrapolated to uranium ISR operations.

6.1.4.1 Vegetation

RG 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.

Vegetation will be sampled as described in Section 6.2.1.5, **Table 6.1-41 and Figure 6.1-1** following guidance in RG 4.14. Using the recently acquired meteorological data and completed MILDOS calculations, vegetation samples will be collected in grazing areas located downwind of the Marsland satellite facility in sectors having the highest predicted air particulate concentrations during operations. A minimum of three samples will be collected three times during the grazing season and analyzed for natural uranium, radium-226, thorium-230, lead-210, and polonium-210.

6.1.4.2 Food

- Crops

RG 4.14 recommends that crops raised within ~1.86 miles (3 km) of the mill site be sampled at the time of harvest. 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.

Cameco is proposing an alternative approach to estimating baseline radionuclide concentrations in vegetables because the quantity of vegetables required to meet LLDs is very large, and in many instances will decimate the homeowner's crop. The proposal relies heavily on the approach developed by Powertech for use at the Dewey Burdock site (ML11208B714).

Cameco will sample the soil in the vegetable garden rather than the vegetables and will estimate the radionuclide concentrations using Equation 1, Section 5 (Equation 5.5) of NUREG-5512 to calculate the vegetable concentration factors (**Table 6.1-36**).

A schedule for remaining baseline sampling is provided on **Figure 6.1-1**.

- Livestock

RG 4.14 recommends that livestock raised within ~1.86 miles (3 km) of the mill site be sampled at the time of slaughter. Grab samples should be analyzed for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. Cattle are the livestock present in the area. Samples will be collected from three locally fed cattle.

CBR will survey the area for the presence of livestock, and when found, will seek approval from the owner(s) to collect tissue samples at the time of slaughter. Samples for crops and livestock will be obtained at the time of harvest or slaughter.

Samples will be analyzed for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. A schedule for remaining baseline sampling is provided on **Figure 6.1-1**.

6.1.4.3 Fish

RG 4.14 requires that fish be collected, if available, from lakes and 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, sampled, and analyzed semiannually for natural uranium, radium-226, thorium-230, lead-210, and polonium-210. There are no streams or water impoundments located within the MEA license boundary. There are only two dry drainages that cross the license area. Therefore, fish sampling within the MEA license boundary is not feasible.

The nearest permanent stream is the Niobrara River located just to the south of MEA license boundary which flows into Box Butte Reservoir. Given the large sample size required to attain LLDs (14 pounds) and the limited fish population present in the stream, the fish sampling focused on northern pike in the inlet of Box Butte Reservoir. Box Butte Reservoir is overpopulated with northern pike and allows a larger bag limit than elsewhere in Nebraska. As the most prevalent species, a popular gamefish, and known human food source, sampling the meat of the northern pike is the only feasible approach to assessing potential dietary contribution to humans. Collection of fish tissue at N-1 and N-2 is not feasible due to the small fish population (insufficient fish biomass) and the lack of a required population of northern pike. Attempting to collect the required amount of fish tissue needed for the analytical laboratory to obtain the required LLD would decimate the limited fish population.

Tissue samples were collected from northern pike on August 22, 2011 and May 25, 2012 and analyzed for lead-210, polonium-210, radium-226, thorium-230, uranium, and uranium activity (**Table 6.1-37**). The analytical results were considered low. The sampling results are reported on a wet weight basis (as received). Sampling results for lead-210 were classified as "U" or undetected at minimum detectable concentration (<1.0E-06 and 7.9E-07 microCuries per kilogram [μCi/kg], respectively). One analytical result for polonium-210 was at the reporting limit of 5.0E-07 μCi/kg, with the other value not detected at the RL of 2.8E-07 μCi/kg. For radium-226, the sampling results were at or below the RLs of 2.0E-07 and 2.2E-07 μCi/kg. The thorium-230 concentration was 1.0E-5 μCi/kg versus the RL of 8.0E-06 μCi/kg for one sampling event, and was not detected at the RL of 6.7E-08 μCi/kg for the other sampling event. The uranium and uranium activity values were below the RLs of <0.0003 mg/kg and <2E-07 μCi/kg, respectively, for one sampling event, while for the other sampling event, levels of 0.00099 μCi/kg and 6.7E-07 μCi/kg were reported, respectively.

Additional fish sampling will be performed in Box Butte Reservoir in 2014 to provide data that meets the LLDs required in RG 4.14. The schedule for additional baseline sampling is provide in **Figure 6.1-1**.

As of May 2010, the Nebraska Department of Human and Health Services (NDHHS) with the NDEQ, the NGPC, and the Nebraska Department of Agriculture (NDA), have issued fish consumption advisories for warning to limit the consumption of northern pike in Box Butte Reservoir due to elevated mercury concentrations (NDEQ 2011a). This advisory remains in effect in 2013.

Due to the lack of background data from the study area with which to compare the current findings, radionuclide data interpretation is impracticable at this time, other than that the concentrations are considered low. The radiological results will serve as background information for future sampling events and the development of long-term trends.

6.1.4.4 Quality of Vegetation, Food, and Fish (wet) Measurements

As noted above, CBR proposes to use an alternative approach to estimate baseline radionuclide concentrations in food crops. CBR will estimate wet-weight vegetable concentrations from dry-weight soil concentrations and will use the MDC/LLDs provided in RG 4.14 for dry soil and sediment. Specifically: 2 10^{-7} µCi/g for uranium-natural, thorium-230, radium-226 and lead-210

RG 4.14 does not provide an LLD for polonium-210 in dry soil. CBR will work with laboratories to justify an appropriate LLD when the data is submitted to NRC. A schedule for remaining baseline sampling is provide on **Figure 6.1-1**.

The private laboratory employed by CBR (ELI), reported the lower limits of detection for fish tissue sample analyses as MDC/LLD values. ELI stated in a letter dated April 23, 2012 (ELI 2012, **Appendix Q**) that the reported MDC/LLD values for the MEA samples were in compliance with RG 4.14, Section 5 "LLD". The LLD levels specified in RG 4.14 will be met for future fish and vegetation sample analyses.

Radionuclide	**MDC/LLD for Fish Tissue (wet)**	
	µCi/kg	**pCi/g**
Natural Uranium	2 x 10^{-7}	200
Thorium-230	2 x 10^{-7}	200
Radium-226	5 x 10^{-8}	50
Polonium-210	1 x 10^{-6}	1000
Lead-210	1 x 10^{-6}	1000

Source: ELI 2012 (Appendix Q)

Note: For analytes reported in two significant figures. MDC/LLD values rounded off to only one significant figure (e.g., 1.3 pCi/g = 1 pCi/g).

ELI met the criteria of the guidance suggested by the NRC when reasonably achievable by available conventional laboratory methodology. If for some reason the MDC/LLD was not met on the original analysis, the samples were recounted or re-analyzed until RG 4.14 MDC/LLDs were achieved. See **Appendix Q** for additional discussions by ELI of MDC/LLD reporting.

MDC levels for surface and groundwater radiological analytes are presented in the respective data tables of this document.

MDC levels for fish tissue radiological analytes are presented in **Table 6.1-37.**

6.1.5 Baseline Soil Monitoring

RG 4.14 recommends that soil samples be collected as follows:

- Up to 40 surface soil samples would be collected at 300-meter intervals to a distance of 1,500 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 radium-226, and 10 percent 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 at distances of 750 meters in each of four directions. Subsurface soil samples would be collected to a depth of 1 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 radium-226, and one set of the samples would be analyzed for natural uranium, thorium-230, and lead-210.

Soil samples will be collected at 300-meter intervals to a distance of 1,500 meters in each of eight directions from the center point of the satellite facility. In addition, transects will be made through the center area of each proposed mine unit to collect samples at 300-meter intervals. Sampling distances for some sampling points on transects from the center point of the satellite facility and through the mine units may be modified to obtain a more representative sampling of the project area (e.g., proposed wellfield layouts).

Surface soil samples to a depth of 5 cm will be collected at 300-meter intervals to a distance of 1,500 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 percent of the samples for natural uranium, thorium-230, and lead-210. Surface soil 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. Subsurface samples will be analyzed once prior to construction and repeated for any locations disturbed by construction.

In this application, Cameco requests a soil sampling program different from that specified in NUREG-1569, Standard Review Plan for In situ Leach Uranium Extraction License Applications. Specifically, Cameco proposes taking soil samples at both a 5 cm and 15 cm depth as recommended by NUREG-1569, Acceptance Criteria 2.9.3 (2) for background decommissioning, with the exception of samples taken at the air monitoring stations. In a public meeting (ML 12255A258), NRC stated that, in light of the EPA's technical basis for its radium-226 soil cleanup standard (refer to EPA 520/4-82-013-2, Final Environmental Impact Statement for remedial Action Standards for Inactive Uranium Processing Sites [40 CFR 192], Volume II, October 1982, pages D-51, 52), where EPA found no difference in health protection between averaging contamination throughout the top 5 cm of soil versus the top 15 cm of soil, it is not necessary to sample to 15 cm at the air monitoring stations. That rationale is applicable here.

For background samples (excluding the air monitoring stations), 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 four directions. 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 1 meter. Samples would be divided into three equal sections for analysis. All subsurface samples would be analyzed for radium-226 and one set of samples for natural uranium, thorium-230, and lead-210.

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

6.1.5.1 Quality of Soil Measurements

The accuracy of monitoring data is critical to ensure that the soil monitoring program precisely reflects radionuclide concentrations. RG 4.14 specifies the following LLDs:

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

The LLD levels specified by RG 4.14 will be met for future soil sample analyses.

6.1.6 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.

RG 4.14 recommends that sediment samples be collected from sediments of surface water passing through the project site or off-site surface waters that may be subject to drainage from potentially contaminated areas. The PPMP and operational monitoring plan will be designed to meet the criteria outlined in RG 4.14 (NRC 1980). Samples are to be collected once following spring runoff and in late summer following a period of extended low flow.

Niobrara River Sediments

Sediment sampling in RG 4.14 requires samples from each large on-site body of water or off-site surface waters that may be subject to direct surface drainage from potentially contaminated areas that could be affected by a tailings impoundment failure. There are no on-site surface impoundments; therefore, such sampling is not required. Sediment samples will be collected from the Niobrara River, which could receive surface water runoff by means of ephemeral drainages located on the MEA project site (**Figure 3.4-4**). Sediments of the Niobrara River were sampled at designated upstream and downstream sampling locations (sample points N-1 and N-2) (**Figure 3.4-4**). Water samples are also collected at these sampling points. The downstream sampling point is located to assess potential impacts from either of the two ephemeral drainages that drain the MEA.

Niobrara River sediment samples at N-1 and N-2 sampling points were collected on March 20, 2013. The radiological sample analytical results for lead-210, radium-226, thorium-230, and natural uranium are shown in **Table 6.1-38**. The analytical results for lead-210, radium-226, thorium-230, and uranium were the same for each parameter for both sampling sites, with all but radium-226 being at or near the reporting limits. (i.e., lead-210 at 0.3 pCi/g – dry weight [RL 0.2 pCi/g – dry weight], radium-226 at 0.4 pCi/g – dry weight [RL 0.04 mg/kg – dry weight], thorium-230 at 0.2 pCi/g – dry weight [RL 0.2 pCi/g – dry weight], and uranium at 0.4 mg/kg – dry weight [RL 0.3 mg/kg – dry weight] and 0.3 pCi/g – dry weight [RL 0.2 pCi/g – dry weight]).

As discussed in Section 6.1.3.4, the N-2 sampling point was moved upstream closer to the MEA project site after the completion of the sampling described above. N-1 and the relocated N-2 will be sampled twice more before construction begins. Sampling is scheduled for the fall of 2013 and the spring of 2014. The samples will be analyzed for natural uranium, radium-226, and thorium-230 and lead-210.

Ephemeral Drainages

Two major ephemeral drainages traverse across the MEA license area north-to-south (**Figure 3.4-4).** Six upgradient and downgradient sampling points have been selected on these drainages to measure radiological concentrations in the sediment (MED-1 through MED-6).

The ephemeral drainages and the Niobrara River at designated sampling points will be sampled twice, once following spring runoff and in late summer following period of extended low flow. Samples will be analyzed for natural uranium, radium-226, thorium-230, and lead-210.

Ephemeral drainage sediment sampling at Marsland was conducted in the fourth quarter of 2011 and the first quarter of 2013. The proposed PPMP and operational monitoring program is shown in **Tables 6.1-41 and Figure 6.1-42**.

The 2012 and 2013 radionuclide measurements are shown in **Table 6.1-39**. A summary of the analytical results is as follows:

Analyte	Units	Minimum	Maximum	Reporting Limit
Lead-210	pCi/g-dry	<0.2	1.5	0.2
Radium-226	pCi/g-dry	0.2	0.8	0.02 to 0.04
Thorium-230	pCi/g-dry	< 0.2	0.5	0.2
Uranium Activity	pCi/g-dry	<0.2	0.7	0.2
Uranium (metal)	mg/kg-dry	<0.3	1.0	0.3

Sediment samples were collected in accordance with the SHEQMS Volume VI Environmental Manual (CBR 2010). The analytical data sheets and the QA/QC summary reports for the Niobrara River (N-1 and N-2) and ephemeral drainages sediment samples are provided in **Appendix W-2** of the MEA Technical Report.

6.1.6.1 Quality of Sediment Measurements

The accuracy of monitoring data is critical to ensure that the sediment monitoring program precisely reflects radionuclide concentrations.

The private laboratory employed by CBR (ELI) reported the lower limits of detection for sediment sample analyses as MDC/LLD values. ELI stated in a letter dated April 23, 2012 (ELI 2012, **Appendix Q**) that the reported MDC/LLD values for the MEA samples were in compliance with RG 4.14, Section 5 “LLD”.

Radionuclide	MDC/LLD for Sediment (dry)	
	µCi/g	**pCi/g**
Natural Uranium	2 x 10^{-7}	0.2
Thorium-230	2 x 10^{-7}	0.2
Radium-226	2 x 10^{-7}	0.2
Polonium-210	No guidance	No guidance
Lead-210	2 x 10^{-7}	0.2

Source: ELI 2012 (Appendix Q)

Note: For analytes reported in two significant figures. MDC/LLD values rounded off to only one significant figure (e.g., 1.3 pCi/g = 1 pCi/g).

ELI met the criteria of the guidance suggested by the NRC when reasonably achievable by available conventional laboratory methodology. If for some reason the MDC/LLD was not met on the original analysis, the samples were recounted or re-analyzed until RG 4.14 MDC/LLDs were achieved. See **Appendix Q** for additional discussions by ELI of MDC/LLD reporting.

MDC levels for surface and groundwater radiological analytes are presented in the respective data tables of this document as well as in the individual Analytical Summary Reports of **Appendix J**.

6.1.7 Baseline Direct Radiation Monitoring

6.1.7.1 Survey Intervals

RG 4.14 recommends that direct radiation measurements be collected at 150-meter intervals to a distance of 4,921.26 feet (1,500 meters) in each of eight directions from the center point of the milling area or at a point equidistant from the milling area and tailings disposal area. The direct gamma radiation sampling at MEA will be designed to meet or exceed this guidance. Because there is no milling or tailings disposal area, CBR will use the satellite facility as the centerpoint.

A baseline sampling plan with details on where and how direct radiation monitoring will occur will be submitted for NRC review in December 2013. Following resolution of any issues, the application will be revised to highlight the elements of that plan. Sampling will be conducted in late spring or early summer of 2014, prior to construction..

6.1.7.2 .Survey Measurements at Air Particulate Monitoring Stations

The PPMP includes routine monitoring of direct radiation levels at the air monitoring stations.

Monitoring has been conducted by placing the OSLDs provided by Landauer, Inc. quarterly at the air particulate monitoring sites (**Figure 6.1-2**). The monitors were located approximately 1 meter above ground level. They were exchanged with new monitors quarterly, 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 PPMP and operational monitoring plan has been designed to meet the criteria outlined in RG 4.14 (NRC 1980). As with air particulate and radon-220 monitoring, gamma monitoring began in the fourth quarter of 2011 and was completed in the fourth quarter of 2012 (five quarters of data). The PPMP and operational monitoring program are shown in **Tables 6.1-41 and 6.1-42**.

The results of gamma measurements conducted at the air particulate monitoring stations (MAR-1 through MAR-5) for the fourth quarter of 2011 through the fourth quarter of 2012 are presented in **Table 6.1-40**. The gross and net measurements for all sampling locations over the entire sampling period ranged from 19.9 to 40.9 (average of 33.3 and 4.5 to 14.5 (average of 8.0) mRems ambient dose equivalent, respectively. The range of the gross and net measurements for MAR-1 through MAR-4 was 19.9 through 40.9 (average of 33.8) and 4.6 to 14.5 (average of 8.5) mRems ambient dose equivalent, respectively, compared to MAR-5, with a range of 20.9 through 38.1 (average of 31.8) and 4.5 to 7.7 (average of 6.2) mRems ambient dose equivalent, respectively.

The average background gamma level in the Western Great Plains have been reported to be 0.014 milli-Roentgens per hour (mR/hr) (NRC 1979).

NRC RG 4.14 guidance recommends a combination of direct gamma radiation measurements and exposure measurements made with integrating devices (i.e., OSLDs) during the PPMP. 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 RG 4.14, CBR will perform preoperational/preconstruction gamma radiation measurements at 150-meter intervals as discussed above. Note that some alternate sampling locations may be employed as discussed in Section 6.1.5. These measurements will be made once prior to construction and will be repeated for areas 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.

6.1.8 Preoperational Baseline Monitoring Program Summary

The MEA PPMP discussed in this section is summarized in **Table 6.1-41**, and the remaining monitoring tasks and completion timelines are presented on **Figure 6.1-1.**

6.2 Operational Environmental Monitoring Program

The operational baseline monitoring program is presented in **Table 6.1-42**.

6.2.1 Airborne Effluent and Environmental Monitoring Program

6.2.1.1 Air Particulate Monitoring

Composite airborne particulate samples for natural uranium, radium-226, lead-210, and thorium-230 will be obtained quarterly from air monitoring locations MAR-1 through MAR-5. The quality of sample collection and analysis shall be maintained by adhering to QC procedures discussed in Section 6.2.4 and LLC concentration limits discussed in Section 6.1.1.4.

The air particulate samplers described in Section 6.1.1 will continue to be used for the operational monitoring program.

6.2.1.2 Radon

The radon gas effluent released to the environment from satellite facility will be monitored at the same air monitoring locations (MAR-1 through MAR-5) used for baseline determination of radon concentrations as described in Section 6.1.1. Sampling locations are shown on **Figure 6.1-2**.

Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged semiannually to achieve the required LLD. SHEQMS Volume IV, Health Physics Manual currently provides the instructions for environmental radon gas monitoring. In addition to the manufacturer's QA program, CBR will expose one duplicate radon Track Etch cup per monitoring period. The quality of sample collection and analysis shall be maintained by adhering to QC procedures discussed in Section 6.2.4 and LLC concentration limits discussed in Section 6.1.1.4.

Monitoring of radon gas releases from the satellite facility building and ventilation discharge points is not deemed to be practicable. Section 3.3 of RG 8.37 indicates that, where monitoring effluent points is not practicable, an estimate can be made of the magnitude of these releases, with such estimated releases used in demonstrating compliance with the annual dose limit. In 10 CFR 20.1302, allowance is made for demonstrating by measurement or calculation that the TEDE to the individual likely to receive the highest dose from licensed operations does not exceed the annual dose limit of 100 mRem.

The satellite facility would use pressurized downflow IX columns, which do not routinely release radon gas except during resin transfer and column backwashing. The design and operation of these systems result in the majority of the radon in the production fluid staying in solution and not being released from the columns. Radon may be released from occasional venting of process vessels and tanks, small leaks in IX equipment, and maintenance of equipment. Therefore, releases via the vent stacks would not have a consistent concentration of radon or flowrate, making it impracticable to try to use such data for public exposure estimates.

CBR has used MILDOS-AREA to model the dose from facility operations resulting from releases of radon gas (Savignac 2013). MILDOS-AREA outputs are presented in **Appendix M** and discussed in Section 4.12.2.3. In determining the source term for MILDOS-AREA for the satellite facility, radon gas release was estimated at 25 percent of the radon-222 in the production fluid from the wellfields and an additional 10 percent in the IX circuit in the satellite building. The release of radon-222 at this concentration did not result in a significant public dose.

Environmental monitoring and estimated release of radon from process operations will be reported in the semi-annual reports required by 10 CFR § 40.65 and License SUA-1534 License Condition Number 12.1.

6.2.1.3 Surface Soil

Surface soil will be sampled as described in Section 6.1.5. Surface soil samples will be taken annually at the monitoring locations (MAR-1 through MAR-5) during operations. Following conclusion of operations, samples will be collected and compared to the results of the PPMP. Samples shall be analyzed for natural uranium, radium-226, thorium-230, and lead-210.

Surface soil will also be sampled at the satellite plant location as described in Section 6.1.5. Surface soil samples will be taken following conclusion of operations and compared to the results of the PPMP. The quality of sample collection and analysis shall be maintained by adhering to QC procedures and LLC concentration limits discussed in Section 6.1.5.

6.2.1.4 Subsurface Soil

Subsurface soil will be sampled at the facility location as described in Section 6.1.5. Subsurface soil samples will be taken following conclusion of operations and compared to the results of the PPMP. The quality of samples shall be maintained by following QC procedures discussed in Section 6.2.4 and adhering to the LLC concentration limits discussed in Section 6.1.5.1.

6.2.1.5 Vegetation

Operational Environmental Monitoring Approach

At the existing Crow Butte Operation, Cameco provided long-term data and demonstrated to the NRC that annual vegetation sampling and surface soil sampling at the air monitor locations was not required because increases in concentrations above baseline levels were not occurring.

In light of that experience, Cameco is proposing to employ surrogate media sampling (soil and sediment, addressed above) to identify increasing concentration trends that may require additional dose evaluation and sampling. Given the pathway dynamics, increasing detectable concentrations in the soil and sediment media will occur earlier and to a larger extent than the more attenuated levels present in the contact media (forage, food crops, livestock, and fish).

Vegetation (Forage)

At Marsland, the wind transport/deposition mechanism for contaminants ends up either in the surface soil, surface water, or as folial deposition on forage. Forage may then uptake contaminates in surface soil and shallow subsurface soil. As an alternate approach to operational vegetation (forage) sampling at Marsland, Cameco proposes to use soil samples taken annually from gardens in the AOR as surrogates to identify uptake trends in foliage radionuclide concentrations. If increasing concentrations are noted, Cameco will further evaluate the dose implications and if appropriate propose additional forage sampling for NRC written verification.

Surface water flows at Marsland are not suitable for ongoing monitoring given the highly sporadic nature of flows in the otherwise dry drainages. Sediment is the best media surrogate to track wind transport and dispersion of contaminants in lieu of operational surface water sampling. Cameco proposes to use the annual sediment as surrogates to identify potential uptake trends in foliage radionuclide concentrations. If increasing concentrations are noted, Cameco will further evaluate the dose implications and, if appropriate, will propose additional forage sampling for NRC written verification.

Folial deposition is periodic in nature and occurs only for a portion of each year; any deposited contaminants are either grazed or harvested each year. In contrast, surface soil samples collected yearly accumulate deposited contamination and increase the likelihood that rising trends will be detected.

As an alternate approach at Marsland, Cameco proposes to use the annual surface soil samples collected at the air monitoring locations as surrogates to identify trends in airborne deposition of radionuclides. If increasing concentrations are noted, Cameco will further evaluate the dose implications and, if appropriate, propose additional forage sampling to NRC for written verification.

6.2.1.6 Food, Crops, Livestock, and Fish

Food Crops (Garden Vegetables)

As an alternate approach to operational food crop sampling at Marsland, Cameco proposes to use soil samples taken annually from gardens in the AOR as surrogates to identify trends in food crop radionuclide concentrations. If increasing concentrations are noted, Cameco will further evaluate the dose implications and, if appropriate, propose additional food crop sampling to NRC for written verification.

Livestock

Similar to the above proposals, as an alternate approach for operational livestock sampling, Cameco proposes to use the approach described above for forage and crops to trigger further evaluation of the dose implications. If appropriate, Cameco will propose additional livestock sampling to NRC for written verification.

Fish

There are currently no plans to collect fish for tissue analysis of radiological constituents. Due to the arid nature of the area in which the MEA is located, the dry drainages that traverse to MEA license boundary do not support a fish population. The two major ephemeral drainages eventually connect to the Niobrara River, which is the nearest stream with permanent water. The river is located south of the license boundary, flowing west to east. The Box Butte Reservoir is located on the Niobrara River approximately 3.5 miles (5.6 km) from the southeastern corner of the MEA license boundary. The Marsland operations will not discharge any liquids to the ephemeral drainages or to any other areas of the proposed operations. Any spills that could occur would be contained per the site spill control plans, and it is highly unlikely that any liquid spills would ever reach the Niobrara River. Therefore, operational sampling of fish is not deemed to be of value.

As an alternative, Cameco proposes that, if upward trends in radionuclide concentrations are observed in sediment samples, further dose evaluation and, if appropriate, operational fish sampling will be proposed to NRC for written verification. This alternative is justified because surface water flow is absent and because contaminant releases will be significantly attenuated due to the distance to Box Butte Reservoir. Unlike the Niobrara River upstream, Box Butte Reservoir is the only location where sufficient fish mass exists to allow sampling and analysis.

6.2.1.7 Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (MAR-1 through MAR-5) during operations. Gamma radiation will be monitored using environmental dosimeters obtained from a National Voluntary Laboratory Accreditation Program (NVLAP)-certified vendor. Dosimeters will be exchanged quarterly.

6.2.1.8 Sediment

Upstream and downstream sediment samples will be collected annually at the sample locations described in Section 6.1.6 and shown on **Figure 3.4-4**. Samples will be collected as described in Section 6.1.6 and analyzed for natural uranium, radium-226, thorium-230, and lead-210. The quality of sample collection and analysis shall be maintained by adhering to QC procedures as discussed in Section 6.2.4 and LLC concentration limits discussed in Section 6.1.6.1.

6.2.2 Groundwater/Surface Water Monitoring Program

6.2.2.1 Program Description

During operations at the satellite facility, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. The CBR operational water monitoring program includes the regional evaluation of groundwater, groundwater within the permit or licensed area, and surface water on a regional and site-specific basis. The quality of sample collection and analysis shall be maintained by adhering to QC procedures discussed in Section 6.2.4 and LLC concentration limits discussed in Section 6.1.2.4. 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 water-bearing strata. Monitor wells will be placed in the basal sandstone of the Chadron Formation and in the overlying Brule Formation and Arikaree Group aquifers. All monitor wells will be completed by one of the three methods discussed in Section 1.3.2.2 and developed prior to recovery solution injection. The development process for monitor wells includes establishing baseline water quality before the initiation of mining operations. The Pierre Shale below the ore zone is approximately 1,500 feet thick and contains no water-bearing strata. Therefore, it is not necessary to monitor any water-bearing strata below the ore zone.

- Private Well Monitoring

During operations, all active, operational and accessible private wells located within the MEA license boundary and within 0.62 mile (1 km) of the MEA license boundary will be monitored quarterly (**Figures 3.4-6 and 6.1-5**). Groundwater samples are taken in accordance with the instructions contained in SHEQMS Volume VI, Environmental Manual*,* and are analyzed for natural uranium and radium-226. Water well samples will be collected and analyzed as described in Section 6.1.2.1.

- Monitor Well Baseline Water Quality

After delineation of the production unit boundaries, monitor wells are installed no farther than 300 feet from the wellfield boundary and no further than 400 feet apart or as required by the NDEQ. After completion, wells are washed out and developed (by air flushing or pumping) until 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 data. 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 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 UCLs for excursion detection. Wells are developed and sampled in accordance with the instructions contained in SHEQMS Volume VI, Environmental Manual.

Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, UCLs are set for chemical constituents that would indicate a migration of lixiviant from the well field. 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. UCLs are set at 20 percent above the maximum baseline concentration for the excursion indicator. For excursion indicators with a baseline average below 50 mg/L, the UCL may be determined by adding five standard deviations or 15 mg/L to the baseline average for the indicator.

Operational monitoring consists of sampling the monitor wells biweekly 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 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 5 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 nor third sample results exceeded the UCLs, the results from the first sample are 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 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 well field 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 1-week samples.

A sufficient number of monitoring wells will be installed in the Brule Formation between the permit boundary and the Niobrara River to monitor water quality in the event of failure of an injection well or production well, and to prevent potential communication of mining fluids with surface water. Installation of such monitoring wells is required under the Class III injection well permit. Alluvial deposits along the margins of the Niobrara River may offer limited groundwater storage depending on river levels. Beyond the MEA permit boundary, the magnitude of regional groundwater flow will not be meaningfully affected by operations at the MEA and will resume to regional flow conditions within a few hundred feet outside the permit boundary.

6.2.2.2 Surface Water Monitoring

If available, surface water samples will be collected as described in Section 6.1.3. Samples will be collected quarterly and analyzed for dissolved and suspended natural uranium, radium-226, thorium-230, lead-210, and polonium-210. Sample locations are shown on **Figure 3.4-4.** The quality of sample collection and analysis shall be maintained by adhering to QC procedures discussed in Section 6.2.4 and LLC concentration limits discussed in Section 6.1.3.5.

Surface water samples will be taken in accordance with the instructions contained in SHEQMS Volume VI, Environmental Manual. Upstream and downstream samples from all locations will be obtained quarterly. Surface water samples are analyzed for the parameters identified in Section 6.1.3. Surface monitoring results are submitted in the semi-annual environmental and effluent reports submitted to NRC.

6.2.3 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 MEA. 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), 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 O**.

6.2.4 Quality Assurance Program

A QA program is in place at Crow Butte Uranium Project for all relevant operational monitoring and analytical procedures. The objective of the program is to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program provides assurance to both regulatory agencies and the public that the monitoring results are valid.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports is provided;
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program;
- Written procedures for QA activities. These procedures include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting;
- QC for on-site analytical instrumentation and sampling. Procedures cover statistical data evaluation, instrument calibration, duplicate sample programs, and spike sample programs. Outside laboratory QA/QC programs are included; and
- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations, and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

The SHEQMS developed by CBR is a critical step to ensuring that QA objectives are met. Current procedures exist for a variety of areas, including but not limited to:

1. Environmental monitoring
2. Testing
3. Exposure
4. Equipment operation and maintenance
5. Employee health and safety
6. Incident responses

Table 6.1-1 Locations of Environmental Sampling Stations, SAT Facility and MET Station at the Marsland Expansion Area Site

Table 6.1-1 Locations of Environmental Sampling Stations, SAT Facility and MET Station at the Marsland Expansion Area Site

Environmental Sampling Station	Geographic Cartesian Coordinates (ft)		Section\Township/Range	Elevation (ft)	Locations as per RG-4.14
	Easting	Northing			
MAR-1	1119537.74	440509.22	SE Qtr of SE Qtr of Section 11, T29N, R51W	4250	Nearest Residence
MAR-2	1122400.98	434909.68	NE Qtr of NW Qtr of Section 24, T29N, R51W	4175	Site Boundary
MAR-3	1132760.45	426936.82	SE Qtr of NW Qtr of Section 29, T29N, R50W	4073	Site Boundary
MAR-4	1128689.68	426950.02	SW Qtr of NE Qtr of Section 30, T29N, R50W	4093	Site Boundary
MAR-5	1103038.51	425031.57	SE Qtr of SE Qtr of Section 29, T29N, R51W	4175	Background
Satellite Facility	1122432.30	442424.53	NE Qtr of SW Qtr of Section 12, T29N, R51W	4244	--
MET Station	1124820.50	443837.11	SE Qtr of NE Qtr of Section 12, T29N, R51W	4236	--

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area 2011 - 2012

Analyte	Result pCi/filter	Precision + pCi/filter	Result uCi/ml	Precision + uCi/ml	RL uCi/ml	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Concentration
Fourth Quarter 2011								
MA-1 [Sample Air Volume 3,850,477 liters]								
Lead 210	72.2	6.4	2E-14	2E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.3	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-26	--	1E-16	9E-14	Year	0.00
MA-2 [Sample Air Volume 3,851,229 liters]								
Lead 210	86.9	6.9	2E-14	2E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.3	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-3 [Sample Air Volume 3,852,794 liters]								
Lead 210	83.0	6.2	2E-14	2E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	0.4	0.4	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-4 [Sample Air Volume 3,853,046 liters]								
Lead 210	91.2	7.2	2E-14	2E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.3	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-5 (Sample Air Volume 3,856,136 liters]								
Lead 210	70.5	6.0	2E-14	2E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	0.4	0.4	1E-16	1E-16	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
First Quarter 2012								
MA-1 [Sample Air Volume 6,334,637 liters]								
Lead 210	115	7.5	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	1.4	--	2E-16	--	1E-16	9E-14	Year	0.22

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area 2011 - 2012

Analyte	Result pCi/filter	Precision ± pCi/filter	Result uCi/ml	Precision ± uCi/ml	RL uCi/ml	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Concentration
MA-2 [Sample Air Volume 6,337,547 liters]								
Lead 210	108	7.7	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	1.8	--	3E-16	--	1E-16	9E-14	Year	0.33
MA-3 [Sample Air Volume 6,322,001 liters]								
Lead 210	109	7.0	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	0.6	0.2	1E-16	3E-17	1E-16	9E-13	Week	0.01
Thorium 230	1.0	0.4	2E-16	6E-17	1E-16	3E-14	Year	0.67
Uranium	1.9	--	3E-16	--	1E-16	9E-14	Year	0.33
MA-4 [Sample Air Volume 6,333,500 liters]								
Lead 210	120	7.9	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	0.4	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	0.3	0.2	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	1.6	--	3E-16	--	1E-16	9E-14	Year	0.33
MA-5 (Sample Air Volume 6,338,171 liters]								
Lead 210	116	7.2	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	0.2	0.2	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	1.4	--	2E-16	--	1E-16	9E-14	Year	0.22
Second Quarter 2012								
MA-1 [Sample Air Volume 6,196,200 liters]								
Lead 210	68.9	6.1	1E-14	1E-15	2E-15	6E-13	Day	1.67
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-2 [Sample Air Volume 6,203,400 liters]								
Lead 210	82.7	5.4	1E-14	9E-16	2E-15	6E-13	Day	1.67
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area 2011 - 2012

Analyte	Result pCi/filter	Precision ± pCi/filter	Result uCi/ml	Precision ± uCi/ml	RL uCi/ml	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Concentration
MA-3 [Sample Air Volume 6,067,000 liters]								
Lead 210	75.7	5.1	1E-14	8E-16	2E-15	6E-13	Day	1.67
Radium 226	0.5	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-4 [Sample Air Volume 6,049,000 liters]								
Lead 210	78.2	5.2	1E-14	9E-16	2E-15	6E-13	Day	1.67
Radium 226	0.3	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.4	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-5 [Sample Air Volume 5,575,200 liters]								
Lead 210	62.2	4.8	1E-14	9E-16	2E-15	6E-13	Day	1.67
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
Third Quarter 2012								
MA-1 [Sample Air Volume 6,108,764 liters]								
Lead 210	116	7.0	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	0.4	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-2 [Sample Air Volume 6,002,630 liters]								
Lead 210	122	7.4	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	3.0	0.4	5E-16	7E-17	1E-16	9E-13	Week	0.06
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-3 [Sample Air Volume 6,532,003 liters]								
Lead 210	129	7.6	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	0.9	0.2	1E-16	3E-17	1E-16	9E-13	Week	0.01
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.4	--	<1E-16	--	1E-16	9E-14	Year	0.00

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area 2011 - 2012

Analyte	Result	Precision ±	Result	Precision ±	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Concentration
	pCi/filter	pCi/filter	uCi/ml	uCi/ml	uCi/ml			
MA-4 [Sample Air Volume 5,889,397 liters]								
Lead 210	103	6.3	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	0.6	0.2	1E-16	3E-17	1E-16	9E-13	Week	0.01
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.5	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-5 [Sample Air Volume 5,337,479 liters]								
Lead 210	103	6.6	2E-14	1E-15	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
Fourth Quarter 2012								
MA-1 [Sample Air Volume 6,682,410 liters]								
Lead 210	129	5.8	2E-14	9E-16	2E-15	6E-13	Day	3.33
Radium 226	0.3	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	0.4	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-2 [Sample Air Volume 6,581,476 liters]								
Lead 210	128	6.1	2E-14	9E-16	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	0.2	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-3 [Sample Air Volume 6,575,697 liters]								
Lead 210	128	5.8	2E-14	9E-16	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00
MA-4 [Sample Air Volume 6,582,882 liters]								
Lead 210	132	5.8	2E-14	9E-16	2E-15	6E-13	Day	3.33
Radium 226	0.4	0.1	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00

Table 6.1-2 Airborne Particulate Concentrations for Marsland Expansion Area 2011 - 2012

Analyte	Result pCi/filter	Precision + pCi/filter	Result uCi/ml	Precision + uCi/ml	RL uCi/ml	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Concentration
MA-5 [Sample Air Volume 6,584,474 liters]								
Lead 210	134	6.1	2E-14	9E-16	2E-15	6E-13	Day	3.33
Radium 226	<0.3	--	<1E-16	--	1E-16	9E-13	Week	0.00
Thorium 230	<0.2	--	<1E-16	--	1E-16	3E-14	Year	0.00
Uranium	<0.3	--	<1E-16	--	1E-16	9E-14	Year	0.00

RL – Reporting Limit
uCi/ml – microuries per milliliter
pCi/filter – picocuries per filter

Table 6.1-3 Ambient Atmospheric Radon-222 Concentration for Marsland Expansion Area

Table 6.1-3 Ambient Atmospheric Radon-222 Concentration for Marsland Expansion Area

Location	Date	Gross Count	Average Radon Concentration (x 10^{-9} uCi/ml)	Accuracy (x 10^{-9} uCi/ml)	Percent Effluent Concentration
MA-1	11/11/2011 – 1/04/2012	132	0.3	0.03	3.0
MA-2		136	0.3	0.03	3.0
MA-3		130	0.2	0.02	2.0
MA-4		167	0.6	0.05	6.0
MA-5		173	0.7	0.05	7.0
	Average	**148**	**0.4**	**0.04**	**4.2**
MA-1	1/04/2012 – 4/02/2012	120	0.7	0.06	7.0
MA-2		87	0.3	0.03	3.0
MA-3		47	0.07	0.01	0.7
MA-4		43	0.07	0.01	0.7
MA-5		251	1.0	0.06	10.0
	Average	**110**	**0.4**	**0.03**	**4.2**
MA-1	4/02/2012 – 6/29/2012	241	0.8	0.05	8.0
MA-2		362	1.6	0.08	16.0
MA-3		271	1.0	0.06	10.0
MA-4		244	0.9	0.06	9.0
MA-5		255	0.9	0.06	9.0
	Average	**275**	**1.0**	**0.06**	**10.0**
MA-1		76	0.2	0.02	2.0
MA-2	6/29/2012 – 10/01/2012	81	0.2	0.02	2.0
MA-3		77	0.2	0.02	2.0
MA-4		79	0.2	0.02	2.0
MA-5		70	0.1	0.01	1.0
	Average	**77**	**0.2**	**0.2**	**2.0**
MA-1	10/01/2012 – 1/02/2013	290	0.8	0.05	8.0
MA-2		256	0.6	0.04	6.0
MA-3		216	0.4	0.03	4.0
MA-4		196	0.3	0.02	3.0
MA-5		206	0.3	0.02	3.0
	Average	**233**	**0.5**	**0.03**	**5.0**

LLD (x 10^{-9} uCi/ml): 0.2
Effluent Concentration Limit, 10 CFR 20 App B Column 2: 10
Equipment: Track Etch Cup
LLD – Lower Limit of Detection
uCi/ml – microcuries per milliliter

Table 6.1-4 Summary of Water Quality for the MEA and Vicinity (2011-2013)

Table 6.1-4 Summary of Water Quality for the Marsland Expansion Area and Vicinity (2011-2013)

Constituent	Units	Private Wells in AOR[a] Arikaree Group and Brule Formations		MEA Wells[b] Brule Formation		MEA Wells[c] Basal Sandstone of Chadron Formation	
		Range	Mean	Range	Mean	Range	Mean
Calcium	mg/l	21-73	38.9	5-32	12.7	2 - 19	6.52
Magnesium[d]	mg/l	3 - 13	8.8	<1 U - 7	2.2	<1 U - 3	1.06
Sodium	mg/l	8 - 49	19.8	24-156	89.7	298 - 550	408
Potassium	mg/l	2 -13	4.2	4 - 12	9.1	8 - 41	19.5
Bicarbonate as HCO_3	mg/l	160 - 480	201.9	48 - 202	150.2	125 - 918	348
Sulfate	mg/l	3 - 44	10.2	2 - 62	37.9	45 - 396	173
Chloride	mg/l	2 - 9	3.5	2 - 63	24.6	137 - 605	270
Conductivity @ 25 °C	µmhos/cm	241 - 578	329.9	307 - 763	482	1340 - 2740	1848
Total Dissolved Solids @ 180 C	mg/l	202 - 400	250.2	200 - 537	341	778 - 1420	1086
Total Dissolved Solids Calculated	mg/l	166 - 870	270.7	241 - 567	376	770 - 1470	1096
pH	s.u.	7.64 - 8.5	8.1	8.19 - 10.00	9.03	8.25 - 10	8.87
Cations	meq/l	2.75 - 6.29	3.6	3.24 - 7.36	4.94	13.5 - 25	18.7
Anions	meq/l	2.94 - 6.71	3.7	3.1 - 7.44	4.99	13.6 - 24.6	17.9
Uranium, Suspended[d]	mg/l	<0.0003 U - 0.001	0.00021	<0.0003 U - 0.0017	0.00025	<0.0003 U - 0.0843	0.00246
Uranium, Dissolved[d]	mg/l	0.0028 - 0.0373	0.00745	0.002 - 0.0095	0.0052	<0.0003 U - 0.084	0.00828
Radium-226, Dissolved[d]	pCi/l	<0.1 U - 9.5	0.21	<0.10 - 0.66	0.22	<0.1 - 390	30
Radium-226, Suspended[d]	pCi/l	<0.06 U - 0.2	0.07	<0.1 U - 0.6	0.14	<0.1 - 45	1.82
Uranium Activity, Dissolved[d]	uCi/mL	3.8E-10 - 18.1	1.3349	1.3E-09 - 6.4E-09	3.8E-09	<2.0E-10 - 6.2	3.87E-10[e]
Uranium Activity, Suspended[d]	uCi/mL	<2.0E-10 - 0.4	.000151[e]	<2.0E-10 - 1.2E-09	1.59E-10	<2.0E-10 - 6.2	0.151

Notes:

[a] 57 private water supply wells (700, 702, 703, 704, 705, 706, 707, 714, 715, 716, 719, 720, 721, 722, 723, 725, 727, 728, 730, 731, 732, 733, 734, 735, 736, 737, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 750, 752, 753, 754, 755, 759, 760, 777, 788, 794, 795, 799, 802, 809, 810, 811, 815, 821, 836, 841, 845) (March 24, 2011 - March 21, 2013).

[b] 10 CBR MEA Brule monitor wells (BOW-2010-1, BOW-2010-2, BOW-2010-3, BOW-2010-4A, BOW-2010-5, BOW-2010-6, BOW-2010-7, BOW-2010-8 (March 4 - May 3, 2011).

[c] 12 CBR MEA Basal Chadron monitor wells (Monitor-1, Monitor-2, Monitor-3, Monitor-4A, Monitor-5, Monitor-6, Monitor-7, Monitor-8, Monitor-9, Monitor-10, Monitor-11, CPW-2010-1) (March 12, 2011 - August 20, 2012).

[d] Values less than detection limits reduced by one-half in order to provide a conservative estimate.

[e] All data collected during Quarter 3 2012 was recorded with a RL of 0.2, average reported using RL of 2.0E-10 to prevent bias

mg/l = milligrams/liter
meq/l = milliequivalents per liter
pCi/l = picocuries per liter

<0.0003 U = non-detect result and detection limit
µmhos/cm = micromhos per centimeter
s.u. = standard units

AOR = Area of Review
CBR = Crow Butte Resources, Inc.
MEA = Marsland Expansion Area

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		700		700		700		700		702		702		702		702		703	
Date Collected:		6/18/2012		9/17/2012		11/26/2012		3/18/2013		6/18/2012		9/17/2012		11/26/2012		3/18/2013		3/31/2011	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.8 U	0.8	1.3	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	<1 U	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.8		-		0.8		-		0.8		-		0.7		-		0.8	
Lead 210 precision (±)	pCi/L	0.5		0.4		0.5		-		0.5		-		0.4		-		0.5	
Polonium 210	pCi/L	1.7	1	<1 U	1	<1 U	1	<1.0 U	1	<0.7 U	0.7	<1 U	1	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7
Polonium 210 MDC	pCi/L	0.6		-		1		-		0.7		-		0.8		-		0.7	
Polonium 210 precision (±)	pCi/L	0.9		-		0.4		-		0.5		-		0.3		-		0.3	
Radium 226	pCi/L	<0.18 U	0.18	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.18		-		0.14		-		0.15		-		0.15		-		0.2	
Radium 226 precision (±)	pCi/L	0.07		-		0.1		-		0.1		-		0.06		-		0.08	
Thorium 230	pCi/L	<0.2 U	0.2	-		<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	-		<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.2		-		0.2		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.05		-		0.06		-		0.04		-		0.04		-		0.08	
SUSPENDED																			
Lead 210	pCi/L	<0.6 U	0.6	1.3	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	<1 U	1	<0.5 U	0.5	<1.0 U	1	<0.7 U	0.7
Lead 210 MDC	pCi/L	0.6		-	-	0.5		-		0.6		-		0.5		-		0.7	
Lead 210 precision (±)	pCi/L	0.4		-	-	0.3		-		0.4		-		0.3		-		0.4	
Polonium 210	pCi/L	0.3	0.2	<1 U	1	<0.9 U	0.9	<1.0 U	1	0.6	0.3	<1 U	1	<0.7 U	0.7	<1.0 U	1	<0.2 U	0.2
Polonium 210 MDC	pCi/L	0.2		-	-	0.9		-		0.3		-		0.7		-		0.2	
Polonium 210 precision (±)	pCi/L	0.2		-	-	0.3		-		0.4		-		0.3		-		0.1	
Radium 226	pCi/L	<0.12 U	0.12	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.1 U	0.1
Radium 226 MDC	pCi/L	0.12		-	-	0.12		-		0.13		-		0.11		-		0.1	
Radium 226 precision (±)	pCi/L	0.07		-	-	0.06		-		0.07		-		0.06		-		0.08	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-	-	0.1		-		0.1		-		0.2		-		0.1	
Thorium 230 precision (±)	pCi/L	0.04		-	-	0.04		-		0.05		-		0.07		-		0.05	
METALS, DISSOLVED																			
Uranium	mg/L	0.006	0.0003	0.0066	0.0003	0.0073	0.0003	0.0072	0.0003	0.0034	0.0003	0.0039	0.0003	0.0041	0.0003	0.0072	0.0003	0.0053	0.0003
Uranium Activity	uCi/mL	4.10E-09	2.00E-01	4.50E+00	2.00E-10	4.90E-09	2.00E-01	4.90E+00	2.00E-01	2.30E-09	2.00E-01	2.60E+00	2.00E-10	2.80E-09	2.00E-01	4.90E+00	2.00E-01	3.60E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable concentration
B- Analyete detected in the associated method blank

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		703		703		703		703		703		703		703		704		704	
Date Collected:		6/10/2011		9/22/2011		12/15/2011		6/20/2012		9/7/2012		11/27/2012		3/21/2013		6/20/2012		9/7/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<1.1 U	1.1	<0.7 U	0.7	<0.7 U	0.7	<0.8 U	0.8	1.9	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8	1.3	1
Lead 210 MDC	pCi/L	1.1		0.7		0.7		0.8		-		0.7		-		0.8		-	
Lead 210 precision (±)	pCi/L	0.6		0.4		0.4		0.5		0.6		0.4		-		0.5		0.5	
Polonium 210	pCi/L	<0.6 U	0.6	0.7	0.6	<0.5 U	0.5	<0.6 U	0.6	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.6 U	0.6	<1.0 U	1
Polonium 210 MDC	pCi/L	0.6		0.6		0.5		0.6		-		0.7		-		0.6		-	
Polonium 210 precision (±)	pCi/L	0.2		0.6		0.4		0.4		-		0.4		-		0.6		-	
Radium 226	pCi/L	0.46	0.1	<0.2 U	0.2	0.5	0.1	<0.15 U	0.15	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.17 U	0.15	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.1		0.2		0.1		0.15		-		0.2		-		0.17		-	
Radium 226 precision (±)	pCi/L	0.12		0.1		0.1		0.9		-		0.12		-		0.9		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		0.2		0.1		0.2		-		0.2		-		0.2		-	
Thorium 230 precision (±)	pCi/L	0.06		0.09		0.08		0.08		-		0.06		-		0.07		-	
SUSPENDED																			
Lead 210	pCi/L	<0.6 U	0.6	<0.6 U	0.6	<0.8 U	0.8	<0.5 U	0.5	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	<1.0 U	1
Lead 210 MDC	pCi/L	0.6		0.6		0.8		0.5		-		0.5		-		0.6		-	
Lead 210 precision (±)	pCi/L	0.4		0.3		0.5		0.3		-		0.3		-		0.4		-	
Polonium 210	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.5 U	0.5	<0.3 U	0.3	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.3 U	0.3	<1.0 U	1
Polonium 210 MDC	pCi/L	0.2		0.2		0.5		0.3		-		0.7		-		0.3		-	
Polonium 210 precision (±)	pCi/L	0.08		0.1		0.2		0.2		-		0.3		-		0.1		-	
Radium 226	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.12 U	0.12	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.12		-		0.1		-		0.12		-	
Radium 226 precision (±)	pCi/L	0.06		0.05		0.07		0.07		-		0.06		-		0.06		-	
Thorium 230	pCi/L	<0.1 U	0.1	0.3	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		-		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.08		0.2		0.06		0.06		-		0.05		-		0.06		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0048	0.0003	0.0061	0.0003	0.004	0.0003	0.0036	0.0003	0.0049	0.0003	0.0051	0.0003	0.0055	0.0003	0.0032	0.0003	0.0052	0.0003
Uranium Activity	uCi/mL	3.20E-09	2.0E-10	4.10E-09	2.0E-10	2.70E-09	2.0E-10	2.50E-09	2.00E-01	3.30E+00	2.00E-10	3.50E-09	2.00E-01	3.70E+00	2.00E-01	2.20E-09	2.00E-01	3.50E+00	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		704		704		705		705		705		705		705		705		705	
Date Collected:		11/27/2012		3/21/2013		3/24/2011		4/6/2011		4/20/2011		6/20/2012		9/19/2012		11/28/2012		3/21/2013	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.7 U	0.7	<1.3 U	1.3	<0.9 U	0.9	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Lead 210 MDC	pCi/L	0.7		-		0.7		1.3		0.9		0.9		-		0.7		-	
Lead 210 precision (±)	pCi/L	0.4		-		0.4		0.8		0.5		0.5		-		0.4		-	
Polonium 210	pCi/L	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7	<0.6 U	0.6	<0.6 U	0.6	<0.6 U	0.6	1.3	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	0.9		-		0.7		0.6		0.6		0.6		-		0.7		-	
Polonium 210 precision (±)	pCi/L	0.3		-		0.3		0.3		0.2		0.3		0.8		0.3		-	
Radium 226	pCi/L	<0.16 U	0.16	<0.2 U	0.2	0.32	0.12	<0.1 U	0.1	0.9	0.1	<0.16 U	0.16	<0.2 U	0.2	<0.18 U	0.18	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.16		-		0.12		0.1		0.1		0.16		-		0.18		-	
Radium 226 precision (±)	pCi/L	0.09		-		0.12		0.07		0.2		0.9		-		0.8		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.2		0.2		0.2		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.08		-		0.1		0.07		0.08		0.06		-		0.07		-	
SUSPENDED																			
Lead 210	pCi/L	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8	<0.9 U	0.9	<0.9 U	0.9	<0.8 U	0.8	3.8 B	1	0.9	0.6	1	1
Lead 210 MDC	pCi/L	0.5		-		0.8		0.9		0.9		0.8		-		0.6		-	
Lead 210 precision (±)	pCi/L	0.3		-		0.5		0.6		0.6		0.5		0.6 B		0.4		0.4	
Polonium 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.3 U	0.3	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	0.7		-		0.3		0.2		0.2		0.2		-		0.7		-	
Polonium 210 precision (±)	pCi/L	0.5		-		0.1		0.07		0.09		0.2		-		0.5		-	
Radium 226	pCi/L	<0.11 U	0.11	<0.2 U	0.2	0.14	0.09	<0.1 U	0.1	<0.1 U	0.1	<0.13 U	0.13	<0.2 U	0.2	0.17	0.12	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.11		-		0.09		0.1		0.1		0.13		-		0.12		-	
Radium 226 precision (±)	pCi/L	0.05		-		0.08		0.04		0.05		0.05		-		0.1		-	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 u	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		-		0.1		0.1		0.1		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.05		-		0.08		0.06		0.1		0.04		-		0.07		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0053	0.0003	0.0051	0.0003	0.0068	0.0003	0.0071	0.0003	0.0065	0.0003	0.0056	0.0003	0.0064	0.0003	0.0059	0.0003	0.0052	0.0003
Uranium Activity	uCi/mL	3.60E-09	2.00E-01	3.50E+00	2.00E-01	4.60E-09	2.0E-10	4.80E-09	2.0E-10	4.40E-09	2.0E-10	3.80E-10	2.00E-01	4.30E+00	2.00E-01	4.00E-09	2.00E-01	3.50E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		706		706		706		706		707		707		707		707		714	
Date Collected:		6/20/2012		9/7/2012		11/28/2012		3/20/2013		6/19/2012		9/7/2012		11/28/2012		3/21/2013		6/21/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8	1.2	1	<0.7 U	0.7	1.1	1	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.9		-		0.7		-		0.8		-		0.7		-		0.9	
Lead 210 precision (±)	pCi/L	0.5		-		0.4		-		0.5		0.5		0.4		0.4		0.5	
Polonium 210	pCi/L	<1.0 U	1	1.2	1	<0.8 U	0.8	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	pCi/L	1		-		0.8		-		0.3		-		0.7		-		1	
Polonium 210 precision (±)	pCi/L	0.7		0.8		0.4		-		0.2		-		0.3		-		0.8	
Radium 226	pCi/L	<0.16 U	0.16	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.17 U	0.17
Radium 226 MDC	pCi/L	0.16		-		0.16		-		0.16		-		0.14		-		0.17	
Radium 226 precision (±)	pCi/L	0.1		-		0.8		-		0.09		-		0.09		-		0.1	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.09 U	0.09	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.1		-		0.2		-		0.09		-		0.2	
Thorium 230 precision (±)	pCi/L	0.1		-		0.03		-		0.06		-		0.06		-		0.05	
SUSPENDED																			
Lead 210	pCi/L	<0.5 U	0.5	<1.0 U	1	0.6	0.6	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	0.7	0.6	1.1	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	0.5		-		0.6		-		0.8		-		0.6		-		0.6	
Lead 210 precision (±)	pCi/L	0.3		-		0.4		-		0.5		-		0.4		0.4		0.4	
Polonium 210	pCi/L	<0.2 U	0.2	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.3 U	0.3
Polonium 210 MDC	pCi/L	0.2		-		0.5		-		0.3		-		0.7		-		0.3	
Polonium 210 precision (±)	pCi/L	0.1		-		0.4		-		0.2		-		0.5		-		0.1	
Radium 226	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	0.1		-		0.12		-		0.12		-		0.12		-		0.13	
Radium 226 precision (±)	pCi/L	0.05		-		0.7		-		0.05		-		0.7		-		0.06	
Thorium 230	pCi/L	<0.09 U	0.09	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.09		-		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.04		-		0.05		-		0.06		-		0.06		-		0.09	
METALS, DISSOLVED																			
Uranium	mg/L	0.0038	0.0003	0.0056	0.0003	0.0059	0.0003	0.0058	0.0003	0.0036	0.0003	0.005	0.0003	0.0048	0.0003	0.0052	0.0003	0.0086	0.0003
Uranium Activity	uCi/mL	2.50E-09	2.00E-01	3.50E+00	2.00E-01	4.00E-09	2.00E-01	3.90E+00	2.00E-01	2.40E-09	2.00E-01	3.40E+00	2.00E-01	3.20E-09	2.00E-01	3.50E+00	2.00E-01	5.80E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	2.00E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		714		714		714		715		716		719		719		719		719	
Date Collected:		9/18/2012		11/28/2012		3/21/2013		6/21/2012		6/21/2012		6/21/2012		9/18/2012		11/27/2012		3/18/2013	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	1.1	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	<0.9 U	0.9	<0.9 U	0.9	1.4	1	<0.7 U	0.7	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.7		-		0.9		0.9		0.9		-		0.7		-	
Lead 210 precision (±)	pCi/L	0.5		0.4		-		0.5		0.5		0.5		0.5		0.4		-	
Polonium 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.9 U	0.9	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.8		-		1		1		0.6		-		0.9		-	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.5		0.4		0.4		-		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.17 U	0.17	<0.17 U	0.17	<0.17 U	0.17	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.16		-		0.17		0.17		0.17		-		0.17		-	
Radium 226 precision (±)	pCi/L	-		0.08		-		0.1		0.08		0.08		-		0.05		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		0.1		0.2		-		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.06		0.05		0.06		-		0.08		-	
SUSPENDED																			
Lead 210	pCi/L	1.4	1	<0.5 U	0.5	3.5	1	<0.7 U	0.7	<0.7 U	0.7	<0.7 U	0.7	1.3 B	1	<0.5 U	0.5	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.5		-		0.7		0.7		0.7		-		0.5		-	
Lead 210 precision (±)	pCi/L	0.4		0.3		0.6		0.4		0.4		0.4		0.5 B		0.3		-	
Polonium 210	pCi/L	<1.0 U	1	<0.7 U	0.7	2.9	1	<0.3 U	0.3	<0.4 U	0.4	<0.3 U	0.3	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.7		-		0.3		0.4		0.3		-		0.7		-	
Polonium 210 precision (±)	pCi/L	-		0.3		0.9		0.2		0.1		0.2		-		0.4		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13	<0.13 U	0.13	<0.11 U	0.11	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.11		-		0.13		0.13		0.11		-		0.11		-	
Radium 226 precision (±)	pCi/L	-		0.07		-		0.06		0.07		0.06		-		0.06		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.09 U	0.09	<0.1 U	0.1	<0.09	0.09	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		-		0.09		0.1		0.09		-		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.05		-		0.06		0.08		0.06		-		0.04		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0055	0.0003	0.006	0.0003	0.006	0.0003	0.0058	0.0003	0.0059	0.0003	0.0072	0.0003	0.0087	0.0003	0.0065	0.0003	0.006	0.0003
Uranium Activity	uCi/mL	3.70E+00	2.00E-01	4.10E-09	2.00E-01	4.10E+00	2.00E-01	3.90E-09	2.00E-10	4.00E-09	2.00E-10	4.90E-09	2.0E-10	5.90E+00	2.00E-01	4.40E-09	2.00E-01	4.10E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		720		720		720		720		721		721		721		721		722	
Date Collected:		6/21/2012		9/17/2012		11/27/2012		3/21/2013		6/21/2012		9/17/2012		11/27/2012		3/18/2013		6/21/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	1.3	1	<0.7 U	0.7	1	1	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.8		-		0.7		-		0.9		-		0.7		-		0.9	
Lead 210 precision (±)	pCi/L	0.5		-		0.4		-		0.5		0.4		0.4		0.4		0.5	
Polonium 210	pCi/L	1.5	0.7	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<1.7 U	1.7	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7
Polonium 210 MDC	pCi/L	0.9		-		0.7		-		1.7		-		0.9		-		0.7	
Polonium 210 precision (±)	pCi/L	0.7		-		0.4		-		1		-		0.3		-		0.3	
Radium 226	pCi/L	<0.18 U	0.18	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	1.3	0.18	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.17	0.17
Radium 226 MDC	pCi/L	0.18		-		0.14		-		0.18		-		0.15		-		0.17	
Radium 226 precision (±)	pCi/L	0.09		-		0.08		-		0.26		-		0.09		-		0.07	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.2		-		0.2		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.09		-		0.07		-		0.07		-		0.07		-		0.05	
SUSPENDED																			
Lead 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.7 U	0.7
Lead 210 MDC	pCi/L	0.8		-		0.5		-		0.7		-		0.5		-		0.7	
Lead 210 precision (±)	pCi/L	0.5		-		0.3		-		0.4		-		0.3		-		0.4	
Polonium 210	pCi/L	<0.3 U	0.3	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.4 U	0.4	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.4 U	0.4
Polonium 210 MDC	pCi/L	0.3		-		0.9		-		0.4		-		0.6		-		0.4	
Polonium 210 precision (±)	pCi/L	0.2		-		0.4		-		0.1		-		0.4		-		0.1	
Radium 226	pCi/L	<0.15 U	0.15	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	0.15		-		0.1		-		0.13		-		0.1		-		0.13	
Radium 226 precision (±)	pCi/L	0.06		-		0.06		-		0.06		-		0.06		-		0.06	
Thorium 230	pCi/L	<0.1	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.06		-		0.04		-		0.07		-		0.04		-		0.07	
METALS, DISSOLVED																			
Uranium	mg/L	0.0067	0.0003	0.0073	0.0003	0.0082	0.0003	0.0077	0.0003	0.0074	0.0003	0.0055	0.0003	0.0056	0.0003	0.0054	0.0003	0.0088	0.0003
Uranium Activity	uCi/mL	4.60E-09	2.0E-10	4.90E+00	2.00E-01	5.60E-09	2.0E-10	5.20E+00	2.00E-01	5.00E-09	2.0E-10	3.70E+00	2.00E-01	3.80E-09	2.0E-10	3.70E+00	2.00E-01	6.00E-09	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	722		722		722		723		723		723		723		723		723	
	Date Collected:	9/17/2012		11/27/2012		3/21/2013		3/31/2011		6/10/2011		9/22/2011		12/20/2011		6/19/2012		9/17/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	1.3	1	<0.7 U	0.7	1.6	1	<1.6 U	1.6	<1.2 U	1.2	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	1.5	1
Lead 210 MDC	pCi/L	-		0.7		-		1.6		1.2		0.8		1		0.8		-	
Lead 210 precision (±)	pCi/L	0.4		0.4		0.7		0.9		0.7		0.4		0.6		0.5		0.6	
Polonium 210	pCi/L	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	0.8	0.5	<0.5 U	0.5	<0.6 U	0.6	<0.9 U	0.9	<0.6 U	0.6	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.9		-		0.5		0.5		0.6		0.9		0.6		-	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.6		0.3		0.3		0.7		0.5		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	0.2	0.2	<0.2 U	0.2	<0.16	0.16	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.15		-		0.2		0.2		0.2		0.2		0.16		-	
Radium 226 precision (±)	pCi/L	-		0.09		-		0.07		0.1		0.1		0.1		0.08		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.2		0.2		0.2		0.1		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.09		0.06		0.08		0.06		0.06		-	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8	<0.6 U	0.6	<0.6 U	0.6	<0.8 U	0.8	<0.8 U	0.8	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.5		-		0.8		0.6		0.6		0.8		0.8		-	
Lead 210 precision (±)	pCi/L	-		0.3		-		0.5		0.4		0.3		0.4		0.5		-	
Polonium 210	pCi/L	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.2 U	0.2	<0.3 U	0.3	<0.1 U	0.1	<0.9 U	0.9	<0.3 U	0.3	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.6		-		0.2		0.3		0.1		0.9		0.3		-	
Polonium 210 precision (±)	pCi/L	-		0.4		-		0.09		0.2		0.07		0.4		0.1		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.12 U	0.12	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.1		-		0.2		0.1		0.1		0.1		0.12		-	
Radium 226 precision (±)	pCi/L	-		0.07		-		0.07		0.07		0.04		0.06		0.06		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	0.1	0.04	<0.2	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		0.1		0.1		0.04		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.09		0.06		0.09		0.04		0.08		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0061	0.0003	0.0086	0.0003	0.0084	0.0003	0.0078	0.0003	0.0071	0.0003	0.0073	0.0003	0.0058	0.0003	0.0056	0.0003	0.0078	0.0003
Uranium Activity	uCi/mL	4.10E+00	2.00E-01	5.80E-09	2.0E-10	5.70E+00	2.00E-01	5.30E-09	2.0E-10	4.80E-09	2.0E-10	5.00E-09	2.0E-10	3.90E-09	2.0E-10	3.80E-09	2.0E-10	5.30E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		725		725		725		725		725		725		725		725		727	
Date Collected:		3/31/2011		6/15/2011		9/29/2011		12/16/2011		6/21/2012		9/18/2012		11/29/2012		3/20/2013		3/24/2011	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.8 U	0.8	<0.8 U	0.8	<0.8 U	0.8	<0.7 U	0.7	<0.8 U	0.8	1.7	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.8		0.8		0.8		0.7		0.8		-		0.7		-		0.8	
Lead 210 precision (±)	pCi/L	0.5		0.5		0.4		0.4		0.5		0.6		0.4		-		0.5	
Polonium 210	pCi/L	<0.5 U	0.5	<0.5 U	0.5	1	0.5	<0.5 U	0.5	<0.5 U	0.5	1.2	1	<0.7 U	0.7	<1.0 U	1	<0.7 U	0.7
Polonium 210 MDC	pCi/L	0.5		0.5		0.5		0.5		0.5		-		0.7		-		0.7	
Polonium 210 precision (±)	pCi/L	0.3		0.3		0.6		0.3		0.4		0.7		0.4		-		0.3	
Radium 226	pCi/L	<0.2 U	0.2	0.3	0.09	0.3	0.1	<0.1 U	0.1	<0.16 U	0.16	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	0.33	0.12
Radium 226 MDC	pCi/L	0.2		0.09		0.1		0.1		0.16		-		0.16		-		0.12	
Radium 226 precision (±)	pCi/L	0.06		0.1		0.1		0.09		0.07		-		0.07		-		0.13	
Thorium 230	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		0.1		0.2		0.1		0.2		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.06		0.07		0.09		0.08		0.05		-		0.06		-		0.1	
SUSPENDED																			
Lead 210	pCi/L	<0.7 U	0.7	<0.6 U	0.6	<0.6 U	0.6	<0.9 U	0.9	<0.8 U	0.8	1.1 B	1	<0.6 U	0.6	1.8	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.7		0.6		0.6		0.9		0.8		-		0.6		-		0.8	
Lead 210 precision (±)	pCi/L	0.4		0.3		0.4		0.5		0.5		0.5 B		0.4		0.5		0.5	
Polonium 210	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.6 U	0.6	<0.3 U	0.3	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.3 U	0.3
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.6		0.3		-		0.6		-		0.3	
Polonium 210 precision (±)	pCi/L	0.1		0.08		0.09		0.2		0.1		-		0.3		-		0.2	
Radium 226	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.14 U	0.14	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	0.11	0.09
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.14		-		0.13		-		0.09	
Radium 226 precision (±)	pCi/L	0.06		0.05		0.03		0.05		0.07		-		0.09		-		0.08	
Thorium 230	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	0.2	0.2	<0.09 U	0.09	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		-		0.09		-		0.1	
Thorium 230 precision (±)	pCi/L	0.07		0.04		0.04		0.06		0.05		0.1		0.04		-		0.1	
METALS, DISSOLVED																			
Uranium	mg/L	0.0071	0.0003	0.0065	0.0003	0.0061	0.0003	0.0057	0.0003	0.0047	0.0003	0.006	0.0003	0.0075	0.0003	0.0059	0.0003	0.0102	0.0003
Uranium Activity	uCi/mL	4.80E-09	2.0E-10	4.40E-09	2.0E-10	4.10E-09	2.0E-10	3.80E-09	2.0E-10	3.20E-09	2.0E-10	4.10E+00	2.00E-01	5.10E-09	2.0E-10	4.00E+00	2.00E-01	6.90E-09	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	727		727		727		727		727		727		727		727		727	
	Date Collected:	4/6/2011		4/20/2011		6/15/2011		9/22/2011		12/15/2011		6/19/2012		9/18/2012		11/29/2012		3/18/2013	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7 U	0.7	<0.9 U	0.9	<0.8 U	0.8	<0.8 U	0.8	<0.7	0.7	<0.9 U	0.9	1.9	1	<0.7 U	0.7	<1.0 U	1
Lead 210 MDC	pCi/L	0.7		0.9		0.8		0.8		0.7		0.9		-		0.7		-	
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.5		0.4		0.5		0.5		0.4		-	
Polonium 210	pCi/L	<0.8 U	0.8	<0.8 U	0.8	<0.5 U	0.5	<0.5 U	0.5	<0.7	0.7	<0.7 U	0.7	1.8	1	<0.9 U	0.9	<1.0 U	1
Polonium 210 MDC	pCi/L	0.8		0.8		0.5		0.5		0.7		0.7		-		0.9		-	
Polonium 210 precision (±)	pCi/L	0.5		0.5		0.3		0.2		0.4		0.4		0.9		0.3		-	
Radium 226	pCi/L	<0.1 U	0.1	0.1	0.1	0.1	0.1	0.2	0.2	1.8	0.1	<0.15 U	0.15	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.2		0.1		0.15		-		0.16		-	
Radium 226 precision (±)	pCi/L	0.05		0.09		0.08		0.1		0.2		0.07		-		0.09		-	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<.1 U	0.1	<0.1	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		0.2		0.1		0.1		0.1		0.2		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.09		0.09		0.04		0.04		0.07		0.06		-		0.07		-	
SUSPENDED																			
Lead 210	pCi/L	<0.8 U	0.8	<0.9 U	0.9	<0.6 U	0.6	<0.6 U	0.6	<0.8	0.8	<0.8 U	0.8	1.5 B	1	0.7	0.6	1.4	1
Lead 210 MDC	pCi/L	0.8		0.9		0.6		0.6		0.8		0.8		-		0.6		-	
Lead 210 precision (±)	pCi/L	0.5		0.5		0.4		0.3		0.5		0.5		0.5 B		0.4		0.4	
Polonium 210	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.6	0.6	<0.3 U	0.3	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0..2		0.6		0.3		-		0.7		-	
Polonium 210 precision (±)	pCi/L	0.1		0.09		0.08		0.07		0.3		0.2		-		0.4		-	
Radium 226	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1	0.1	<0.12 U	0.12	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.12		-		0.12		-	
Radium 226 precision (±)	pCi/L	0.04		0.07		0.08		0.04		0.05		0.05		-		0.08		-	
Thorium 230	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1	0.1	<0.1 U	0.1	0.2	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.2		0.1		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.08		0.07		0.05		0.1		0.06		0.06		0.1		0.05		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0107	0.0003	0.0097	0.0003	0.0112	0.0003	0.0119	0.0003	0.008	0.0003	0.0089	0.0003	0.009	0.0003	0.0104	0.0003	0.0084	0.0003
Uranium Activity	uCi/mL	7.20E-09	2.0E-10	6.60E-09	2.0E-10	7.60E-09	2.0E-10	8.00E-09	2.0E-10	5.40E-09	2.0E-10	6.10E-09	2.0E-10	6.10E+00	2.00E-01	7.00E-09	2.0E-10	5.70E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0006	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	4.00E-01	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		728		728		728		728		730		730		731		731		732	
Date Collected:		6/19/2012		9/17/2012		12/5/2012		3/18/2013		6/19/2012		9/17/2012		6/20/2012		9/18/2012		6/19/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7	1.2	1	<0.8 U	0.8	1.5	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.8		-		0.7		-		0.8		-		0.8		-		0.8	
Lead 210 precision (±)	pCi/L	0.5		-		0.4		0.4		0.5		0.5		0.5		-		0.5	
Polonium 210	pCi/L	<0.6 U	0.6	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	0.5	0.5	<1.0 U	1	<0.6	0.6
Polonium 210 MDC	pCi/L	0.6		-		1		-		0.5		-		0.5		-		0.6	
Polonium 210 precision (±)	pCi/L	0.2		-		0.6		-		0.3		-		0.5		-		0.4	
Radium 226	pCi/L	<0.16 U	0.16	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.16 U	0.16
Radium 226 MDC	pCi/L	0.16		-		0.2		-		0.16		-		0.17		-		0.16	
Radium 226 precision (±)	pCi/L	0.06		-		0.1		-		0.07		-		0.12		-		0.09	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.1		-		0.1		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.05		-		0.04		-		0.05		-		0.06		-		0.07	
SUSPENDED																			
Lead 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	1.1	1	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.8		-		0.6		-		0.8		-		0.8		-		0.9	
Lead 210 precision (±)	pCi/L	0.5		-		0.4		-		0.5		-		0.5		0.5		0.5	
Polonium 210	pCi/L	<0.2 U	0.2	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.2 U	0.2
Polonium 210 MDC	pCi/L	0.2		-		0.5		-		0.3		-		0.2		-		0.2	
Polonium 210 precision (±)	pCi/L	0.07		-		0.2		-		0.1		-		0.2		-		0.1	
Radium 226	pCi/L	<0.13 U	0.13	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12
Radium 226 MDC	pCi/L	0.13		-		0.1		-		0.13		-		0.13		-		0.12	
Radium 226 precision (±)	pCi/L	0.07		-		0.05		-		0.06		-		0.05		-		0.05	
Thorium 230	pCi/L	<0.1 U	0.1	0.2	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	0.2	0.2	<0.1 U	0.1	0.2	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.2		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.04		0.1		0.07		-		0.06		0.1		0.06		0.1		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0063	0.0003	0.0066	0.0003	0.0077	0.0003	0.0067	0.0003	0.0056	0.0003	0.0079	0.0003	0.0055	0.0003	0.0073	0.0003	0.0066	0.0003
Uranium Activity	uCi/mL	4.30E-09	2.0E-10	4.50E+00	2.00E-01	5.20E-09	2.0E-10	4.50E+00	2.00E-01	3.80E-09	2.0E-10	5.40E+00	2.00E-01	3.70E-09	2.0E-10	4.90E+00	2.00E-01	4.50E-09	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		732		732		734		734		734		734		735		736		736	
Date Collected:		9/7/2012		11/28/2012		6/20/2012		9/7/2012		12/5/2012		3/21/2013		6/20/2012		6/2012		9/7/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<1.0 U	1	<0.7 U	0.7	<0.8 U	0.8	1.6	1	<0.8 U	0.8	2.5	1	<0.8 U	0.8	<0.9 U	0.9	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.7		0.8		-		0.8		-		0.8		0.9		-	
Lead 210 precision (±)	pCi/L	-		0.4		0.5		0.6		0.5		0.4		0.5		0.5		-	
Polonium 210	pCi/L	<1.0 U	1	<0.6 U	0.6	0.7	0.6	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.7 U	0.7	<0.8 U	0.8	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.6		0.6		-		1		-		0.7		0.8		-	
Polonium 210 precision (±)	pCi/L	-		0.2		0.7		-		0.7		-		0.4		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.16	0.16	<0.16 U	0.16	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.16 U	0.16	<0.19 U	0.19	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.16		0.16		-		0.17		-		0.16		0.19		-	
Radium 226 precision (±)	pCi/L	-		0.8		0.06		-		0.09		-		0.11		0.12		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		0.1		-		0.1		-		0.2		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.07		0.06		-		0.06		-		0.1		0.07		-	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	0.8	0.6	<0.8 U	0.8	1	1	0.8	0.6	<1.0 U	1	<0.8 U	0.8	<0.8 U	0.8	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.6		0.8		-		0.6		-		0.8		0.8		-	
Lead 210 precision (±)	pCi/L	-		0.4		0.5		0.4		0.4		-		0.5		0.5		-	
Polonium 210	pCi/L	<1.0 U	1	<0.9 U	0.9	<0.3 U	0.3	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.3 U	0.3	<0.4 U	0.4	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.9		0.3		-		0.5		-		0.3		0.4		-	
Polonium 210 precision (±)	pCi/L	-		0.6		0.2		-		0.4		-		0.1		0.2		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.12 U	0.12	<0.13 U	0.13	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13	<0.06 U	0.06	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.12		0.13		-		0.11		-		0.13		0.06		-	
Radium 226 precision (±)	pCi/L	-		0.07		0.06		-		0.06		-		0.05		0.03		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	0.06	0.04	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		0.1		-		0.1		-		0.1		0.04		-	
Thorium 230 precision (±)	pCi/L	-		0.05		0.08		-		0.07		-		0.04		0.03		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0075	0.0003	0.005	0.0003	0.0078	0.0003	0.0089	0.0003	0.009	0.0003	0.0069	0.0003	0.0063	0.0003	0.0081	0.0003	0.0069	0.0003
Uranium Activity	uCi/mL	5.10E+00	2.00E-01	3.40E-09	2.00E-10	5.20E-09	2.0E-10	6.00E+00	2.00E-01	6.10E-09	2.0E-10	4.70E+00	2.00E-01	4.20E-09	2.0E-10	5.50E-09	2.0E-10	4.70E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	0.001	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	6.50E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		737		737		737		739		739		739		739		740		740	
Date Collected:		6/29/2012		9/28/2012		3/21/2013		6/20/2012		9/18/2012		11/27/2012		3/21/2013		6/20/2012		9/18/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.9 U	0.9	<1.0 U	1	1.5	1	<0.8 U	0.8	1.5	1	<0.8 U	0.8	3	1	<0.8 U	0.8	1.7	1
Lead 210 MDC	pCi/L	0.9		-		-		0.8		-		0.8		-		0.8		-	
Lead 210 precision (±)	pCi/L	0.5		-		0.4		0.5		0.5		0.5		1		0.5		0.5	
Polonium 210	pCi/L	<1.0 U	1	<1.0 U	1	0.6	1	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7	1.1	1	<0.6 U	0.6	<1.0 U	1
Polonium 210 MDC	pCi/L	1		-		-		0.8		-		0.7		-		0.6		-	
Polonium 210 precision (±)	pCi/L	0.7		-		-		0.4		-		0.4		0.4		0.5		-	
Radium 226	pCi/L	<0.20 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.2		-		-		0.15		-		0.16		-		0.13		-	
Radium 226 precision (±)	pCi/L	0.11		-		-		0.11		-		0.07		-		0.09		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		-		0.2		-		0.2		-		0.2		-	
Thorium 230 precision (±)	pCi/L	0.06		-		-		0.06		-		0.06		-		0.08		-	
SUSPENDED																			
Lead 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<1.0 U	1	<0.8 U	0.8	1.2	1	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8	<1.0 U	1
Lead 210 MDC	pCi/L	0.7		-		-		0.8		-		0.5		-		0.8		-	
Lead 210 precision (±)	pCi/L	0.4		-		-		0.4		0.5		0.3		-		0.5		-	
Polonium 210	pCi/L	<0.4 U	0.4	<1.0 U	1	<1.0 U	1	<0.3 U	0.3	2.8	1	<1.0 U	1	<1.0 U	1	<0.2 U	0.2	1.2	1
Polonium 210 MDC	pCi/L	0.4		-		-		0.3		-		1		-		0.2		-	
Polonium 210 precision (±)	pCi/L	0.2		-		-		0.2		0.6		0.5		-		0.2		0.5	
Radium 226	pCi/L	<0.06 U	0.06	<0.2 U	0.2	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2
Radium 226 MDC	pCi/L	0.06		-		-		0.12		-		0.1		-		0.13		-	
Radium 226 precision (±)	pCi/L	0.03		-		-		0.05		-		0.04		-		0.06		-	
Thorium 230	pCi/L	0.05	0.04	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.04		-		-		0.1		-		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	0.03		-		-		0.05		-		0.04		-		0.06		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0086	0.0003	0.0061	0.0003	0.0059	0.0003	0.0089	0.0003	0.0097	0.0003	0.0114	0.0003	0.0102	0.0003	0.013	0.0003	0.0191	0.0003
Uranium Activity	uCi/mL	5.80E-09	2.0E-10	4.10E+00	2.00E-01	4.00E+00	2.00E-01	6.00E-09	2.0E-10	6.60E+00	2.00E-01	7.70E-09	2.0E-10	6.90E+00	2.00E-01	8.80E-09	2.0E-10	1.29E+01	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	0.001	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	6.50E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	741		741		741		741		742		742		742		742		743	
	Date Collected:	3/31/2011		6/10/2011		9/22/2011		12/15/2011		6/20/2012		9/18/2012		11/27/2012		3/21/2013		6/18/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.8 U	0.8	<1.1 U	1.1	<0.7	0.7	<0.7	0.7	<0.7 U	0.7	2.2	1	<0.8 U	0.8	1.5	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.8		1.1		0.7		0.7		0.7		-		0.8		-		0.8	
Lead 210 precision (±)	pCi/L	0.5		0.6		0.4		0.4		0.5		0.5		0.5		0.5		0.5	
Polonium 210	pCi/L	<0.5 U	0.5	<0.5 U	0.5	0.6	0.5	1.7	1.3	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	1.6	0.6
Polonium 210 MDC	pCi/L	0.5		0.5		0.5		1.3		0.8		-		0.8		-		0.6	
Polonium 210 precision (±)	pCi/L	0.4		0.3		0.5		1.5		0.3		-		0.6		-		1	
Radium 226	pCi/L	<0.2 U	0.2	0.29	0.1	2.4	0.2	0.5	0.1	<0.15 U	0.15	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	0.42	0.18
Radium 226 MDC	pCi/L	0.2		0.1		0.2		0.1		0.15		-		0.15		-		0.18	
Radium 226 precision (±)	pCi/L	0.06		0.1		0.3		0.1		0.09		-		0.1		-		0.17	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2	0.2	<0.1	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.2		0.2		0.2		0.1		0.2		-		0.2		-		0.1	
Thorium 230 precision (±)	pCi/L	0.08		0.07		0.06		0.05		0.06		-		0.05		-		0.05	
SUSPENDED																			
Lead 210	pCi/L	<0.7 U	0.7	<0.6 U	0.6	<0.6	0.6	<0.8	0.8	<0.8 U	0.8	1.5	1	<0.5 U	0.5	1.9	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	0.7		0.6		0.6		0.8		0.8		-		0.5		-		0.6	
Lead 210 precision (±)	pCi/L	0.4		0.4		0.3		0.5		0.5		0.5		0.3		0.4		0.4	
Polonium 210	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2	0.2	<0.6	0.6	<0.2 U	0.2	<1.0 U	1	<1.0 U	1	<1.0 U	1	0.7	0.3
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.6		0.2		-		1		-		0.3	
Polonium 210 precision (±)	pCi/L	0.1		0.1		0.08		0.2		0.1		-		0.4		-		0.4	
Radium 226	pCi/L	<0.1 U	0.1	<0.1 U	0.1	<0.1	0.1	<0.1	0.1	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.14 U	0.14
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.13		-		0.12		-		0.14	
Radium 226 precision (±)	pCi/L	0.06		0.05		0.03		0.08		0.05		-		0.06		-		0.05	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	0.2	0.1	<0.1	0.1	<0.1 U	0.1	0.3	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.2		0.1		0.1		0.1		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.09		0.07		0.1		0.05		0.06		0.1		0.04		-		0.05	
METALS, DISSOLVED																			
Uranium	mg/L	0.0058	0.0003	0.0081	0.0003	0.0091	0.0003	0.0057	0.0003	0.0128	0.0003	0.0116	0.0003	0.0128	0.0003	0.0095	0.0003	0.0165	0.0003
Uranium Activity	uCi/mL	3.90E-09	2.0E-10	5.50E-09	2.0E-10	6.20E-09	2.0E-10	3.90E-09	2.0E-10	8.60E-09	2.0E-10	7.90E+00	2.00E-01	8.70E-09	2.00E-10	6.40E+00	2.00E-01	1.10E-08	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		743		743		743		744		744		744		744		745		745	
Date Collected:		9/17/2012		11/26/2012		3/18/2013		6/18/2012		9/17/2012		11/26/2012		3/18/2013		3/31/2011		6/10/2011	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7	1.3	1	<0.8 U	0.8	<1.1 U	1.1
Lead 210 MDC	pCi/L	-		0.8		-		0.8		-		0.7		-		0.8		1.1	
Lead 210 precision (±)	pCi/L	-		0.5		-		0.5		-		0.4		0.4		0.5		0.7	
Polonium 210	pCi/L	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	1	0.5	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.6 U	0.6	<0.5 U	0.5
Polonium 210 MDC	pCi/L	-		0.7		-		0.5		-		0.8		-		0.6		0.5	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.6		-		0.3		-		0.4		0.4	
Radium 226	pCi/L	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	0.46	0.2	<0.2 U	0.2	0.19	0.16	<0.2 U	0.2	<0.2 U	0.2	0.4	0.2
Radium 226 MDC	pCi/L	-		0.15		-		0.2		-		0.16		-		0.2		0.2	
Radium 226 precision (±)	pCi/L	-		0.08		-		0.19		-		0.13		-		0.08		0.2	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.2		-		0.2		-		0.1		0.2	
Thorium 230 precision (±)	pCi/L	-		0.09		-		0.09		-		0.07		-		0.08		0.05	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.7 U	0.7	<0.7 U	0.7
Lead 210 MDC	pCi/L	-		0.5		-		0.6		-		0.5		-		0.7		0.7	
Lead 210 precision (±)	pCi/L	-		0.3		-		0.4		-		0.3		-		0.4		0.4	
Polonium 210	pCi/L	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	pCi/L	-		0.7		-		0.2		-		0.9		-		0.2		0.2	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.2		-		0.3		-		0.1		0.1	
Radium 226	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	pCi/L	-		0.1		-		0.15		-		0.1		-		0.1		0.1	
Radium 226 precision (±)	pCi/L	-		0.07		-		0.1		-		0.07		-		0.06		0.06	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	pCi/L	-		0.1		-		0.1		-		0.1		-		0.1		0.1	
Thorium 230 precision (±)	pCi/L	-		0.05		-		0.04		-		0.05		-		0.08		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0057	0.0003	0.0077	0.0003	0.0075	0.0003	0.0043	0.0003	0.0038	0.0003	0.0034	0.0003	0.0028	0.0003	0.0373	0.0003	0.017	0.0003
Uranium Activity	uCi/mL	3.90E+00	2.00E-01	5.20E-09	2.00E-01	5.10E+00	2.00E-01	2.90E-09	2.00E-10	2.60E+00	2.00E-01	2.30E-09	2.00E-01	1.90E+00	2.00E-01	2.50E-08	2.0E-10	1.10E-08	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		745		745		745		745		745		745		746		746		746	
Date Collected:		9/22/2011		12/15/2011		6/18/2012		9/17/2012		11/26/2012		3/18/2013		6/18/2012		9/18/2012		11/29/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7	0.7	<0.7	0.7	<0.8 U	0.8	2.8	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.7 U	0.7
Lead 210 MDC	pCi/L	0.7		0.7		0.8		-		0.7		-		0.8		-		0.7	
Lead 210 precision (±)	pCi/L	0.4		0.4		0.5		0.7		0.4		-		0.5		-		0.4	
Polonium 210	pCi/L	0.5	0.4	<1.0	1	<0.4 U	0.4	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	pCi/L	0.4		1		0.4		-		0.7		-		0.7		-		1	
Polonium 210 precision (±)	pCi/L	0.4		0.5		0.4		-		0.3		-		0.5		-		0.4	
Radium 226	pCi/L	0.4	0.2	0.4	0.1	<0.24 U	0.24	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	0.17	0.17	<0.2 U	0.2	<0.15 U	0.15
Radium 226 MDC	pCi/L	0.2		0.1		0.24		-		0.16		-		0.17		-		0.15	
Radium 226 precision (±)	pCi/L	0.1		0.1		0.15		-		0.07		-		0.12		-		0.06	
Thorium 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		0.1		0.1		-		0.2		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.06		0.05		0.05		-		0.06		-		0.08		-		0.07	
SUSPENDED																			
Lead 210	pCi/L	<0.6	0.6	<0.8	0.8	<0.7 U	0.7	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	0.6		0.8		0.7		-		0.5		-		0.6		-		0.6	
Lead 210 precision (±)	pCi/L	0.3		0.5		0.4		-		0.3		-		0.4		-		0.4	
Polonium 210	pCi/L	0.3	0.1	<0.5	0.5	0.5	0.3	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.5 U	0.5
Polonium 210 MDC	pCi/L	0.1		0.5		0.3		-		0.8		-		0.2		-		0.5	
Polonium 210 precision (±)	pCi/L	0.2		0.2		0.3		-		0.3		-		0.1		-		0.3	
Radium 226	pCi/L	0.2	0.1	<0.1	0.1	<0.17 U	0.17	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.12 U	0.12
Radium 226 MDC	pCi/L	0.1		0.1		0.17		-		0.1		-		0.16		-		0.12	
Radium 226 precision (±)	pCi/L	0.08		0.05		0.07		-		0.07		-		0.09		-		0.07	
Thorium 230	pCi/L	0.2	0.2	<0.1	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.2		0.1		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.1		0.07		0.04		-		0.05		-		0.04		-		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0349	0.0003	0.0165	0.0003	0.0072	0.0003	0.0268	0.0003	0.0282	0.0003	0.0179	0.0003	0.0114	0.0003	0.0069	0.0003	0.0075	0.0003
Uranium Activity	uCi/mL	2.40E-08	2.0E-10	1.10E-08	2.0E-10	4.80E-09	2.00E-10	1.81E+01	2.00E-01	1.90E-08	2.00E-01	1.21E+01	2.00E-01	7.80E-09	2.00E-10	4.70E+00	2.00E-01	5.10E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	2.1E-10	2.0E-10	<2.0E-10	2.0E-10	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		**746**		**747**		**747**		**747**		**747**		**747**		**747**		**747**		**748**	
Date Collected:		**3/18/2013**		**3/25/2011**		**4/8/2011**		**4/25/2011**		**6/18/2012**		**9/17/2012**		**11/26/2012**		**3/18/2013**		**6/18/2012**	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<0.8 U	0.8	<1.2 U	0.7	<0.8 U	0.8	1.6	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	-		0.8		0.8		1.2		0.8		-		0.7		-		0.8	
Lead 210 precision (±)	pCi/L	-		0.5		0.5		0.7		0.5		0.4		0.4		-		0.5	
Polonium 210	pCi/L	<1.0 U	1	<0.6 U	0.6	<0.5 U	0.5	<0.5 U	0.3	<0.4 U	0.4	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.7 U	0.7
Polonium 210 MDC	pCi/L	-		0.6		0.5		0.5		0.4		-		1		-		0.7	
Polonium 210 precision (±)	pCi/L	-		0.4		0.2		0.3		0.3		-		0.4		-		0.4	
Radium 226	pCi/L	<0.2 U	0.2	0.2	0.1	<0.1 U	0.1	0.2	0.1	0.17	0.17	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.17 U	0.17
Radium 226 MDC	pCi/L	-		0.1		0.1		0.1		0.17		-		0.14		-		0.17	
Radium 226 precision (±)	pCi/L	-		0.09		0.05		0.1		0.11		-		0.07		-		0.12	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.08	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		0.2		0.2		0.2		-		0.1		-		0.2	
Thorium 230 precision (±)	pCi/L	-		0.09		0.1		0.08		0.07		-		0.05		-		0.07	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<0.9 U	0.9	<1.2 U	0.7	<0.6 U	0.6	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	-		0.8		0.9		1.2		0.6		-		0.5		-		0.6	
Lead 210 precision (±)	pCi/L	-		0.5		0.5		0.7		0.4		-		0.3		-		0.4	
Polonium 210	pCi/L	<1.0 U	1	0.3	0.2	<0.3 U	0.3	<0.2 U	0.1	<0.3 U	0.3	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.2 U	0.2
Polonium 210 MDC	pCi/L	-		0.2		0.3		0.2		0.3		-		0.5		-		0.2	
Polonium 210 precision (±)	pCi/L	-		0.3		0.1		0.1		0.1		-		0.3		-		0.1	
Radium 226	pCi/L	<0.2 U	0.2	<0.09 U	0.09	<0.1 U	0.1	<0.1 U	0.1	<0.15 U	0.15	<0.2 U	0.2	<0.09 U	0.09	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	-		0.09		0.1		0.1		0.15		-		0.09		-		0.13	
Radium 226 precision (±)	pCi/L	-		0.06		0.05		0.04		0.06		-		0.05		-		0.09	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.08	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	-		0.1		0.1		0.1		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	-		0.09		0.07		0.08		0.07		-		0.06		-		0.05	
METALS, DISSOLVED																			
Uranium	mg/L	0.0073	0.0003	0.0101	0.0003	0.0064	0.0003	0.0059	0.0003	0.0134	0.0003	0.0078	0.0003	0.0061	0.0003	0.0047	0.0003	0.0082	0.0003
Uranium Activity	uCi/mL	4.90E+00	2.00E-01	6.80E-09	2.0E-10	4.30E-09	2.0E-10	4.00E-09	2.0E-10	9.10E-09	2.00E-10	5.30E+00	2.00E-01	4.20E-09	2.00E-10	3.20E+00	2.00E-01	5.60E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	748		748		748		750		750		750		750		752		752	
	Date Collected:	9/17/2012		11/26/2012		3/21/2013		6/18/2012		9/17/2012		11/26/2012		3/18/2013		6/21/2012		9/7/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	1.3	1	<0.7 U	0.7	<1.0 U	1	<0.7 U	0.7	2.1	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	1.5	1
Lead 210 MDC	pCi/L	-		0.7		-		0.7		-		0.7		-		0.9		-	
Lead 210 precision (±)	pCi/L	0.4		0.4		-		0.4		0.7		0.4		-		0.5		0.5	
Polonium 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.8		-		0.6		-		1		-		0.7		-	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.5		-		0.7		-		0.5		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	0.29	0.19	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.15		-		0.17		-		0.15		-		0.19		-	
Radium 226 precision (±)	pCi/L	-		0.09		-		0.08		-		0.09		-		0.16		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		-		0.2		-		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.09		-		0.07		-		0.06		-	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<0.5 U	0.5	1.9	1	<0.6 U	0.6	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.5		-		0.6		-		0.5		-		0.7		-	
Lead 210 precision (±)	pCi/L	-		0.3		0.4		0.4		-		0.3		-		0.4		-	
Polonium 210	pCi/L	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.4 U	0.3	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.8		-		0.3		-		0.9		-		0.4		-	
Polonium 210 precision (±)	pCi/L	-		0.5		-		0.1		-		0.4		-		0.1		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.11		-		0.13		-		0.11		-		0.13		-	
Radium 226 precision (±)	pCi/L	-		0.05		-		0.06		-		0.06		-		0.08		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		-		0.1		-		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.05		-		0.05		-		0.04		-		0.07		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0051	0.0003	0.0043	0.0003	0.0042	0.0003	0.0054	0.0003	0.0059	0.0003	0.0058	0.0003	0.0066	0.0003	0.0096	0.0003	0.0087	0.0003
Uranium Activity	uCi/mL	3.50E+00	2.00E-01	2.90E-09	2.00E-10	2.80E+00	2.00E-01	3.70E-09	2.00E-10	4.00E+00	2.00E-01	3.90E-09	2.00E-10	4.50E+00	2.00E-01	6.50E-09	2.00E-10	5.90E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		752		752		753		753		753		753		754		754		754	
Date Collected:		11/27/2012		3/21/2013		6/21/2012		9/7/2012		11/27/2012		3/21/2013		6/21/2012		9/7/2012		11/27/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7 U	0.7	1.3	1	<0.9 U	0.9	1.3	1	<0.7 U	0.7	1.3	1	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7
Lead 210 MDC	pCi/L	0.7		-		0.9		-		0.7		-		0.9		-		0.7	
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.4		0.4		0.4		0.5		-		0.4	
Polonium 210	pCi/L	<1.0 U	1	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.8 U	0.8
Polonium 210 MDC	pCi/L	1		-		1		-		0.8		-		0.8		-		0.8	
Polonium 210 precision (±)	pCi/L	0.6		-		0.4		-		0.4		-		0.3		-		0.4	
Radium 226	pCi/L	<0.12 U	0.15	<0.2 U	0.2	<0.19 U	0.19	<0.2 U	0.2	<0.18 U	0.18	<0.2 U	0.2	9.5	0.19	<0.2 U	0.2	<0.19 U	0.19
Radium 226 MDC	pCi/L	0.12		-		0.19		-		0.18		-		0.19		-		0.19	
Radium 226 precision (±)	pCi/L	0.09		-		0.08		-		0.09		-		0.67		-		0.1	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.2		-		0.2		-		0.1		-		0.2		-		0.1	
Thorium 230 precision (±)	pCi/L	0.08		-		0.1		-		0.04		-		0.07		-		0.06	
SUSPENDED																			
Lead 210	pCi/L	<0.6 U	0.6	<1.0 U	1	<0.7 U	0.7	1.4	1	0.6	0.6	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	0.6	0.6
Lead 210 MDC	pCi/L	0.6		-		0.7		-		0.6		-		0.7		-		0.6	
Lead 210 precision (±)	pCi/L	0.4		-		0.4		0.4		0.4		-		0.4		-		0.4	
Polonium 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.6 U	0.6
Polonium 210 MDC	pCi/L	0.8		-		0.3		-		0.6		-		0.3		-		0.6	
Polonium 210 precision (±)	pCi/L	0.3		-		0.1		-		0.3		-		0.2		-		0.2	
Radium 226	pCi/L	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	0.12		-		0.13		-		0.12		-		0.13		-		0.13	
Radium 226 precision (±)	pCi/L	0.06		-		0.07		-		0.08		-		0.07		-		0.08	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.04		-		0.07		-		0.06		-		0.07		-		0.04	
METALS, DISSOLVED																			
Uranium	mg/L	0.0084	0.0003	0.007	0.0003	0.0059	0.0003	0.0057	0.0003	0.0055	0.0003	0.0054	0.0003	0.0082	0.0003	0.0065	0.0003	0.0077	0.0003
Uranium Activity	uCi/mL	5.90E-09	2.00E-10	4.70E+00	2.00E-01	4.00E-09	2.00E-10	3.90E+00	2.00E-01	3.70E-09	2.00E-10	3.70E+00	2.00E-01	5.50E-09	2.00E-10	4.40E+00	2.00E-01	5.20E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		754		755		755		755		755		759		759		759		759	
Date Collected:		3/21/2013		6/21/2012		9/7/2012		11/28/2012		3/21/2013		3/31/2011		6/10/2011		9/22/2011		12/15/2011	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	1.8	1	<0.9 U	0.9	1.8	1	<0.7 U	0.7	1.8	1	<0.8 U	0.8	<1.1 U	1.1	<0.8 U	0.8	<0.7 U	0.7
Lead 210 MDC	pCi/L	-		0.9		-		0.7		-		0.8		1.1		0.8		0.7	
Lead 210 precision (±)	pCi/L	0.7		0.5		0.5		0.4		0.6		0.5		0.7		0.5		0.4	
Polonium 210	pCi/L	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.6 U	0.6	<0.5 U	0.5	<0.5 U	0.5	<0.6 U	0.6
Polonium 210 MDC	pCi/L	-		1		-		0.8		-		0.6		0.5		0.5		0.6	
Polonium 210 precision (±)	pCi/L	-		0.8		-		0.3		-		0.2		0.2		0.4		0.2	
Radium 226	pCi/L	<0.2 U	0.2	2.4	0.17	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	0.7	0.2	1	0.1
Radium 226 MDC	pCi/L	-		0.17		-		0.15		-		0.2		0.2		0.2		0.1	
Radium 226 precision (±)	pCi/L	-		0.32		-		0.08		-		0.07		0.1		0.2		0.2	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.2		-		0.2		0.2		0.2		0.2	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.1		-		0.09		0.07		0.08		0.07	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	0.09	0.6	<1.0 U	1	<0.7 U	0.7	<0.6 U	0.6	<0.6 U	0.6	<0.8 U	0.8
Lead 210 MDC	pCi/L	-		0.7		-		0.6		-		0.7		0.6		0.6		0.8	
Lead 210 precision (±)	pCi/L	-		0.4		-		0.4		-		0.4		0.4		0.3		0.5	
Polonium 210	pCi/L	<1.0 U	1	<0.4 U	0.4	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.5 U	0.5
Polonium 210 MDC	pCi/L	-		0.4		-		0.6		-		0.2		0.2		0.2		0.5	
Polonium 210 precision (±)	pCi/L	-		0.2		-		0.3		-		0.1		0.1		0.1		0.2	
Radium 226	pCi/L	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	pCi/L	-		0.14		-		0.12		-		0.1		0.1		0.1		0.1	
Radium 226 precision (±)	pCi/L	-		0.08		-		0.07		-		0.06		0.06		0.04		0.04	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	-		0.1		-		0.1		-		0.1		0.1		0.2		0.1	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.04		-		0.08		0.05		0.1		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0067	0.0003	0.0075	0.0003	0.0051	0.0003	0.0052	0.0003	0.0051	0.0003	0.0072	0.0003	0.0064	0.0003	0.0075	0.0003	0.0049	0.0003
Uranium Activity	uCi/mL	4.50E+00	2.00E-01	5.10E-09	2.00E-10	3.50E+00	2.00E-01	3.50E-09	2.00E-10	3.50E+00	2.00E-01	4.90E-09	2.0E-10	4.30E-09	2.0E-10	5.10E-09	2.0E-10	3.30E-09	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		760		760		777		777		777		777		788		788		788	
Date Collected:		11/28/2012		3/21/2013		6/20/2012		9/7/2012		11/27/2012		3/21/2013		3/24/2011		4/6/2011		4/20/2011	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7 U	0.7	1.2	1	<0.8 U	0.8	3	1	<0.7 U	0.7	2.2	1	<0.8 U	0.8	<0.7 U	0.7	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.7		-		0.8		-		0.7		-		0.8		0.7		0.9	
Lead 210 precision (±)	pCi/L	0.4		0.4		0.5		0.6		0.4		0.7		0.5		0.4		0.5	
Polonium 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.7 U	0.7	<0.5 U	0.5	<0.7 U	0.7
Polonium 210 MDC	pCi/L	0.8		-		0.6		-		1		-		0.7		0.5		0.7	
Polonium 210 precision (±)	pCi/L	0.3		-		0.4		-		0.4		-		0.4		0.2		0.2	
Radium 226	pCi/L	<0.16 U	0.16	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	0.67	0.11	<0.1 U	0.1	0.3	0.1
Radium 226 MDC	pCi/L	0.16		-		0.14		-		0.17		-		0.11		0.1		0.1	
Radium 226 precision (±)	pCi/L	0.09		-		0.08		-		0.08		-		0.16		0.05		0.1	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.1		-		0.2		-		0.1		-		0.1		0.2		0.2	
Thorium 230 precision (±)	pCi/L	0.07		-		0.09		-		0.06		-		0.06		0.07		0.09	
SUSPENDED																			
Lead 210	pCi/L	<0.6 U	0.6	<1.0 U	1	<0.8 U	0.8	1.5 B	1	0.7	0.6	<1.0 U	1	<0.8 U	0.8	<0.8 U	0.8	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.6		-		0.8		-		0.6		-		0.8		0.8		0.9	
Lead 210 precision (±)	pCi/L	0.4		-		0.5		0.5 B		0.4		-		0.5		0.5		0.6	
Polonium 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	pCi/L	0.7		-		0.2		-		0.8		-		0.2		0.2		0.2	
Polonium 210 precision (±)	pCi/L	0.3		-		0.1		-		0.4		-		0.2		0.08		0.2	
Radium 226	pCi/L	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.09 U	0.09	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	pCi/L	0.12		-		0.13		-		0.12		-		0.09		0.1		0.1	
Radium 226 precision (±)	pCi/L	0.08		-		0.06		-		0.05		-		0.07		0.04		0.08	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.2		-		0.1		0.1		0.1	
Thorium 230 precision (±)	pCi/L	0.05		-		0.04		-		0.09		-		0.07		0.08		0.07	
METALS, DISSOLVED																			
Uranium	mg/L	0.0069	0.0003	0.0065	0.0003	0.0113	0.0003	0.0148	0.0003	0.0136	0.0003	0.0132	0.0003	0.0072	0.0003	0.0073	0.0003	0.0071	0.0003
Uranium Activity	uCi/mL	4.70E-09	2.00E-10	4.40E+00	2.00E-01	7.70E-09	2.00E-10	1.00E+01	2.00E-01	9.20E-09	2.00E-10	8.90E+00	2.00E-01	4.80E-09	2.0E-10	4.90E-09	2.0E-10	4.80E-09	2.0E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	<2.0E-10	2,0E-10	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		788		788		788		788		794		794		794		794		795	
Date Collected:		6/22/2012		9/18/2012		12/5/2012		3/20/2013		6/19/2012		9/6/2012		12/5/2012		3/21/2013		6/19/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.9 U	0.9	1.7	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8	1.9	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.9		-		0.7		-		0.8		-		0.7		-		0.9	
Lead 210 precision (±)	pCi/L	0.5		0.6		0.4		-		0.5		0.6		0.4		-		0.5	
Polonium 210	pCi/L	<0.6 U	0.6	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.6 U	0.6
Polonium 210 MDC	pCi/L	0.6		-		0.7		-		0.5		-		0.9		-		0.6	
Polonium 210 precision (±)	pCi/L	0.5		-		0.3		-		0.3		-		0.4		-		0.3	
Radium 226	pCi/L	<0.19 U	0.19	<0.2 U	0.2	0.21	0.18	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.18 U	0.18	<0.2 U	0.2	<0.18 U	0.18
Radium 226 MDC	pCi/L	0.19		-		0.18		-		0.16		-		0.18		-		0.18	
Radium 226 precision (±)	pCi/L	0.12		-		0.14		-		0.06		-		0.11		-		0.08	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.1		-		0.2		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.08		-		0.07		-		0.07		-		0.06		-		0.08	
SUSPENDED																			
Lead 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	0.7	0.6	<1.0 U	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	0.7		-		0.6		-		0.6		-		0.6		-		0.6	
Lead 210 precision (±)	pCi/L	0.4		-		0.4		-		0.4		-		0.4		-		0.4	
Polonium 210	pCi/L	<0.4 U	0.4	<1.0 U	1	<0.4 U	0.4	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.3 U	0.3
Polonium 210 MDC	pCi/L	0.4		-		0.4		-		0.2		-		0.5		-		0.3	
Polonium 210 precision (±)	pCi/L	0.2		-		0.2		-		0.1		-		0.4		-		0.2	
Radium 226	pCi/L	<0.14 U	0.14	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	0.14		-		0.1		-		0.13		-		0.1		-		0.13	
Radium 226 precision (±)	pCi/L	0.07		-		0.06		-		0.07		-		0.05		-		0.08	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.06		-		0.06		-		0.04		-		0.06		-		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0081	0.0003	0.0069	0.0003	0.0076	0.0003	0.0062	0.0003	0.0055	0.0003	0.0063	0.0003	0.0063	0.0003	0.006	0.0003	0.005	0.0003
Uranium Activity	uCi/mL	5.50E-09	2.00E-10	4.70E+00	2.00E-01	5.10E-09	2.00E-10	4.20E+00	2.00E-01	3.80E-09	2.00E-10	4.30E+00	2.00E-01	4.30E-09	2.00E-10	4.10E+00	2.00E-01	3.40E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		795		795		795		799		799		799		799		802		802	
Date Collected:		9/6/2012		12/5/2012		3/21/2013		6/19/2012		9/18/2012		11/29/2012		3/20/2013		6/18/2012		9/18/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	1.2	1	<0.7 U	0.7	1	1	<0.8 U	0.8	1.2	1	<0.7 U	0.7	<1.0 U	1	<0.8 U	0.8	1.1	1
Lead 210 MDC	pCi/L	-		0.7		-		0.8		-		0.7		-		0.8		-	
Lead 210 precision (±)	pCi/L	0.5		0.4		0.4		0.5		0.8		0.4		-		0.5		0.5	
Polonium 210	pCi/L	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.5 U	0.5	<1.0 U	1
Polonium 210 MDC	pCi/L	-		1		-		0.5		-		0.8		-		0.5		-	
Polonium 210 precision (±)	pCi/L	-		0.4		-		0.3		-		0.3		-		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.19 U	0.19	<0.2 U	0.2	<0.18 U	0.18	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.19		-		0.18		-		0.15		-		0.17		-	
Radium 226 precision (±)	pCi/L	-		0.13		-		0.12		-		0.06		-		0.08		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		-		0.2		-		0.1		-		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.06		-		0.06		-		0.04		-		0.05		-	
SUSPENDED																			
Lead 210	pCi/L	1.1	1	0.6	0.6	<1.0 U	1	<0.8 U	0.8	1.1	1	0.6	0.6	<1.0 U	1	<0.9 U	0.9	1.1	1
Lead 210 MDC	pCi/L	-		0.6		-		0.8		-		0.6		-		0.9		-	
Lead 210 precision (±)	pCi/L	0.5		0.4		-		0.5		0.4		0.4		-		0.6		0.4	
Polonium 210	pCi/L	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.2 U	0.2	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	0.8	0.4	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.5		-		0.2		-		0.7		-		0.4		-	
Polonium 210 precision (±)	pCi/L	-		0.2		-		0.09		-		0.3		-		0.5		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.19 U	0.19	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.11		-		0.13		-		0.13		-		0.19		-	
Radium 226 precision (±)	pCi/L	-		0.08		-		0.05		-		0.07		-		0.1		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	0.2	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		-		0.1		-		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.09		-		0.06		-		0.05		-		0.06		0.1	
METALS, DISSOLVED																			
Uranium	mg/L	0.0058	0.0003	0.0062	0.0003	0.0062	0.0003	0.0063	0.0003	0.0079	0.0003	0.0086	0.0003	0.0076	0.0003	0.0045	0.0003	0.0046	0.0003
Uranium Activity	uCi/mL	3.90E+00	2.00E-01	4.20E-09	2.00E-10	4.20E+00	2.00E-01	4.30E-09	2.00E-10	5.40E+00	2.00E-01	5.90E-09	2.00E-10	5.20E+00	2.00E-01	3.00E-09	2.00E-10	3.10E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	802		802		809		809		809		809		810		810		810	
	Date Collected:	11/29/2012		3/18/2013		6/21/2012		9/18/2012		11/29/2012		3/18/2013		6/21/2012		9/18/2012		11/29/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	1.6	1	<0.7 U	0.7	1.1	1	<0.9 U	0.9	<1.0 U	1	<0.7 U	0.7
Lead 210 MDC	pCi/L	0.7		-		0.9		-		0.7		-		0.9		-		0.7	
Lead 210 precision (±)	pCi/L	0.4		-		0.5		0.5		0.4		0.4		0.5		-		0.4	
Polonium 210	pCi/L	<0.8 U	0.8	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.8 U	0.8	<1.0 U	1	<0.9 U	0.9	<1.0 U	1	<0.8 U	0.8
Polonium 210 MDC	pCi/L	0.8		-		0.9		-		0.8		-		0.9		-		0.8	
Polonium 210 precision (±)	pCi/L	0.4		-		0.6		-		0.3		-		0.6		-		0.4	
Radium 226	pCi/L	<0.17 U	0.17	<0.2 U	0.2	0.57	0.17	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	1.1	0.17	<0.2 U	0.2	<0.15 U	0.15
Radium 226 MDC	pCi/L	0.17		-		0.17		-		0.17		-		0.17		-		0.15	
Radium 226 precision (±)	pCi/L	0.1		-		0.18		-		0.07		-		0.23		-		0.05	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.2		-		0.2		-		0.1	
Thorium 230 precision (±)	pCi/L	0.07		-		0.05		-		0.07		-		0.05		-		0.07	
SUSPENDED																			
Lead 210	pCi/L	<0.6 U	0.6	<1.0 U	1	<0.7 U	0.7	1.1	1	<0.6 U	0.6	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.6 U	0.6
Lead 210 MDC	pCi/L	0.6		-		0.7		-		0.6		-		0.6		-		0.6	
Lead 210 precision (±)	pCi/L	0.4		-		0.4		0.4		0.3		-		0.4		-		0.4	
Polonium 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.3 U	0.3	2.1	1	<0.5 U	0.5
Polonium 210 MDC	pCi/L	0.7		-		0.5		-		0.6		-		0.3		-		0.5	
Polonium 210 precision (±)	pCi/L	0.3		-		0.3		-		0.2		-		0.1		0.6		0.2	
Radium 226	pCi/L	<0.13 U	0.13	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.14 U	0.14
Radium 226 MDC	pCi/L	0.13		-		0.13		-		0.12		-		0.15		-		0.14	
Radium 226 precision (±)	pCi/L	0.07		-		0.08		-		0.05		-		0.09		-		0.05	
Thorium 230	pCi/L	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	0.2	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.1		-		0.1		-		0.1	
Thorium 230 precision (±)	pCi/L	0.04		-		0.06		0.1		0.04		-		0.05		-		0.04	
METALS, DISSOLVED																			
Uranium	mg/L	0.005	0.0003	0.0043	0.0003	0.0067	0.0003	0.0083	0.0003	0.0079	0.0003	0.0072	0.0003	0.0064	0.0003	0.0053	0.0003	0.0039	0.0003
Uranium Activity	uCi/mL	3.40E-09	2.00E-10	2.90E+00	2.00E-01	4.60E-08	2.00E-10	5.60E+00	2.00E-01	5.40E-09	2.00E-10	4.90E+00	2.00E-01	4.40E-08	2.00E-10	3.60E+00	2.00E-01	2.60E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

	Location ID:	810		811		811		811		811		815		815		815		815	
	Date Collected:	3/18/2013		6/21/2012		9/18/2012		11/29/2012		3/18/2013		6/21/2012		9/18/2012		11/29/2012		3/21/2013	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	5.9	1	<0.9 U	0.9	1.5	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	2.3	1	<0.7 U	0.7	1.2	1
Lead 210 MDC	pCi/L	-		0.9		-		0.7		-		0.9		-		0.7		-	
Lead 210 precision (±)	pCi/L	0.7		0.5		0.5		0.4		-		0.5		0.05		0.4		0.4	
Polonium 210	pCi/L	4.4	1	<1.0 U	1	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<1.0 U	1	2.9	1	<0.8 U	0.8	<1.0 U	1
Polonium 210 MDC	pCi/L	-		1		-		0.7		-		1		-		0.8		-	
Polonium 210 precision (±)	pCi/L	1		0.5		-		0.3		-		0.7		1.1		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	0.95	0.17	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.17		-		0.17		-		0.17		-		0.14		-	
Radium 226 precision (±)	pCi/L	-		0.22		-		0.08		-		0.09		-		0.07		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.1	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		-		0.2		-		0.2		-		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.06		-		0.09		-		0.06		-		0.06		-	
SUSPENDED																			
Lead 210	pCi/L	<1.0 U	1	<1.0	1	1.2 B	1	<0.7 U	0.7	2.5	1	<0.7 U	0.7	<1.0 U	1	<0.6 U	0.6	<1.0 U	1
Lead 210 MDC	pCi/L	-		1		-		0.7		-		0.7		-		0.6		-	
Lead 210 precision (±)	pCi/L	-		0.6		0.4 B		0.4		0.5		0.4		-		0.4		-	
Polonium 210	pCi/L	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.6 U	0.6	1.5	1	<0.4 U	0.4	<1.0 U	1	<0.7 U	0.7	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.5		-		0.6		-		0.4		-		0.7		-	
Polonium 210 precision (±)	pCi/L	-		0.2		-		0.3		1		0.2		-		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.20 U	0.2	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.14 U	0.14	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.2		-		0.14		-		0.14		-		0.12		-	
Radium 226 precision (±)	pCi/L	-		0.08		-		0.05		-		0.08		-		0.07		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		-		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.05		-		0.06		-		0.03		-	
METALS, DISSOLVED																			
Uranium	mg/L	0.0056	0.0003	0.0077	0.0003	0.0055	0.0003	0.0071	0.0003	0.0059	0.0003	0.0058	0.0003	0.0046	0.0003	0.0055	0.0003	0.0052	0.0003
Uranium Activity	uCi/mL	3.80E+00	2.00E-01	5.20E-08	2.00E-10	3.70E+00	2.00E-01	4.80E-09	2.00E-10	4.00E+00	2.00E-01	3.90E-09	2.00E-10	3.10E+00	2.00E-01	3.70E-09	2.00E-10	3.50E+00	2.00E-01
METALS, SUSPENDED																			
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	3.00E-01	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		821		821		821		821		836		836		836		836		841	
Date Collected:		6/21/2012		9/18/2012		11/29/2012		3/21/2013		6/19/2012		9/17/2012		11/26/2012		3/20/2013		6/19/2012	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.9 U	0.9	1.4	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9	1.2	1	<0.7 U	0.7	<1.0 U	1	<0.9 U	0.9
Lead 210 MDC	pCi/L	0.9		-		0.7		-		0.9		-		0.7		-		0.9	
Lead 210 precision (±)	pCi/L	0.5		0.5		0.4		-		0.5		0.5		0.4		-		0.5	
Polonium 210	pCi/L	<1.0 U	1	1	1	<0.7 U	0.7	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<1.0 U	1	<1.0 U	1	2.8	0.6
Polonium 210 MDC	pCi/L	1		-		0.7		-		0.6		-		1		-		0.6	
Polonium 210 precision (±)	pCi/L	0.9		0.7		0.4		-		0.5		-		0.6		-		1.2	
Radium 226	pCi/L	<0.17 U	0.17	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.19 U	0.19	<0.2 U	0.2	<0.16 U	0.16	<0.2 U	0.2	<0.17 U	0.17
Radium 226 MDC	pCi/L	0.17		-		0.15		-		0.19		-		0.16		-		0.17	
Radium 226 precision (±)	pCi/L	0.08		-		0.08		-		0.11		-		0.07		-		0.12	
Thorium 230	pCi/L	<0.2 U	0.1	<0.2 U	0.2	<0.08 U	0.08	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.2		-		0.08		-		0.2		-		0.2		-		0.2	
Thorium 230 precision (±)	pCi/L	0.06		-		0.05		-		0.07		-		0.05		-		0.06	
SUSPENDED																			
Lead 210	pCi/L	<0.7 U	0.7	<1.0 U	1	<0.6 U	0.6	<1.0 U	1	<0.8 U	0.8	1.4	1	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8
Lead 210 MDC	pCi/L	0.7		-		0.6		-		0.8		-		0.5		-		0.8	
Lead 210 precision (±)	pCi/L	0.4		-		0.4		-		0.5		0.5		0.3		-		0.5	
Polonium 210	pCi/L	<0.4 U	0.4	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.2 U	0.2
Polonium 210 MDC	pCi/L	0.4		-		0.7		-		0.3		-		0.5		-		0.2	
Polonium 210 precision (±)	pCi/L	0.2		-		0.3		-		0.1		-		0.2		-		0.1	
Radium 226	pCi/L	<0.13 U	0.13	<0.2 U	0.2	<0.12 U	0.12	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13
Radium 226 MDC	pCi/L	0.13		-		0.12		-		0.13		-		0.1		-		0.13	
Radium 226 precision (±)	pCi/L	0.05		-		0.07		-		0.07		-		0.06		-		0.05	
Thorium 230	pCi/L	<0.09 U	0.09	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	0.09		-		0.1		-		0.1		-		0.1		-		0.2	
Thorium 230 precision (±)	pCi/L	0.03		-		0.04		-		0.06		-		0.04		-		0.06	
METALS, DISSOLVED																			
Uranium	mg/L	0.0057	0.0003	0.0053	0.0003	0.006	0.0003	0.0057	0.0003	0.0048	0.0003	0.0068	0.0003	0.0066	0.0003	0.0068	0.0003	0.0038	0.0003
Uranium Activity	uCi/mL	3.90E-09	2.00E-10	3.60E+00	2.00E-01	4.10E-09	2.00E-10	3.90E+00	2.00E-01	3.20E-09	2.00E-10	4.60E+00	2.00E-01	4.50E-09	2.00E-10	4.60E+00	2.00E-01	2.60E-09	2.00E-10
METALS, SUSPENDED																			
Uranium	mg/L	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003
Uranium Activity	uCi/mL	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-5 Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		841		841		841		845		845		845		845	
Date Collected:		9/17/2012		11/26/2012		3/20/2013		6/19/2012		9/17/2012		11/26/2012		3/21/2013	
Analyte	Units	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
RADIONUCLIDES-DISSOLVED															
Lead 210	pCi/L	1.6	1	<0.8 U	0.8	<1.0 U	1	<1.0 U	1	<1.0	1	<0.7 U	0.7	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.8		-		1		-		0.7		-	
Lead 210 precision (±)	pCi/L	0.6		0.5		-		0.6		-		0.4		-	
Polonium 210	pCi/L	<1.0 U	1	<1.0 U	1	<1.0 U	1	<0.7	0.7	<1.0 U	1	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	pCi/L	-		1		-		0.7		-		1		-	
Polonium 210 precision (±)	pCi/L	-		0.5		-		0.3		-		0.4		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.15 U	0.15	<0.2 U	0.2	<0.17 U	0.17	<0.2 U	0.2	<0.18 U	0.18	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.15		-		0.17		-		0.18		-	
Radium 226 precision (±)	pCi/L	-		0.06		-		0.12		-		0.08		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.2		-		0.2		-		0.2		-	
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.06		-		0.06		-	
SUSPENDED															
Lead 210	pCi/L	<1.0 U	1	<0.5 U	0.5	<1.0 U	1	<0.8 U	0.8	1.1	1	<0.5 U	0.5	<1.0 U	1
Lead 210 MDC	pCi/L	-		0.5		-		0.8		-		0.5		-	
Lead 210 precision (±)	pCi/L	-		0.3		-		0.5		0.5		0.3		-	
Polonium 210	pCi/L	<1.0 U	1	<0.7 U	0.7	<1.0 U	1	<0.3 U	0.3	<1.0 U	1	<0.6 U	0.6	<1.0 U	1
Polonium 210 MDC	pCi/L	-		0.7		-		0.3		-		0.6		-	
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.2		-		0.3		-	
Radium 226	pCi/L	<0.2 U	0.2	<0.10 U	0.1	<0.2 U	0.2	<0.13 U	0.13	<0.2 U	0.2	<0.11 U	0.11	<0.2 U	0.2
Radium 226 MDC	pCi/L	-		0.1		-		0.13		-		0.11		-	
Radium 226 precision (±)	pCi/L	-		0.06		-		0.06		-		0.06		-	
Thorium 230	pCi/L	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	pCi/L	-		0.1		-		0.1		-		0.1		-	
Thorium 230 precision (±)	pCi/L	-		0.04		-		0.06		-		0.06		-	
METALS, DISSOLVED															
Uranium	mg/L	0.0053	0.0003	0.0055	0.0003	0.0053	0.0003	0.0039	0.0003	0.0064	0.0003	0.00565	0.0003	0.0056	0.0003
Uranium Activity	uCi/mL	3.60E+00	2.00E-01	3.70E-09	2.00E-10	3.60E+00	2.00E-01	2.60E-09	2.00E-10	4.30E+00	2.00E-01	3.80E-09	2.00E-10	3.80E+00	2.00E-01
METALS, SUSPENDED															
Uranium	mg/L	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01	2.00E-10	2.0E-10	<2.0E-10	2.0E-01

Notes:
RL - Analyte reporting limit.
U - Not detected at minimum detectable conce
B- Analyete detected in the associated methoc

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		703		703		703		703		705		705		705		705		714		719	
Date Collected:		3/31/2011		6/10/2011		9/22/2011		12/15/2011		3/24/2011		4/6/2011		4/20/2011		9/19/2012		9/18/2012		9/18/2012	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																					
Alkalinity Total as CaCO3	mg/L	158	1	160	1	148	1	144	1	153	1	150	1	149	1	167	5	148	5	157	5
Bicarbonate as HCO3	mg/L	193	1	195	1	181	1	176	1	187	1	184	1	182	1	199	5	181	5	188	5
Carbonate as CO3	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<5	5	<5	5	<5	5
Chloride	mg/L	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	9	1	<1	1
Fluoride	mg/L	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1
Magnesium	mg/L	8	1	8	1	8	1	8	1	8	1	8	1	8	1	8	1	8	1	8	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	<0.1	0.1	<0.1	0.1	<0.1	0.1
Nitrogen Nitrate+Nitrite as N	mg/L	1.6	0.1	1.7	0.1	1.7	0.1	1.7	0.1	1.4	0.1	1.4	0.1	1.4	0.1	1.7	0.1	7	0.1	1.3	0.1
Potassium	mg/L	3	1	3	1	3	1	3	1	4	1	4	1	4	1	4	1	4	1	3	1
Silica	mg/L	69.7	0.2	64.9	0.2	68.5	0.2	65.7	0.2	70.6	0.2	74.6	0.2	72.4	0.2	60	1	61	1	67	1
Sodium	mg/L	16	1	15	1	13	1	16	1	19	1	19	1	19	1	21	1	17	1	20	1
Sulfate	mg/L	7	1	7	1	7	1	7	1	9	1	9	1	9	1	8	1	9	1	6	1
PHYSICAL PROPERTIES																					
Conductivity @ 25 C	umhos/cm	317	1	311	1	315	1	325	1	307	1	306	1	301	1	315	1	338	1	299	1
pH	s.u.	7.78	0.01	7.81	0.01	7.99	0.01	7.79	0.01	7.94	0.01	7.74	0.01	7.93	0.01	8.4	0.1	8.4	0.1	8.4	0.1
Solids Total Dissolved TDS @ 180 C	mg/L	238	10	230	10	231	10	208	10	216	10	227	10	234	10	250	10	260	10	220	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	<0.1	0.1
Arsenic	mg/L	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.001	0.003	0.001	0.001	0.001	0.0003	0.001	0.002	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	<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	<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	<0.005	0.005
Calcium	mg/L	41	1	42	1	41	1	42	1	33	1	35	1	34	1	35	1	43	1	32	1
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	<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	<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	0.04	0.03	0.06	0.03	0.06	0.05	<0.05	0.05	<0.05	0.05
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	0.05	<0.001	0.05	<0.001	0.05
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	0.02	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	<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	<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	<0.05	0.05
Selenium	mg/L	0.002	0.001	0.001	0.001	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
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	0.02	<0.1	0.02	<0.1	0.02
Zinc	mg/L	0.04	0.01	0.05	0.01	0.07	0.01	0.11	0.01	0.08	0.01	0.06	0.01	0.1	0.01	0.05	0.01	<0.01	0.01	0.01	0.01
DATA QUALITY																					
A/C Balance (± 5)	%	-1.31		-0.711		0.341		3.88		-3.67		-0.777		-0.304		4.13		3.51		2.1	
Anions	meq/L	3.53		3.58		3.33		3.25		3.46		3.4		3.37		3.74		3.9		3.38	
Cations	meq/L	3.44		3.53		3.36		3.51		3.22		3.35		3.35		3.44		3.63		3.24	
Solids Total Dissolved Calculated	mg/L	268		265		259		173		268		270		265		250		870		240	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentration

Revised July 2013

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		723		723		723		723		725		725		725		725		725		727	
Date Collected:		3/31/2011		6/10/2011		9/22/2011		12/20/2011		3/31/2011		6/15/2011		9/29/2011		12/16/2011		9/18/2012		3/24/2011	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																					
Alkalinity Total as CaCO3	mg/L	156	1	159	1	154	1	149	1	149	1	149	1	156	1	141	1	146	5	160	1
Bicarbonate as HCO3	mg/L	191	1	194	1	187	1	182	1	181	1	182	1	182	1	172	1	175	5	195	1
Carbonate as CO3	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	4	1	<1	1	<5	5	<1	1
Chloride	mg/L	2	1	3	1	3	1	2	1	2	1	3	1	3	1	2	1	3	1	5	1
Fluoride	mg/L	0.6	0.1	0.7	0.1	0.7	0.1	0.6	0.1	0.7	0.1	0.8	0.1	0.7	0.1	0.7	0.1	0.6	0.1	0.4	0.1
Magnesium	mg/L	8	1	9	1	8	1	9	1	6	1	7	1	7	1	6	1	6	1	12	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	<0.1	0.1	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	0.8	0.1	0.9	0.1	0.8	0.1	0.7	0.1	0.6	0.1	0.7	0.1	0.8	0.1	0.7	0.1	1	0.1	1.4	0.1
Potassium	mg/L	4	1	3	1	3	1	3	1	5	1	4	1	4	1	4	1	4	1	4	1
Silica	mg/L	80.8	0.2	77.3	0.2	78.3	0.2	75.6	0.2	64.4	0.2	72.2	0.2	72.0	0.2	68.4	0.2	64	1	77.8	0.2
Sodium	mg/L	20	1	17	1	17	1	22	1	33	1	26	1	25	1	31	1	27	1	19	1
Sulfate	mg/L	9	1	8	1	9	1	9	1	19	1	11	1	13	1	16	1	12	1	9	1
PHYSICAL PROPERTIES																					
Conductivity @ 25 C	umhos/cm	310	1	304	1	308	1	306	1	313	1	296	1	309	1	241	1	300	1	325	1
pH	s.u.	7.76	0.01	7.77	0.01	7.99	0.01	7.72	0.01	7.95	0.01	8.15	0.01	8.00	0.01	7.95	0.01	8.4	0.1	8.05	0.01
Solids Total Dissolved TDS @ 180 C	mg/L	228	10	240	10	235	10	215	10	230	10	234	10	248	10	234	10	240	10	290	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	<0.1	0.1
Arsenic	mg/L	0.006	0.001	0.007	0.001	0.007	0.001	0.006	0.001	0.003	0.001	0.006	0.001	0.005	0.001	0.004	0.001	0.005	0.001	0.002	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	<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	<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	<0.005	0.005
Calcium	mg/L	33	1	38	1	34	1	34	1	30	1	29	1	30	1	33	1	29	1	30	1
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	<0.05	0.05
Copper	mg/L	0.05	0.01	<0.01	0.01	0.04	0.01	0.06	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	0.08	0.03	0.06	0.03	0.04	0.03	0.06	0.03	0.09	0.05	<0.03	0.03
Lead	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	0.05	<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	<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	<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	<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	<0.05	0.05
Selenium	mg/L	0.002	0.001	0.002	0.001	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	0.003	0.001
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	0.02	<0.1	0.1
Zinc	mg/L	0.21	0.01	0.03	0.01	0.1	0.01	0.19	0.01	0.32	0.01	0.29	0.01	0.18	0.01	0.24	0.01	0.1	0.01	0.28	0.01
DATA QUALITY																					
A/C Balance (± 5)	%	-2.04		-0.463		-3.11		1.91		-0.00531		-2.8		-5.17		4.47		1.86		-2.51	
Anions	meq/L	3.47		3.53		3.41		3.31		3.5		3.42		3.56		3.3		3.35		3.65	
Cations	meq/L	3.33		3.5		3.21		3.44		3.5		3.23		3.21		3.61		3.23		3.47	
Solids Total Dissolved Calculated	mg/L	277		277		269		172		268		174		270		181		240		290	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentratior

Revised July 2013

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		727		727		727		727		727		727		731		739		740		741	
Date Collected:		4/6/2011		4/20/2011		6/15/2011		9/22/2011		12/15/2011		9/18/2012		9/18/2012		9/18/2012		9/18/2012		3/31/2011	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																					
Alkalinity Total as CaCO3	mg/L	160	1	159	1	158	1	150	1	146	1	161	5	151	5	223	5	228	5	159	1
Bicarbonate as HCO3	mg/L	195	1	194	1	193	1	182	1	178	1	189	5	180	5	269	5	272	5	194	1
Carbonate as CO3	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<5	5	<5	5	<5	5	<5	5	<1	1
Chloride	mg/L	5	1	5	1	5	1	5	1	5	1	4	1	3	1	4	1	7	1	4	1
Fluoride	mg/L	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.5	0.1	0.6	0.1
Magnesium	mg/L	13	1	13	1	13	1	13	1	13	1	12	1	8	1	10	1	11	1	7	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	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.3	0.1	1.3	0.1	1.3	0.1	1.4	0.1	1.6	0.1	1.8	0.1	1.9	0.1	8.7	0.1	1.6	0.1	1.8	0.1
Potassium	mg/L	4	1	4	1	4	1	4	1	4	1	4	1	3	1	7	1	9	1	5	1
Silica	mg/L	81.8	0.2	78.9	0.2	84.5	0.2	81.8	0.2	83	1	72	1	67	1	53	1	53	1	70	0.2
Sodium	mg/L	19	1	19	1	20	1	17	1	19	1	20	1	19	1	23	1	31	1	19	1
Sulfate	mg/L	9	1	9	1	9	1	9	1	8	1	12	1	8	1	12	1	44	1	11	1
PHYSICAL PROPERTIES																					
Conductivity @ 25 C	umhos/cm	322	1	324	1	312	1	325	1	344	1	308	1	292	1	476	1	519	1	324	1
pH	s.u.	7.94	0.01	8.05	0.01	8.19	0.01	8.01	0.01	7.73	0.01	8.4	0.1	8.4	0.1	8.3	0.1	8.3	0.1	7.72	0.01
Solids Total Dissolved TDS @ 180 C	mg/L	247	10	250	10	245	10	244	10	229	10	260	10	230	10	320	10	370	10	244	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	<.1	0.1
Arsenic	mg/L	0.002	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.002	0.001	0.002	0.001	0.003	0.001	0.005	0.001	0.008	0.001	0.005	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	0.2	0.1	0.2	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	<.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	<0.005	0.005
Calcium	mg/L	31	1	31	1	32	1	31	1	34	1	29	1	30	1	61	1	62	1	38	1
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	<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	<0.01	0.01
Iron	mg/L	<0.03	0.03	<0.03	0.03	0.05	0.03	<0.03	0.03	0.03	0.03	0.6	0.05	<0.5	0.05	<0.5	0.05	<0.5	0.05	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	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<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	0.08	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	<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	<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	<0.05	0.05
Selenium	mg/L	0.002	0.001	0.002	0.001	0.003	0.001	0.003	0.001	0.002	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.1
Zinc	mg/L	0.26	0.01	0.28	0.01	0.25	0.01	0.3	0.01	0.49	0.01	0.18	0.01	0.23	0.01	0.01	0.01	<0.01	0.01	0.03	0.01
DATA QUALITY																					
A/C Balance (± 5)	%	-1.17		-1.03		0.0438		0.00487		5.25		4.6		4.44		4.42		2.69		-2.98	
Anions	meq/L	3.64		3.62		3.61		3.44		3.37		3.64		3.41		5.45		5.82		3.67	
Cations	meq/L	3.55		3.54		3.61		3.44		3.74		3.32		3.12		4.99		5.51		3.46	
Solids Total Dissolved Calculated	mg/L	287		283		183		279		179		250		240		340		360		277	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentratior

Revised July 2013

Revised July 2013

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		741		741		741		742		745		745		745		745		746		747	
Date Collected:		6/10/2011		9/22/2011		12/15/2011		9/18/2012		3/31/2011		6/10/2011		9/22/2011		12/15/2011		9/18/2012		3/25/2011	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																					
Alkalinity Total as CaCO3	mg/L	199	1	179	1	173	1	244	5	185	1	175	1	172	1	164	1	155	5	131	1
Bicarbonate as HCO3	mg/L	243	1	218	1	211	1	293	5	226	1	209	1	209	1	200	1	184	5	160	1
Carbonate as CO3	mg/L	<1	1	<1	1	<1	1	<5	5	<1	1	2	1	<1	1	<1	1	<5	5	<1	1
Chloride	mg/L	5	1	5	1	5	1	8	1	4	1	3	1	3	1	4	1	2	1	3	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.5	0.1	1	0.1
Magnesium	mg/L	9	1	8	1	9	1	12	1	11	1	10	1	11	1	11	1	12	1	7	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.1	0.1	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.1	0.1	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	3.3	0.1	3.2	0.2	3.1	0.1	0.8	0.1	6.9 D	0.5	3.9 D	0.2	6.5	0.5	5	0.1	1.1	0.1	1	0.1
Potassium	mg/L	5	1	5	1	5	1	13	1	3	1	2	1	2	1	2	1	2	1	3	1
Silica	mg/L	65.1	0.2	66.2	0.2	64.4	0.2	40	1	72.6	0.2	70.1	0.2	70.9	0.2	67.2	0.2	75	1	85.5	0.2
Sodium	mg/L	26	1	22	1	26	1	28	1	9	1	8	1	8	1	8	1	10	1	13	1
Sulfate	mg/L	13	1	13	1	12	1	24	1	19	1	11	1	16	1	16	1	3	1	5	1
PHYSICAL PROPERTIES																					
Conductivity @ 25 C	umhos/cm	413	1	403	1	327	1	507	1	432	1	356	1	419	1	327	1	278	1	255	1
pH	s.u.	7.72	0.01	7.99	0.01	7.86	0.01	8.3	0.1	7.64	0.01	7.78	0.01	7.94	0.01	7.79	0.01	8.4	0.1	8.07	0.01
Solids Total Dissolved TDS @ 180 C	mg/L	289	10	277	10	259	10	330	10	334	10	280	10	315	10	292	10	220	10	202	10
METALS, DISSOLVED																					
Aluminum	mg/L	<0.1	0.1	<.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	0.006	0.001	0.006	0.001	0.006	0.001	0.01	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.005	0.001
Barium	mg/L	0.1	0.1	0.2	0.1	0.1	0.1	0.2	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	<0.1	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	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	0.005
Calcium	mg/L	52	1	50	1	49	1	59	1	65	1	57	1	64	1	61	1	33	1	31	1
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	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	0.01
Iron	mg/L	0.03	0.03	0.03	0.03	<0.03	0.03	<0.5	0.05	<0.03	0.03	<0.03	0.03		0.03	<0.03	0.03	0.15	0.05	<0.03	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	0.001	0.001	<0.001	0.001	0.001	0.001	0.002	0.001	<0.001	0.05	0.001	0.001
Manganese	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.14	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	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	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	0.05
Selenium	mg/L	0.002	0.001	0.002	0.001	0.002	0.001	<0.001	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002	0.001	<0.001	0.001	0.001	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.1		0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1
Zinc	mg/L	0.02	0.01	0.03	0.01	0.02	0.01	<0.01	0.01	0.43	0.01	0.14	0.01	0.51	0.01	0.72	0.01	0.03	0.01	0.07	0.01
DATA QUALITY																					
A/C Balance (± 5)	%	-0.33		0.0941		3.69		2.48		-0.785		-0.713		2.15		3.13		3.59		-3.49	
Anions	meq/L	4.67		4.24		4.1		5.68		4.7		4.13		4.35		4.1		3.31		2.94	
Cations	meq/L	4.64		4.25		4.42		5.41		4.63		4.07		4.54		4.36		3.08		2.75	
Solids Total Dissolved Calculated	mg/L	329		308		224		330		344		303		327		223		230		255	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentratior

Revised July 2013

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		747		747		759		759		759		759		777		788		788		788	
Date Collected:		4/8/2011		4/25/2011		3/31/2011		6/10/2011		9/22/2011		12/15/2011		9/18/2012		3/24/2011		4/6/2011		4/20/2011	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																					
Alkalinity Total as CaCO3	mg/L	134	1	132	1	163	1	153	1	144	1	140	1	302	5	154	1	151	1	152	1
Bicarbonate as HCO3	mg/L	164	1	161	1	199	1	187	1	175	1	170	1	369	5	187	1	184	1	185	1
Carbonate as CO3	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<5	5	<1	1	<1	1	<1	1
Chloride	mg/L	3	1	3	1	2	1	2	1	2	1	2	1	4	1	3	1	3	1	3	1
Fluoride	mg/L	1	0.1	1	0.1	0.6	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.4	0.1
Magnesium	mg/L	7	1	7	1	3	1	6	1	6	1	6	1	10	1	9	1	9	1	9	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	<0.1	0.1	<0.05	0.05	<0.05	0.05	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	0.7	0.1	0.9	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	3	0.1	2.2	0.1	2.1	0.1	2.1	0.1
Potassium	mg/L	3	1	3	1	6	1	5	1	5	1	5	1	7	1	4	1	4	1	4	1
Silica	mg/L	82.6	0.2	79.8	0.2	74.9	0.2	69.1	0.2	75.3	0.2	71.9	0.2	53	1	69.2	0.2	72.1	0.2	69.5	0.2
Sodium	mg/L	17	1	14	1	49	1	25	1	23	1	25	1	38	1	19	1	20	1	19	1
Sulfate	mg/L	6	1	5	1	15	1	8	1	8	1	7	1	15	1	7	1	7	1	7	1
PHYSICAL PROPERTIES																					
Conductivity @ 25 C	umhos/cm	276	1	263	1	323	1	294	1	299	1	307	1	578	1	307	1	309	1	308	1
pH	s.u.	8.02	0.01	8.07	0.01	7.7	0.01	7.97	0.01	8.05	0.01	7.76	0.01	8.2	0.1	7.98	0.01	7.86	0.01	8.02	0.01
Solids Total Dissolved TDS @ 180 C	mg/L	218	10	216	10	236	10	212	10	217	10	203	10	400	10	231	10	221	10	235	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	<0.1	0.1
Arsenic	mg/L	0.005	0.001	0.005	0.001	0.006	0.001	0.004	0.001	0.004	0.001	0.003	0.001	0.006	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	<0.1	0.1	0.1	0.1	0.2	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	<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	<0.005	0.005
Calcium	mg/L	33	1	32	1	21	1	31	1	31	1	32	1	73	1	34	1	33	1	34	1
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	<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	<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	<0.05	0.05	<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	0.05	<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	<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	<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	<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	<0.05	0.05
Selenium	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	0.001	0.001
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	0.02	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	0.04	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.1	0.01	0.03	0.01	0.07	0.01	0.07	0.01	0.04	0.01
DATA QUALITY																					
A/C Balance (± 5)	%	-0.357		-2.19		-1.48		-1.77		0.123		4.27		3.2		-1.8		-1.03		-0.665	
Anions	meq/L	3.02		2.95		3.7		3.35		3.17		3.08		6.71		3.48		3.42		3.44	
Cations	meq/L	3		2.83		3.59		3.24		3.18		3.35		6.29		3.36		3.35		3.39	
Solids Total Dissolved Calculated	mg/L	259		249		292		262		260		166		400		275		268		265	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentratior

Revised July 2013

Table 6.1-6 Non-Radiological Analyses for Private Water Supply Wells in Marsland Area of Review

Location ID:		788		799		802		809		810		811		815		821		845	
Date Collected:		9/18/2012		9/18/2012		9/18/2012		9/18/2012		9/18/2012		9/18/2012		9/18/2012		9/18/2012		9/18/2012	
	UNITS	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL	RESULT	RL
MAJOR IONS																			
Alkalinity Total as CaCO3	mg/L	148	5	173	5	161	5	170	5	171	5	165	5	168	5	149	5	158	5
Bicarbonate as HCO3	mg/L	480	5	199	5	190	5	198	5	201	5	195	5	198	5	175	5	187	5
Carbonate as CO3	mg/L	<5	5	6	5	<5	5	<5	5	<5	5	<5	5	<5	5	<5	5	<5	5
Chloride	mg/L	3	1	3	1	3	1	3	1	4	1	2	1	4	1	4	1	2	1
Fluoride	mg/L	0.4	0.1	0.4	0.1	0.5	0.1	0.8	0.1	0.9	0.1	0.7	0.1	0.04	0.1	0.5	0.1	0.4	0.1
Magnesium	mg/L	9	1	10	1	8	1	9	1	9	1	10	1	8	1	6	1	7	1
Nitrogen Ammonia as N	mg/L	0.2	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
Nitrogen Nitrate+Nitrite as N	mg/L	3.7	0.1	0.9	0.1	2.7	0.1	0.8	0.1	0.9	0.1	0.5	0.1	5.5	0.1	2.4	0.1	1.4	0.1
Potassium	mg/L	4	1	3	1	2	1	5	1	5	1	5	1	3	1	6	1	4	1
Silica	mg/L	62	1	63	1	61	1	62	1	63	1	54	1	58	1	62	1	60	1
Sodium	mg/L	19	1	8	1	8	1	17	1	18	1	8	1	16	1	30	1	18	1
Sulfate	mg/L	6	1	5	1	3	1	4	1	6	1	3	1	7	1	17	1	7	1
PHYSICAL PROPERTIES																			
Conductivity @ 25 C	umhos/cm	305	1	314	1	298	1	313	1	314	1	289	1	335	1	321	1	302	1
pH	s.u.	8.4	0.1	8.5	0.1	8.4	0.1	8.4	0.1	8.4	0.1	8.4	0.1	8.4	0.1	8.4	0.1	8.4	0.1
Solids Total Dissolved TDS @ 180 C	mg/L	305	10	240	10	220	10	240	10	240	10	220	10	260	10	250	10	250	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	0.004	0.001	0.003	0.001	0.006	0.001	0.008	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
Barium	mg/L	0.2	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	<0.1	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
Calcium	mg/L	32	1	45	1	45	1	37	1	37	1	39	1	45	1	29	1	35	1
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	0.07	0.05	<0.05	0.05	0.09	0.05	0.07	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05
Lead	mg/L	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05	<0.001	0.05
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	<0.001	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
Vanadium	mg/L	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.02
Zinc	mg/L	0.11	0.01	0.06	0.01	0.06	0.01	0.3	0.01	0.18	0.01	0.29	0.01	0.29	0.01	0.29	0.01	0.29	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	3.4		3.66		4.27		3.1		3.92		4.17		4.87		3.1		3.57	
Anions	meq/L	3.46		3.74		3.58		3.67		3.76		3.48		4.02		3.64		3.47	
Cations	meq/L	3.23		3.47		3.29		3.45		3.48		3.2		3.65		3.42		3.23	
Solids Total Dissolved Calculated	mg/L	240		250		220		240		250		220		270		260		230	

Notes:
RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentratior

Revised July 2013

Revised July 2013

Table 6.1-7 Water Levels - Brule Formation and Basal Sandstone of Chadron Formation

Table 6.1-7 Water Levels - Arikaree Group, Brule Formation and Basal Sandstone of Chadron Formation

Well	TOC Elevation (ft amsl)	2/22/11 Water Level (ft TOC)	2/22/11 Groundwater Elevation (ft amsl)	10/17/13 Water Level (ft TOC)	10/17/13 Groundwater Elevation (ft amsl)
ARIKAREE GROUP					
AOW-1	4261.64	--	--	126.4	4135.24
AOW-3	4351.97	--	--	142.2	4209.77
AOW-4	4161.91	--	--	87.3	4074.61
AOW-5	4125.42	--	--	72.0	4053.42
AOW-6	4068.60	--	--	20.0	4048.60
AOW-7	4243.94	--	--	DRY	4093.94
AOW-8	4365.02	--	--	71.7	4293.32
AOW-9	4146.41	--	--	74.9	4071.51
AOW-10	4198.60	--	--	113.3	4085.30
AOW-11	4091.02	--	--	35.4	4055.62
BRULE FORMATION					
BOW 2010-1	4260.10	125.74	4134.36	124.9	4135.20
BOW 2010-2	4324.96	150.03	4174.93	151.4	4173.56
BOW 2010-3	4352.80	137.20	4215.60	139.6	4213.20
BOW-2010-4	4163.13	86.65	4076.48	--	--
BOW 2010-4A	--	--	--	93.7	4069.43
BOW 2010-5	4127.88	71.19	4056.69	74.0	4053.88
BOW 2010-6	4100.43	49.30	4051.13	50.3	4050.13
BOW-2010-7	4248.37	--	--	155.6	4092.77
BOW-2010-8	4369.29	--	--	74.0	4295.29
BOW-2013-9	4145.90	--	--	74.6	4071.30
BOW-2013-10	4197.84	--	--	113.8	4084.04
BOW-2013-11	4091.87	--	--	37.4	4054.47
BASAL SANDSTONE OF CHADRON FORMATION					
CPW-2010-1	4261.35	551.63	3709.72	565.3	3696.05
CPW-2010-1A	4263.28	--	--	567.0	3696.28
Monitor 1	4103.28	387.65	3715.63	399.4	3703.88
Monitor 2	4199.50	484.99	3714.51	500.3	3699.20
Monitor 3	4261.40	550.90	3710.50	565.5	3695.90
Monitor 4A	4329.72	618.09	3711.64	634.3	3695.42
Monitor 5	4340.80	628.87	3711.93	645.4	3695.40
Monitor 6	4216.40	502.80	3713.60	518.2	3698.20
Monitor 7	4246.28	531.20	3715.08	548.0	3698.28
Monitor 8	4355.90	644.97	3710.93	660.5	3695.40
Monitor 9	4367.02	656.54	3710.48	669.7	3697.32
Monitor 10	4163.99	449.01	3714.98	465.0	3698.99
Monitor 11	4128.07	412.74	3715.33	427.9	3700.17

NOTES:

Groundwater elevations for the Brule Formation and Basal Chadron Sandstone are based on depth to water measurements.

TOC = top of casing

ft TOC = feet below top of casing

ft amsl = feet above mean sea level

DRY = measurable water not present in well at time of sampling

Table 6.1-8 Marsland Expansion Area Groundwater Radiological Analytical Results for Brule Wells

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3	
Date Collected:		3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7	0.7	<0.8	0.8	<0.7	0.7	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		0.5		0.4		0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		0.8		0.7		0.7		0.8		0.8		0.7		0.8		0.8	
Polonium 210	pCi/L	<0.7	0.7	<1.2	1.2	<0.5	0.5	<0.7	0.7	<0.9	0.9	<0.6	0.6	<0.6	0.6	<0.9	0.9	<0.7	0.7
Polonium 210 precision (±)	pCi/L	0.4		0.4		0.4		0.3		0.5		0.4		0.2		0.7		0.4	
Polonium 210 MDC	pCi/L	0.7		1.2		0.5		0.7		0.9		0.6		0.6		0.9		0.7	
Radium 226	pCi/L	<0.15	0.15	0.66	0.14	<0.1	0.1	0.31	0.15	0.26	0.1	<0.21	0.21	0.38	0.15	0.23	0.11	<0.22	0.22
Radium 226 precision (±)	pCi/L	0.1		0.19		0.06		0.14		0.11		0.09		0.15		0.11		0.1	
Radium 226 MDC	pCi/L	0.15		0.14		0.1		0.15		0.1		0.21		0.15		0.11		0.22	
Thorium 230	pCi/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	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.06		0.06		0.07		0.09		0.04		0.08		0.08		0.07		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.2	
Uranium	mg/L	0.0032	0.0003	0.0024	0.0003	0.002	0.0003	0.0031	0.0003	0.0032	0.0003	0.0035	0.0003	0.0041	0.0003	0.0035	0.0003	0.0041	0.0003
Uranium Activity	uCi/mL	2.20E-09	2.00E-10	1.60E-09	2.00E-10	1.30E-09	2.00E-10	2.10E-09	2.00E-10	2.20E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10	2.40E-09	2.00E-10	2.80E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																			
Lead 210	pCi/L	<1.2	1.2	<0.8	0.8	<0.9	0.9	<1.3	1.3	<0.9	0.9	<0.7	0.7	<1.2	1.2	<0.9	0.9	<0.7	0.7
Lead 210 precision (±)	pCi/L	0.7		0.5		0.5		0.8		0.6		0.4		0.7		0.6		0.4	
Lead 210 MDC	pCi/L	1.2		0.8		0.9		1.3		0.9		0.7		1.2		0.9		0.7	
Polonium 210	pCi/L	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	0.3	0.2
Polonium 210 precision (±)	pCi/L	0.2		0.2		0.2		0.2		0.3		0.2		0.2		0.2		0.2	
Polonium 210 MDC	pCi/L	0.3		0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.2	
Radium 226	pCi/L	0.14	0.13	0.21	0.09	<0.1	0.1	<0.14	0.14	0.28	0.09	<0.14	0.14	<0.14	0.14	0.15	0.08	<0.14	0.14
Radium 226 precision (±)	pCi/L	0.1		0.09		0.06		0.08		0.1		0.08		0.09		0.08		0.06	
Radium 226 MDC	pCi/L	0.13		0.09		0.1		0.14		0.09		0.14		0.14		0.08		0.14	
Thorium 230	pCi/L	<0.05	0.05	<0.1	0.1	0.3	0.1	<0.06	0.06	0.2	0.1	<0.1	0.1	<0.08	0.08	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.05		0.1		0.2		0.05		0.1		0.1		0.05		0.1		0.08	
Thorium 230 MDC	pCi/L	0.05		0.1		0.1		0.06		0.1		0.1		0.08		0.1		0.1	
METALS, SUSPENDED																			
Uranium	mg/L	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	0.0017	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	2.90E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	1.20E-09	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																			
Lead 210	pCi/L	<0.7	0.7	<1.9	1.9	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8	<0.7	0.7	<0.8	0.8	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		1.1		0.5		0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		1.9		0.8		0.7		0.8		0.8		0.7		0.8		0.8	
Polonium 210	pCi/L	<1.1	1.1	<0.7	0.7	<0.5	0.5	<0.6	0.6	<0.6	0.6	<0.5	0.5	<0.5	0.5	<0.9	0.9	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.6		0.5		0.5		0.3		0.3		0.3		0.3		0.5		0.3	
Polonium 210 MDC	pCi/L	1.1		0.7		0.5		0.6		0.6		0.5		0.5		0.9		0.6	
Radium 226	pCi/L	<0.2	0.2	0.2	0.1	<0.1	0.1	0.36	0.15	0.41	0.11	<0.16	0.16	<0.13	0.13	0.34	0.11	<0.17	0.17
Radium 226 precision (±)	pCi/L	0.1		0.1		0.09		0.15		0.13		0.08		0.08		0.12		0.08	
Radium 226 MDC	pCi/L	0.2		0.1		0.1		0.15		0.11		0.16		0.13		0.11		0.17	
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.09		0.09		0.06		0.07		0.09		0.08		0.06		0.1	
Thorium 230 MDC	pCi/L	0.2		0.2		0.1		0.1		0.1		0.1		0.1		0.1		0.1	
Uranium	mg/L	0.0095	0.0003	0.0053	0.0003	0.0061	0.0003	0.0061	0.0003	0.0075	0.0003	0.0076	0.0003	0.0052	0.0003	0.0055	0.0003	0.0058	0.0003
Uranium Activity	uCi/mL	6.40E-09	2.00E-10	3.60E-09	2.00E-10	4.10E-09	2.00E-10	4.10E-09	2.00E-10	5.10E-09	2.00E-10	5.20E-09	2.00E-10	3.60E-09	2.00E-10	3.70E-09	2.00E-10	3.90E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																			
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<1.1	1.1	<1.2	1.2	<0.9	0.9	<0.7	0.7	<1.2	1.2	<1.1	1.1	<0.7	0.7
Lead 210 precision (±)	pCi/L	0.7		0.5		0.6		0.7		0.5		0.4		0.7		0.6		0.4	
Lead 210 MDC	pCi/L	1.1		0.9		1.1		1.2		0.9		0.7		1.2		1.1		0.7	
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.3	0.3	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.08		0.1		0.1		0.1		0.1		0.1		0.2		0.2		0.08	
Polonium 210 MDC	pCi/L	0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.3		0.2	
Radium 226	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.13	0.13	0.14	0.08	<0.15	0.15	<0.13	0.13	0.16	0.08	<0.13	0.13
Radium 226 precision (±)	pCi/L	0.07		0.05		0.07		0.08		0.08		0.06		0.08		0.08		0.05	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.13		0.08		0.15		0.13		0.08		0.13	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.07	0.07	<0.1	0.1	<0.1	0.1	<0.05	0.05	<0.2	0.2	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.08		0.09		0.06		0.04		0.09		0.06		0.04		0.1		0.07	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.07		0.1		0.1		0.05		0.2		0.1	
METALS, SUSPENDED																			
Uranium	mg/L	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-8 Marsland Expansion Area Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED													
Lead 210	pCi/L	<0.7	0.7	<0.9	0.9	<0.8	0.8	<0.7	0.7	<0.9	0.9	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	0.7		0.9		0.8		0.7		0.9		0.8	
Polonium 210	pCi/L	<1.1	1.1	<0.6	0.6	<0.9	0.9	<1.1	1.1	<1.1	1.1	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.7		0.3		0.7		0.5		0.9		0.3	
Polonium 210 MDC	pCi/L	1.1		0.6		0.9		1.1		1.1		0.6	
Radium 226	pCi/L	<0.1	0.1	0.5	0.1	0.6	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.06		0.1		0.2		0.08		0.08		0.1	
Radium 226 MDC	pCi/L	0.1		0.1		0.2		0.2		0.1		0.1	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.07		0.08		0.1		0.07		0.09		0.09	
Thorium 230 MDC	pCi/L	0.1		0.2		0.1		0.1		0.2		0.2	
Uranium	mg/L	0.0059	0.0003	0.0049	0.0003	0.0049	0.0003	0.0075	0.0003	0.007	0.0003	0.0069	0.0003
Uranium Activity	uCi/mL	4.00E-09	2.00E-10	3.30E-09	2.00E-10	3.30E-09	2.00E-10	5.00E-09	2.00E-10	4.70E-09	2.00E-10	4.70E-09	2.00E-10
RADIONUCLIDES-SUSPENDED													
Lead 210	pCi/L	<1.1	1.1	<0.9	0.9	<0.9	0.9	<1.1	1.1	<0.9	0.9	<0.9	0.9
Lead 210 precision (±)	pCi/L	0.7		0.6		0.5		0.7		0.5		0.5	
Lead 210 MDC	pCi/L	1.1		0.9		0.9		1.1		0.9		0.9	
Polonium 210	pCi/L	<0.2	0.2	0.5	0.2	<0.2	0.2	<0.2	0.2	<0.4	0.4	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.02		0.3		0.2		0.2		0.2		0.07	
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.2		0.4		0.2	
Radium 226	pCi/L	0.6	0.1	0.3	0.1	0.2	0.1	0.3	0.1	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.1		0.1		0.1		0.09		0.05		0.07	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
Thorium 230	pCi/L	0.2	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.1		0.08		0.09		0.07		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		0.1		0.1	
METALS, SUSPENDED													
Uranium	mg/L	0.0005	0.0003	0.0004	0.0003	ND	0.0003	ND	0.0003	ND	0.0003	ND	0.0003
Uranium Activity	uCi/mL	3.70E-10	2.00E-10	3.20E-10	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10	ND	2.00E-10

Notes:

MDC = Minimum Detectable Concentration

uCi/mL = microcuries per milliliter

mg/L = milligrams per Liter

pCi/L = picoCuries per Liter

RL - Analyte reporting limit.

Table 6.1-9 Marsland Expansion Area Groundwater Non-Radiological Analytical Results for Brule Wells

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-1		BOW 2010-1		BOW 2010-1		BOW 2010-2		BOW 2010-2		BOW 2010-2		BOW 2010-3		BOW 2010-3		BOW 2010-3	
Date Collected:		3/9/2011		3/24/2011		4/6/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as $CaCO_3$	mg/L	211	1	217	1	212	1	187	1	187	1	182	1	177	1	145	1	171	1
Bicarbonate as HCO_3	mg/L	139	1	67	1	48	1	152	1	122	1	148	1	154	1	94	1	144	1
Carbonate as CO_3	mg/L	58	1	97	1	104	1	38	1	52	1	37	1	31	1	41	1	32	1
Chloride	mg/L	44	1	55	1	63	1	27	1	32	1	31	1	38	1	37	1	32	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.4	0.1	0.4	0.1	0.4	0.1	0.6	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	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	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.3	0.1	1.3	0.1	1.3	0.1	<0.1	0.1	1.1	0.1	1.1	0.1	1	0.1	0.5	0.1	0.8	0.1
Potassium	mg/L	12	1	12	1	12	1	11	1	12	1	11	1	12	1	10	1	10	1
Silica	mg/L	105	0.2	108	0.2	110	0.2	85.9	0.2	95.1	0.2	88.1	0.2	79.3	0.2	86.5	0.2	87	0.2
Sodium	mg/L	144	1	156	1	145	1	107	1	112	1	107	1	126	1	109	1	118	1
Sulfate	mg/L	60	2	61	2	62	2	37	2	39	2	37	1	60	2	60	2	60	2
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	682	1	724	1	763	1	518	1	542	1	515	1	584	1	527	1	550	1
pH	s.u.	9.56	0.01	9.88	0.01	10	0.01	9.32	0.01	9.58	0.01	9.38	0.01	9.22	0.01	9.57	0.01	9.41	0.01
Total Dissolved Solids @ 180 °C	mg/L	456	10	508	10	537	10	377	10	396	10	342	10	411	10	375	10	374	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	0.018	0.001	0.017	0.001	0.014	0.001	0.005	0.001	0.004	0.001	0.005	0.001	0.01	0.001	0.009	0.001	0.009	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	0.1	0.1	0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.3	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
Calcium	mg/L	5	1	5	1	5	1	7	1	6	1	6	1	7	1	5	1	5	1
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	<0.01	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	0.021	0.001	0.021	0.001	0.016	0.001	0.002	0.001	0.001	0.001	ND	0.001	0.006	0.001	0.003	0.001	0.003	0.001
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	0.04	0.01	0.04	0.01	0.08	0.01	0.03	0.01	0.07	0.01	0.06	0.01	0.05	0.01	0.15	0.01	0.11	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	0.0283		0.476		-3.96		0.0154		-0.717		-0.824		1.57		-0.182		0.062	
Anions	meq/L	6.83		7.29		7.44		5.3		5.57		5.37		5.95		5.27		5.65	
Cations	meq/L	6.83		7.36		6.87		5.3		5.49		5.29		6.14		5.25		5.66	
Solids Total Dissolved Calculated	mg/L	532		567		560		410		439		418		454		420		442	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unti
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-4A		BOW 2010-4A		BOW 2010-4A		BOW 2010-5		BOW 2010-5		BOW 2010-5		BOW 2010-6		BOW 2010-6		BOW 2010-6	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		3/4/2011		3/18/2011		4/1/2011		3/4/2011		3/18/2011		4/1/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																			
Alkalinity Total as $CaCO_3$	mg/L	175	1	131	1	125	1	151	1	151	1	152	1	144	1	143	1	143	1
Bicarbonate as HCO_3	mg/L	180	1	95	1	114	1	174	1	170	1	177	1	165	1	159	1	168	1
Carbonate as CO_3	mg/L	16	1	32	1	19	1	5	1	7	1	4	1	6	1	7	1	3	1
Chloride	mg/L	24	1	33	1	28	1	7	1	7	1	5	1	2	1	10	1	10	1
Fluoride	mg/L	0.5	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.6	0.1
Magnesium	mg/L	2	1	<1	1	<1	1	7	1	7	1	7	1	7	1	7	1	7	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	<0.05	0.05
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1.2	0.1	1.1	0.1	0.9	0.1	0.9	0.1	0.9	0.1	1	0.1	1	0.1	1	0.1
Potassium	mg/L	11	1	9	1	8	1	4	1	5	1	4	1	4	1	5	1	5	1
Silica	mg/L	78.2	0.2	70.6	0.2	75.6	0.2	72.1	0.2	83.9	0.2	78.6	0.2	67.4	0.2	73.7	0.2	71.5	0.2
Sodium	mg/L	100	1	95	1	84	1	26	1	28	1	27	1	24	1	25	1	25	1
Sulfate	mg/L	50	2	50	1	49	1	9	1	9	1	9	1	2	1	10	1	10	1
PHYSICAL PROPERTIES																			
Conductivity @ 25 °C	umhos/cm	514	1	474	1	446	1	313	1	307	1	307	1	320	1	309	1	310	1
pH	s.u.	8.92	0.01	9.4	0.01	9.31	0.01	8.23	0.01	8.34	0.01	8.19	0.01	8.31	0.01	8.5	0.01	8.27	0.01
Total Dissolved Solids @ 180 °C	mg/L	358	10	345	10	316	10	231	10	228	10	200	10	216	10	225	10	206	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	0.015	0.001	0.014	0.001	0.015	0.001	0.003	0.001	0.004	0.001	0.003	0.001	0.005	0.001	0.005	0.001	0.005	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	0.1	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
Calcium	mg/L	13	1	7	1	6	1	29	1	29	1	29	1	31	1	31	1	32	1
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	<0.01	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	0.009	0.001	0.011	0.001	0.012	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
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	<0.01	0.01	0.01	0.01	<0.01	0.01	0.06	0.01	0.09	0.01	0.1	0.01	0.03	0.01	0.06	0.01	0.07	0.01
DATA QUALITY																			
A/C Balance (± 5)	%	1.48		0.755		-1.89		-3.95		-1.58		-1.82		2.6		-1.63		-1.34	
Anions	meq/L	5.3		4.7		4.4		3.51		3.48		3.45		3.1		3.43		3.44	
Cations	meq/L	5.46		4.77		4.24		3.24		3.37		3.33		3.27		3.32		3.34	
Solids Total Dissolved Calculated	mg/L	409		368		256		269		285		277		248		271		269	

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unti
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 6.1-9 Marsland Expansion Area Non-Radiological Analytical Results for CBR Brule Monitor Wells

Location ID:		BOW 2010-7		BOW 2010-7		BOW 2010-7		BOW 2010-8		BOW 2010-8		BOW 2010-8	
Date Collected:		4/5/2011		4/19/2011		5/3/2011		4/5/2011		4/19/2011		5/3/2011	
Formation:		BRULE		BRULE		BRULE		BRULE		BRULE		BRULE	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS													
Alkalinity Total as $CaCO_3$	mg/L	190	1	185	1	180	1	182	1	182	1	179	1
Bicarbonate as HCO_3	mg/L	202	1	182	1	191	1	198	1	172	1	189	1
Carbonate as CO_3	mg/L	15	1	21	1	14	1	12	1	24	1	14	1
Chloride	mg/L	23	1	28	1	25	1	7	1	13	1	9	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.5	0.1	0.5	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	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
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	1	0.1	1	0.1	0.8	0.1	0.6	0.1	0.7	0.1
Potassium	mg/L	11	1	10	1	9	1	10	1	12	1	10	1
Silica	mg/L	80.9	0.2	76.9	0.2	80.1	0.2	81.4	0.2	76.3	0.2	80.2	0.2
Sodium	mg/L	118	1	119	1	106	1	83	1	90	1	79	1
Sulfate	mg/L	55	2	54	2	52	2	27	1	24	1	24	1
PHYSICAL PROPERTIES													
Conductivity @ 25 °C	umhos/cm	547	1	540	1	535	1	407	1	428	1	410	1
pH	s.u.	8.76	0.01	9	0.01	8.93	0.01	8.65	0.01	9.15	0.01	8.93	0.01
Total Dissolved Solids @ 180 °C	mg/L	376	10	411	10	376	10	306	10	326	10	299	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	0.028	0.001	0.029	0.001	0.03	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
Boron	mg/L	0.2	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
Calcium	mg/L	8	1	5	1	6	1	11	1	8	1	9	1
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	<0.03	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
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	0.21	0.001	0.22	0.001	0.235	0.001	ND	0.001	ND	0.001	ND	0.001
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	<0.01	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)	%	1.35		0.159		-2.68		0.681		0.853		-2.91	
Anions	meq/L	5.72		5.71		5.48		4.46		4.57		4.39	
Cations	meq/L	5.88		5.73		5.2		4.52		4.65		4.14	
Solids Total Dissolved Calculated	mg/L	439		430		312		355		356		241	

Revised 11/2013

Notes:
mg/L = milligrams per Liter
umhos/cm = micromhos per centimeter
s.u. = standard unti
meq/L = milliequivalents per Liter
RL = Analyte Reporting Limit

Table 6.1-10 Marsland Expansion Area Groundwater Non-Radiological Analytical Results (2011-2012) Chadron Wells

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 2	
Date Collected:		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	412	1	415	1	405	1	288	1	398	5	411	5	416	5	408	1
Bicarbonate as HCO_3	mg/L	476	1	483	1	478	1	193	1	486	5	488	5	475	5	469	1
Carbonate as CO_3	mg/L	13	1	12	1	8	1	78	1	<5	5	7	5	16	5	15	1
Chloride	mg/L	179	1	179	1	182	1	605	4	180	1	170	1	177	1	169	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.6	0.1	0.9	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.6	0.1
Magnesium	mg/L	1	1	1	1	1	1	<1	1	1	1	1	1	1	1	<1	1
Nitrogen Ammonia as N	mg/L	0.21	0.05	<0.05	0.05	0.18	0.05	0.7	0.05	0.3	0.1	0.22	0.05	0.01	0.1	0.21	0.05
Nitrogen Nitrate+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	8	1	8	1	8	1	35	1	11	1	8	1	11	1	8	1
Silica	mg/L	17	0.2	16.1	0.2	12.9	0.2	20.7	0.2	14	1	15.2	0.2	15	1	17.9	0.2
Sodium	mg/L	332	1	338	1	340	1	514	2	330	1	307	1	349	1	308	1
Sulfate	mg/L	60	4	59	4	59	4	80	8	48	1	60	4	49	1	58	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1410	1	1400	1	1400	1	2740	1	1490	1	1410	1	1350	1	1410	1
pH	s.u.	8.25	0.01	8.29	0.01	8.28	0.01	9.62	0.01	8.3	0.01	8.29	0.01	8.6	0.1	8.3	0.01
Total Dissolved Solids @ 180 °C	mg/L	848	10	817	10	837	10	1400	10	830	10	853	10	840	10	845	10
METALS, DISSOLVED																	
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	0.2	0.1	0.3	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	0.003	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001	0.003	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
Boron	mg/L	1.4	0.1	1.4	0.1	1.3	0.1	1.2	0.1	1.4	0.1	1.4	0.1	1.6	0.1	1.5	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
Calcium	mg/L	5	1	4	1	5	1	10	1	4	1	5	1	5	1	4	1
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	<0.01	0.01	<0.01	0.1	<0.01	0.01
Iron	mg/L	0.15	0.03	0.09	0.03	0.1	0.03	0.04	0.03	<0.05	0.05	0.03	0.03	<0.05	0.05	0.11	0.03
Lead	mg/L	<0.001	0.001	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	0.001	0.001	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.004	0.001	0.002	0.001	0.002	0.002	0.006	0.001	0.002	0.001	0.002	0.001	<0.002	0.001	0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02	<0.1	0.1
Zinc	mg/L	0.02	0.01	0.09	0.01	0.03	0.01	<0.01	0.01	<0.01	0.01	0.03	0.01	<0.01	0.01	0.01	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	1.46		2.06		2.92		-1.57		3.04		-1.19		4.77		-1	
Anions	meq/L	14.6		14.6		14.5		24.6		14.08		14.3		14.34		14.2	
Cations	meq/L	15		15.2		15.3		23.8		14.96		13.9		15.78		13.9	
Solids Total Dissolved Calculated	mg/L	854		860		854		1450		830		800		860		816	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 2		Monitor 2		Monitor 2		Monitor 2		Monitor 2		Monitor 2		CPW-2010-1		CPW-2010-1	
Date Collected:		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/9/2011		3/24/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	406	1	402	1	374	1	394	5	398	5	410	5	370	1	368	1
Bicarbonate as HCO_3	mg/L	473	1	472	1	439	1	480	5	475	5	471	5	422	1	422	1
Carbonate as CO_3	mg/L	11	1	9	1	9	1	<5	5	5	5	14	5	14	1	13	1
Chloride	mg/L	171	1	173	1	176	1	168	1	161	1	166	1	178	1	185	1
Fluoride	mg/L	0.6	0.1	0.6	0.1	0.5	0.1	0.6	0.1	0.6	0.1	0.5	0.1	0.8	0.1	0.8	0.1
Magnesium	mg/L	<1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
Nitrogen Ammonia as N	mg/L	0.23	0.05	0.18	0.05	0.27	0.05	0.2	0.1	0.24	0.05	0.01	0.1	0.24	0.05	0.24	0.05
Nitrogen Nitrate+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	9	1	9	1	8	1	12	1	8	1	11	1	11	1	11	1
Silica	mg/L	16.7	0.2	14.6	0.2	15.6	0.2	15	1	17.2	0.2	16	1	17	0.2	15	0.2
Sodium	mg/L	332	1	328	1	299	1	322	1	298	1	337	1	324	1	337	1
Sulfate	mg/L	57	4	55	4	57	1	47	1	56	4	46	1	94	4	96	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1360	1	1350	1	1410	1	1450	1	1380	1	1340	1	1430	1	1410	1
pH	s.u.	8.27	0.01	8.26	0.01	8.32	0.01	8.3	0.01	8.29	0.01	8.6	0.1	8.34	0.01	8.41	0.01
Total Dissolved Solids @ 180 °C	mg/L	778	10	802	10	791	10	830	10	818	10	850	10	833	10	853	10
METALS, DISSOLVED																	
Aluminum	mg/L	<0.1	0.1	0.2	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	0.003	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.002	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
Boron	mg/L	1.4	0.1	1.4	0.1	1.3	0.1	1.4	0.1	1.5	0.1	1.5	0.1	1.4	0.1	1.3	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
Calcium	mg/L	4	1	5	1	4	1	5	1	5	1	5	1	6	1	6	1
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	<0.01	0.1	<0.01	0.01	<0.01	0.01
Iron	mg/L	0.03	0.03	0.09	0.03	0.05	0.03	0.05	0.05	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.002	0.001	0.003	0.002	0.003	0.001	<0.002	0.001	0.002	0.001	<0.002	0.001	0.003	0.001	<0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.1
Zinc	mg/L	0.01	0.01	<0.01	0.01	0.02	0.01	0.03	0.01	0.5	0.01	0.09	0.01	0.03	0.01	0.01	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	2.9		2.57		-0.51		3.49		-0.691		4.81		1.35		2.56	
Anions	meq/L	14.1		14.1		13.7		13.61		13.7		13.85		14.4		14.6	
Cations	meq/L	15		14.8		13.5		14.6		13.6		15.26		14.8		15.4	
Solids Total Dissolved Calculated	mg/L	839		831		789		810		770		830		858		877	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

	Location ID:	CPW-2010-1		CPW-2010-1		CPW-2010-1		CPW-2010-1		CPW-2010-1		Monitor 4A		Monitor 4A		Monitor 4A	
	Date Collected:	4/6/2011		11/7/2011		2/13/2012		6/4/2013		8/20/2012		3/12/2011		3/28/2011		4/11/2011	
	Formation:	CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	368	1	288	1	281	5	281	5	298	5	352	1	356	1	360	1
Bicarbonate as HCO_3	mg/L	424	1	193	1	286	5	306	5	311	5	374	1	371	1	386	1
Carbonate as CO_3	mg/L	12	1	78	1	28	5	18	5	26	5	28	1	31	1	26	1
Chloride	mg/L	180	1	605	4	563	1	368	5	327	1	284	2	249	2	238	1
Fluoride	mg/L	0.8	0.1	0.9	0.1	0.8	0.1	0.8	0.1	0.6	0.1	0.8	0.1	0.8	0.1	0.8	0.1
Magnesium	mg/L	1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	0.26	0.05	0.7	0.05	0.5	0.1	0.49	0.05	0.4	0.1	0.24	0.05	0.26	0.05	0.22	0.05
Nitrogen Nitrate+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	11	1	35	1	40	1	21	1	23	1	17	1	16	1	16	1
Silica	mg/L	16.4	0.2	20.7	0.2	17	1	17.8	0.2	15	1	18.4	0.2	18.3	0.2	14.4	0.2
Sodium	mg/L	336	1	514	2	488	1	393	1	399	1	394	1	394	1	380	1
Sulfate	mg/L	94	4	80	8	76	1	88	4	73	1	113	4	112	4	112	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1420	1	2740	1	2360	1	1890	1	1740	1	1760	1	1660	1	1620	1
pH	s.u.	8.4	0.01	9.62	0.01	9	0.1	8.98	0.01	8.9	0.1	8.92	0.01	8.97	0.01	8.96	0.01
Total Dissolved Solids @ 180 °C	mg/L	853	10	1400	10	1260	10	1090	10	1070	10	1020	10	955	10	946	10
METALS, DISSOLVED																	
Aluminum	mg/L	<0.1	0.1	0.3	0.1	<0.1	0.1	0.3	0.1	0.2	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	0.006	0.001	0.005	0.001	0.004	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
Boron	mg/L	1.4	0.1	1.2	0.1	1.5	0.1	1.4	0.1	1.3	0.1	1.2	0.1	1.3	0.1	1.3	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
Calcium	mg/L	5	1	10	1	10	1	19	1	14	1	3	1	3	1	3	1
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	0.1	<0.01	0.1	<0.01	0.1	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.05	0.03	0.04	0.03	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.03	<0.05	0.03	<0.05	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.05	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.001	0.001	0.006	0.001	<0.002	0.001	0.002	0.001	0.008	0.001	0.002	0.001	0.002	0.001	0.004	0.002
Vanadium	mg/L	<0.1	0.1	0.1	0.1	<0.1	0.02	<0.1	0.02	<0.1	0.02	<0.1	0.1	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	<0.01	0.01	0.09	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.02	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	2.86		-1.57		0.8		2.28		4.63		1.04		3.7		2.73	
Anions	meq/L	14.4		24.6		23.12		17.9		16.99		17.4		16.5		16.3	
Cations	meq/L	15.3		23.8		22.75		18.7		18.64		17.8		17.8		17.2	
Solids Total Dissolved Calculated	mg/L	870		1450		1360		1100		1030		1050		1010		985	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 4A		Monitor 4A		Monitor 4A		Monitor 4A		Monitor 5		Monitor 5		Monitor 5		Monitor 5	
Date Collected:		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	323	1	358	5	360	5	390	5	318	1	311	1	297	1	248	1
Bicarbonate as HCO_3	mg/L	342	1	414	5	405	5	432	5	155	1	125	1	161	1	140	1
Carbonate as CO_3	mg/L	25	1	11	5	17	5	22	5	115	1	125	1	99	1	80	1
Chloride	mg/L	258	2	226	1	209	1	196	1	369	4	335	2	321	2	320	2
Fluoride	mg/L	0.8	0.1	0.7	0.1	0.8	0.1	0.6	0.1	0.9	0.1	0.8	0.1	0.8	0.1	0.7	0.1
Magnesium	mg/L	<1	1	<1	1	1	1	<1	1	<1	1	<1	1	1	1	1	1
Nitrogen Ammonia as N	mg/L	0.36	0.05	0.3	0.1	0.33	0.05	0.1	0.1	0.5	0.05	0.48	0.05	0.43	0.05	0.54	0.05
Nitrogen Nitrate+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	23	1	16	1	19	1	41	1	39	1	36	1	31	1
Silica	mg/L	15.3	0.2	14	1	18.1	0.2	17	1	30	0.2	30.7	0.2	21.9	0.2	25	0.2
Sodium	mg/L	365	1	367	1	340	1	357	1	519	1	514	1	505	1	438	1
Sulfate	mg/L	113	2	103	1	115	4	95	1	308	4	308	4	312	4	312	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1750	1	1710	1	1580	1	1510	1	2400	1	2290	1	2230	1	2260	1
pH	s.u.	8.91	0.01	8.6	0.01	8.78	0.01	8.7	0.1	9.92	0.01	10	0.01	9.88	0.01	9.72	0.01
Total Dissolved Solids @ 180 °C	mg/L	958	10	940	10	951	10	930	10	1420	10	1290	10	1300	10	1290	10
METALS, DISSOLVED																	
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.4	0.1	0.4	0.1	0.3	0.1	0.3	0.1
Arsenic	mg/L	0.005	0.001	0.002	0.001	0.003	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	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
Boron	mg/L	1.3	0.1	1.6	0.1	1.4	0.1	1.5	0.1	1.2	0.1	1.1	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
Calcium	mg/L	3	1	4	1	5	1	4	1	5	1	4	1	5	1	4	1
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	0.1	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.03	<0.05	0.03	0.04	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05	<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
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	<0.1	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
Selenium	mg/L	0.003	0.001	0.024	0.001	0.002	0.001	<0.002	0.001	0.003	0.001	0.003	0.001	0.005	0.002	0.005	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02	<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	0.02	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	1.32		3.17		0.175		2.72		1.5		3.34		3.78		-8.37	
Anions	meq/L	16.1		15.71		15.5		15.34		23.2		22.1		21.5		20.6	
Cations	meq/L	16.6		16.74		15.6		16.2		23.9		23.7		23.2		20.2	
Solids Total Dissolved Calculated	mg/L	971		950		900		920		1470		1430		1390		1290	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 5		Monitor 5		Monitor 5		Monitor 6		Monitor 6		Monitor 6		Monitor 6		Monitor 6	
Date Collected:		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	260	5	260	5	266	5	370	1	368	1	361	1	271	1	292	5
Bicarbonate as HCO_3	mg/L	214	5	234	5	230	5	313	1	311	1	332	1	280	1	334	5
Carbonate as CO_3	mg/L	51	5	43	5	47	5	68	1	68	1	53	1	25	1	11	5
Chloride	mg/L	280	1	254 D	1	233	1	492	4	428	4	386	4	398	4	361	1
Fluoride	mg/L	0.6	0.1	0.7	0.1	0.5	0.1	0.9	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1
Magnesium	mg/L	1	1	2	1	1	1	<1	1	<1	1	<1	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	0.2	0.1	0.41	0.05	0.2	0.1	0.42	0.05	0.4	0.05	0.3	0.05	0.53	0.05	0.4	0.1
Nitrogen Nitrate+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	36	1	27	1	29	1	29	1	25	1	23	1	22	1	25	1
Silica	mg/L	23	1	22.9	0.2	20	1	21.7	0.2	19.6	0.2	15.1	0.2	15.5	0.2	15	1
Sodium	mg/L	454	1	421	1	429	1	499	1	478	1	455	1	377	1	381	1
Sulfate	mg/L	269	1	308	4	275	1	59	4	59	4	59	4	53	1	45	1
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	2220	1	2010	1	1880	1	2290	1	2100	1	2000	1	1950	1	1920	1
pH	s.u.	9.3	0.01	9.48	0.01	9.3	0.1	9.32	0.01	9.31	0.01	9.17	0.01	8.82	0.01	8.6	0.01
Total Dissolved Solids @ 180 °C	mg/L	1220	10	1270	10	1190	10	1290	10	1160	10	1140	10	1040	10	1000	10
METALS, DISSOLVED																	
Aluminum	mg/L	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	0.2	0.1
Arsenic	mg/L	<0.001	0.001	0.002	0.001	<0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	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
Boron	mg/L	1.2	0.1	1.3	0.1	1.3	0.1	1.3	0.1	1.3	0.1	1.3	0.1	1.2	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
Calcium	mg/L	5	1	7	1	5	1	7	1	7	1	7	1	13	1	5	1
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	0.1	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.05	0.05	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.05
Lead	mg/L	<0.001	0.05	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05
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	<0.1	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
Selenium	mg/L	0.068	0.001	0.003	0.001	0.006	0.001	0.003	0.001	0.003	0.001	0.004	0.002	0.004	0.001	0.068	0.001
Vanadium	mg/L	<0.1	0.02	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02
Zinc	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.02	0.01	<0.01	0.01	<0.01	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	4.76		1.17		4.62		0.72		2.72		3.6		0.32		2.56	
Anions	meq/L	19.11		19.1		17.99		22.6		20.7		19.4		17.8		17.01	
Cations	meq/L	21.03		19.6		19.73		22.9		21.9		20.8		17.7		17.9	
Solids Total Dissolved Calculated	mg/L	1220		1200		1150		1340		1240		1170		1050		1020	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

	Location ID:	Monitor 6		Monitor 6		Monitor 7		Monitor 7		Monitor 7		Monitor 7		Monitor 7		Monitor 7	
	Date Collected:	6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012	
	Formation:	CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	260	5	322	5	253	1	253	1	273	1	245	1	283	5	301	5
Bicarbonate as HCO_3	mg/L	234	5	345	5	237	1	244	1	270	1	264	1	321	5	338	5
Carbonate as CO_3	mg/L	43	5	23	5	36	1	32	1	31	1	17	1	12	5	14	5
Chloride	mg/L	254 D	1	304	1	400	4	371	4	346	4	241	1	216	1	188	1
Fluoride	mg/L	0.7	0.1	0.6	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1
Magnesium	mg/L	2	1	1	1	<1	1	1	1	1	1	2	1	2	1	2	1
Nitrogen Ammonia as N	mg/L	0.41	0.05	0.3	0.1	0.21	0.05	0.25	0.05	0.21	0.05	0.33	0.05	0.2	0.1	0.29	0.05
Nitrogen Nitrate+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	27	1	23	1	19	1	18	1	17	1	16	1	21	1	15	1
Silica	mg/L	22.9	0.2	16	1	18.9	0.2	18	0.2	14	0.2	15.8	0.2	16	1	18.5	0.2
Sodium	mg/L	421	1	378	1	501	1	518	1	511	1	410	1	422	1	386	1
Sulfate	mg/L	308	4	46	1	295	4	295	4	293	4	305	2	266	1	306	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	2010	1	1660	1	2310	1	2220	1	2200	1	1960	1	1970	1	1810	1
pH	s.u.	9.48	0.01	8.8	0.1	9.19	0.01	9.25	0.01	9.1	0.01	8.86	0.01	8.6	0.01	8.76	0.01
Total Dissolved Solids @ 180 °C	mg/L	1270	10	970	10	1380	10	1330	10	1310	10	1110	10	1130	10	1130	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	0.002	0.001	<0.001	0.001	0.002	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.002	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
Boron	mg/L	1.3	0.1	1.4	0.1	1.2	0.1	1.1	0.1	1.4	0.1	1.3	0.1	1.4	0.1	1.5	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
Calcium	mg/L	7	1	9	1	8	1	7	1	7	1	6	1	7	1	10	1
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	0.1	<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	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.05	<0.05	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.003	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.005	0.002	0.004	0.001	0.011	0.001	0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1
Zinc	mg/L	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01	0.02	0.01	0.01	0.01	0.04	0.01	<0.01	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	1.17		4.62		0.568		3.78		3.91		1.67		4.86		0.403	
Anions	meq/L	19.1		16		22.5		21.7		21.4		18.1		17.59		17.7	
Cations	meq/L	19.6		17.55		22.8		23.4		23.1		18.7		19.39		17.9	
Solids Total Dissolved Calculated	mg/L	1200		970		1400		1390		1360		1150		1120		1100	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 7		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8	
Date Collected:		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	311	5	296	1	288	1	294	1	253	1	274	5	282	5	296	5
Bicarbonate as HCO_3	mg/L	339	5	301	1	302	1	314	1	267	1	918	5	323	5	336	5
Carbonate as CO_3	mg/L	20	5	30	1	24	1	21	1	20	1	5	5	10	5	13	5
Chloride	mg/L	192	1	262	2	217	1	197	1	250	2	197	1	177	1	169	1
Fluoride	mg/L	0.6	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.5	0.1
Magnesium	mg/L	2	1	2	1	2	1	2	1	2	1	2	1	3	1	3	1
Nitrogen Ammonia as N	mg/L	0.1	0.1	0.31	0.05	0.32	0.05	0.28	0.05	0.39	0.05	0.3	0.1	0.32	0.05	0.1	0.1
Nitrogen Nitrate+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	20	1	19	1	18	1	20	1	24	1	17	1	23	1
Silica	mg/L	16	1	21	0.2	19.7	0.2	15.5	0.2	18.9	0.2	16	1	18.5	0.2	15	1
Sodium	mg/L	423	1	482	1	472	1	461	1	445	1	441	1	425	1	430	1
Sulfate	mg/L	278	1	389	4	394	4	396	4	388	2	349	1	388	4	362	1
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1730	1	2140	1	2020	1	1960	1	2180	1	2090	1	1950	1	1830	1
pH	s.u.	8.8	0.1	9.05	0.01	8.98	0.01	8.84	0.01	8.91	0.01	8.5	0.01	8.65	0.01	8.6	0.1
Total Dissolved Solids @ 180 °C	mg/L	1080	10	1330	10	1260	10	1230	10	1260	10	1190	10	1220	10	1250	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	0.001	0.001	0.002	0.001	0.002	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
Boron	mg/L	1.4	0.1	1.3	0.1	1.1	0.1	1.4	0.1	1.2	0.1	1.2	0.1	1.4	0.1	1.3	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
Calcium	mg/L	8	1	10	1	9	1	10	1	12	1	10	1	12	1	10	1
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	0.1	<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	0.1
Iron	mg/L	<0.05	0.05	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.05
Lead	mg/L	<0.001	0.05	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05
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	<0.1	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
Selenium	mg/L	<0.002	0.001	0.003	0.001	0.002	0.001	0.006	0.002	0.003	0.001	0.012	0.001	0.002	0.001	<0.002	0.001
Vanadium	mg/L	<0.1	0.02	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02
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
DATA QUALITY																	
A/C Balance (± 5)	%	4.57		1.54		3.53		3.63		0.971		4.86		2.74		4.72	
Anions	meq/L	17.72		21.4		20.1		19.7		20.2		18.6		18.7		18.23	
Cations	meq/L	19.42		22.1		21.6		21.2		20.6		20.51		19.8		20.04	
Solids Total Dissolved Calculated	mg/L	1120		1370		1310		1280		1290		1200		1200		1190	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 10	
Date Collected:		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	295	1	319	1	337	1	307	1	336	5	343	5	356	5	300	1
Bicarbonate as HCO_3	mg/L	272	1	308	1	345	1	297	1	381	5	387	5	390	5	326	1
Carbonate as CO_3	mg/L	43	1	40	1	32	1	38	1	14	5	16	5	22	5	20	1
Chloride	mg/L	366	4	318	2	279	2	269	2	252	1	232	1	224	1	226	1
Fluoride	mg/L	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.8	0.1	0.6	0.1	0.7	0.1
Magnesium	mg/L	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	<1	1	1	1
Nitrogen Ammonia as N	mg/L	0.23	0.05	0.27	0.05	0.27	0.05	0.33	0.05	0.3	0.1	0.34	0.05	0.2	0.1	0.32	0.05
Nitrogen Nitrate+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	22	1	19	1	17	1	15	1	19	1	14	1	18	1	13	1
Silica	mg/L	16.3	0.2	16.5	0.2	14.4	0.2	14.9	0.2	15	1	17.3	0.2	15	1	18.8	0.2
Sodium	mg/L	401	1	399	1	397	1	344	1	362	1	341	1	361	1	451	1
Sulfate	mg/L	73	4	84	8	89	4	91	2	78	1	95	4	79	1	346	4
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1850	1	1740	1	1680	1	1700	1	1690	1	1570	1	1500	1	1950	1
pH	s.u.	9.28	0.01	9.19	0.01	9.02	0.01	8.91	0.01	8.7	0.01	8.75	0.01	8.8	0.1	8.73	0.01
Total Dissolved Solids @ 180 °C	mg/L	1040	10	993	10	964	10	946	10	890	10	910	10	1180	10	1210	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	0.004	0.001	0.004	0.001	0.003	0.001	0.002	0.001	<0.001	0.001	0.001	0.001	0.001	0.001	0.002	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
Boron	mg/L	1.1	0.1	1	0.1	1.2	0.1	1.1	0.1	1.2	0.1	1.3	0.1	1.4	0.1	1.4	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
Calcium	mg/L	4	1	3	1	3	1	2	1	10	1	4	1	3	1	8	1
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	<0.01	0.01	<0.01	0.1	<0.01	0.01
Iron	mg/L	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.05	<0.05	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.003	0.001	0.002	0.001	0.004	0.002	0.004	0.001	0.011	0.001	0.003	0.001	<0.002	0.001	0.003	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02	<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
DATA QUALITY																	
A/C Balance (± 5)	%	1.26		2.53		4.14		-0.463		2.77		0.0047		3.85		2.24	
Anions	meq/L	17.8		17.1		16.5		15.7		15.51		15.5		15.1		19.6	
Cations	meq/L	18.2		18		17.9		15.5		16.4		15.5		16.31		20.5	
Solids Total Dissolved Calculated	mg/L	1060		1040		1010		925		930		890		910		1250	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 11		Monitor 11	
Date Collected:		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS																	
Alkalinity Total as $CaCO_3$	mg/L	313	1	314	1	274	1	307	5	314	5	361	5	339	1	347	1
Bicarbonate as HCO_3	mg/L	346	1	351	1	301	1	363	5	360	5	412	5	260	1	272	1
Carbonate as CO_3	mg/L	18	1	16	1	16	1	6	5	11	5	14	5	76	1	74	1
Chloride	mg/L	186	2	175	1	151	1	143	1	141	1	137	1	519	4	452	2
Fluoride	mg/L	0.7	0.1	0.7	0.1	0.8	0.1	0.7	0.1	0.8	0.1	0.6	0.1	0.9	0.1	0.8	0.1
Magnesium	mg/L	2	1	2	1	1	1	2	1	<1	1	2	1	<1	1	<1	1
Nitrogen Ammonia as N	mg/L	0.35	0.05	0.34	0.05	0.37	0.05	0.4	0.1	0.38	0.05	0.2	0.1	0.26	0.05	0.27	0.05
Nitrogen Nitrate+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	13	1	13	1	11	1	15	1	11	1	16	1	31	1	29	1
Silica	mg/L	17.8	0.2	13.1	0.2	17.2	0.2	16	1	18	0.2	16	1	16.3	0.2	15	0.2
Sodium	mg/L	438	1	432	1	386	1	405	1	392	1	425	1	550	1	522	1
Sulfate	mg/L	344	8	347	4	347	2	307	1	347	4	300	1	130	4	132	8
PHYSICAL PROPERTIES																	
Conductivity @ 25 °C	umhos/cm	1850	1	1820	1	1810	1	1880	1	1770	1	1710	1	2450	1	2300	1
pH	s.u.	8.65	0.01	8.61	0.01	8.66	0.01	8.4	0.01	8.54	0.01	8.6	0.1	9.49	0.01	9.47	0.01
Total Dissolved Solids @ 180 °C	mg/L	1170	10	1140	10	1080	10	1090	10	1120	10	1180	10	1400	10	1330	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	0.002	0.001	0.001	0.001	0.002	0.001	<0.001	0.001	0.001	0.001	<0.001	0.001	0.004	0.001	0.004	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
Boron	mg/L	1	0.1	1.4	0.1	1.3	0.1	1.3	0.1	1.4	0.1	1.5	0.1	1.4	0.1	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
Calcium	mg/L	8	1	9	1	6	1	7	1	8	1	7	1	5	1	4	1
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	<0.01	0.1	<0.01	0.01	<0.01	0.01
Iron	mg/L	<0.05	0.03	<0.05	0.03	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.03
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05	<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	<0.1	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
Selenium	mg/L	0.002	0.001	0.004	0.002	0.003	0.001	<0.002	0.001	0.001	0.001	<0.002	0.001	0.003	0.001	0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.1
Zinc	mg/L	<0.01	0.01	0.02	0.01	<0.01	0.01	0.03	0.01	0.02	0.01	0.04	0.01	<0.01	0.01	<0.01	0.01
DATA QUALITY																	
A/C Balance (± 5)	%	3.18		3.21		1.52		4.67		1.4		4.96		1.8		2.78	
Anions	meq/L	18.7		18.5		17		16.87		17.5		17.61		24.2		22.5	
Cations	meq/L	19.9		19.7		17.5		18.53		18		19.45		25		23.8	
Solids Total Dissolved Calculated	mg/L	1200		1180		1090		1080		1100		1120		1460		1370	

Table 6.1-10 Marsland Expansion Area Non-Radiological Analytical Results (March to May 2011) Chadron Wells

Location ID:		Monitor 11		Monitor 11		Monitor 11		Monitor 11		Monitor 11	
Date Collected:		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
MAJOR IONS											
Alkalinity Total as $CaCO_3$	mg/L	345	1	323	1	352	5	365	5	369	5
Bicarbonate as HCO_3	mg/L	309	1	330	1	393	5	403	5	394	5
Carbonate as CO_3	mg/L	55	1	32	1	18	5	21	5	28	5
Chloride	mg/L	401	4	370	4	318	1	292	2	270	1
Fluoride	mg/L	0.8	0.1	0.7	0.1	0.8	0.1	0.7	0.1	0.6	0.1
Magnesium	mg/L	<1	1	1	1	1	1	2	1	1	1
Nitrogen Ammonia as N	mg/L	0.24	0.05	0.37	0.05	0.3	0.1	0.32	0.05	0.2	0.1
Nitrogen Nitrate+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
Potassium	mg/L	23	1	21	1	28	1	21	1	26	1
Silica	mg/L	11.7	0.2	12.4	0.2	13	1	14.7	0.2	13	1
Sodium	mg/L	420	1	425	1	439	1	403	1	414	1
Sulfate	mg/L	135	4	124	2	107	1	131	4	110	1
PHYSICAL PROPERTIES											
Conductivity @ 25 °C	umhos/cm	2160	1	2120	1	2060	1	1890	1	1760	1
pH	s.u.	9.29	0.01	8.99	0.01	8.7	0.01	8.85	0.01	8.8	0.1
Total Dissolved Solids @ 180 °C	mg/L	1250	10	1160	10	1110	10	1130	10	1120	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
Arsenic	mg/L	0.003	0.001	0.003	0.001	0.002	0.001	0.003	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
Boron	mg/L	1.4	0.1	1.2	0.1	1.3	0.1	1.4	0.1	1.4	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
Calcium	mg/L	5	1	5	1	6	1	8	1	6	1
Chromium	mg/L	<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	0.1
Iron	mg/L	<0.05	0.03	<0.05	0.03	<0.05	0.05	<0.05	0.03	<0.05	0.05
Lead	mg/L	<0.001	0.001	<0.001	0.001	<0.001	0.05	<0.001	0.001	<0.001	0.05
Manganese	mg/L	<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
Molybdenum	mg/L	<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
Selenium	mg/L	0.004	0.002	0.0005	0.001	0.022	0.001	0.002	0.001	<0.002	0.001
Vanadium	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.02	<0.1	0.1	<0.1	0.02
Zinc	mg/L	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)	%	-4.61		-0.277		4.45		0.897		4.88	
Anions	meq/L	21.1		19.5		18.5		18.3		17.31	
Cations	meq/L	19.2		19.4		20.22		18.6		19.09	
Solids Total Dissolved Calculated	mg/L	1210		1160		1120		1100		1060	

Table 6.1-11 Marsland Expansion Area Groundwater Radiological Analytical Results (2011-2012) Chadron Wells

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 1		Monitor 2	
Date Collected:		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	109	0.8	67	0.7	92.1	0.8	15.3	1.3	11	1	39.6	1.1	19.7	1	3.9	0.9
Lead 210 precision (±)	pCi/L	1.5		1.1		1.3		0.9		0.9		1.2		1.1		0.6	
Lead 210 MDC	pCi/L	0.8		0.7		0.8		1.3		-		1.1		-		0.9	
Polonium 210	pCi/L	8.3	0.8	22	0.7	9.8	0.9	6.6	0.6	<1.0	1	4.9	0.6	1	1	<0.7	0.7
Polonium 210 precision (±)	pCi/L	2.5		5.5		3.3		2.2		-		1.8		0.8		0.5	
Polonium 210 MDC	pCi/L	0.8		0.7		0.9		0.6		-		0.6		-		0.7	
Radium 226	pCi/L	16	0.15	18	0.1	9.4	0.1	23	0.1	12.3	0.2	17	0.17	12.9	0.2	1	0.1
Radium 226 precision (±)	pCi/L	0.83		0.8		0.6		0.8		0.4		0.83		0.5		0.18	
Radium 226 MDC	pCi/L	0.15		0.1		0.1		0.1		-		0.17		-		0.1	
Thorium 230	pCi/L	1.7	0.1	1.4	0.2	0.3	0.1	<0.2	0.2	<0.2	0.2	0.4	0.2	<0.2	0.2	0.2	0.1
Thorium 230 precision (±)	pCi/L	0.4		0.3		0.1		0.09		-		0.2		-		0.1	
Thorium 230 MDC	pCi/L	0.1		0.2		0.1		0.2		-		0.2		-		0.1	
Uranium	mg/L	0.0132	0.0003	0.0087	0.0003	0.0077	0.0003	0.0142	0.0003	0.002	0.0003	0.0062	0.0003	0.0073	0.0003	0.0032	0.0003
Uranium Activity	uCi/mL	9.00E-09	2.00E-10	5.90E-09	2.00E-10	5.20E-09	2.00E-10	9.60E-08	2.00E-10	4.30E+00	2.00E-01	4.20E-09	2.00E-10	4.90E+00	2.00E-01	2.20E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	103	0.9	80	0.8	61	0.8	1.5	0.9	61.2	1	44.9	0.8	53	1	<0.9	0.9
Lead 210 precision (±)	pCi/L	1.4		1.2		1.1		0.6		2.1		1		1.5		0.5	
Lead 210 MDC	pCi/L	0.9		0.8		0.8		0.9		-		0.8		-		0.9	
Polonium 210	pCi/L	12.8	0.6	22	0.2	12	0.2	0.8	0.2	8.8	1	14.8	0.6	2.5	1	0.4	0.2
Polonium 210 precision (±)	pCi/L	4.8		4.6		2.7		0.4		1		5.4		0.8		0.3	
Polonium 210 MDC	pCi/L	0.6		0.2		0.2		0.2		-		0.6		-		0.2	
Radium 226	pCi/L	30	0.14	45	0.1	13	0.1	1.6	0.1	8.8	0.2	17	0.12	7.8	0.1	1.1	0.12
Radium 226 precision (±)	pCi/L	1.1		1.2		0.7		0.2		0.5		0.72		0.3		0.2	
Radium 226 MDC	pCi/L	0.14		0.1		0.1		0.1		-		0.12		-		0.12	
Thorium 230	pCi/L	11.6	0.1	25	0.1	4.5	0.1	<0.1	0.1	4.3	0.1	10.1	0.1	3	0.2	0.3	0.07
Thorium 230 precision (±)	pCi/L	1.9		3.7		0.8		0.06		0.6		1.5		0.5		0.1	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		-		0.1		-		0.07	
METALS, SUSPENDED																	
Uranium	mg/L	0.0378	0.0003	0.0843	0.0003	0.0148	0.0003	<0.0003	0.0003	0.0008	0.0003	0.0295	0.0003	0.0092	0.0003	0.0012	0.0003
Uranium Activity	uCi/mL	2.60E-08	2.00E-10	5.70E-08	2.00E-10	1.00E-08	2.00E-10	<2.00E-10	2.00E-10	5.00E-01	2.00E-01	2.00E-08	2.00E-10	6.20E+00	2.00E-01	8.30E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 2		Monitor 2		Monitor 2		Monitor 2		Monitor 2		Monitor 2		CPW-2010-1		CPW-2010-1	
Date Collected:		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/9/2011		3/24/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	1.1	0.7	<0.8	0.8	0.9	0.8	<1.0	1	<0.8	0.8	2.8	1	13.5	0.7	8.4	0.8
Lead 210 precision (±)	pCi/L	0.5		0.5		0.5		-		0.5		0.5		0.6		0.6	
Lead 210 MDC	pCi/L	0.7		0.8		0.3		-		0.8		-		0.7		0.8	
Polonium 210	pCi/L	3.7	0.9	<0.8	0.8	3.3	0.9	1.2	1	<0.5	0.5	<1.0	1	0.5	0.5	<1.1	1.1
Polonium 210 precision (±)	pCi/L	1.8		0.5		1.7		0.1		0.3		-		0.5		0.8	
Polonium 210 MDC	pCi/L	0.9		0.8		0.9		-		0.5		-		0.5		1.1	
Radium 226	pCi/L	0.8	0.1	0.7	0.1	1.7	0.1	<0.2	0.2	1.9	0.16	1.1	0.2	38	0.13	34	1.9
Radium 226 precision (±)	pCi/L	0.2		0.2		0.3		-		0.28		0.1		1.2		1.2	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		-		0.16		-		0.13		0.19	
Thorium 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.1		0.1		0.09		-		0.07		-		0.08		0.1	
Thorium 230 MDC	pCi/L	0.2		0.1		0.2		-		0.2		-		0.1		0.2	
Uranium	mg/L	0.0028	0.0003	0.0025	0.0003	0.0023	0.0003	0.0034	0.0003	0.0021	0.0003	0.0017	0.0003	0.0115	0.0003	0.0112	0.0003
Uranium Activity	uCi/mL	1.90E-09	2.00E-10	1.70E-09	2.00E-10	1.60E-09	2.00E-10	2.30E+00	2.00E-01	1.40E-09	2.00E-10	1.20E+00	2.00E-01	7.80E-09	2.00E-10	7.60E-09	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	<0.8	0.8	0.9	0.8	1.2	0.9	1.1	1	<0.8	0.8	1.2	1	9.4	1.2	2.1	1
Lead 210 precision (±)	pCi/L	0.5		0.5		0.6		0.5		0.5		0.3		0.9		0.6	
Lead 210 MDC	pCi/L	0.8		0.8		0.9		-		0.8		-		1.2		1	
Polonium 210	pCi/L	0.4	0.2	0.4	0.2	0.3	0.3	<1.0	1	<0.3	0.3	<1.0	1	1.9	0.3	0.4	0.2
Polonium 210 precision (±)	pCi/L	0.3		0.3		0.2		-		0.3		-		0.7		0.2	
Polonium 210 MDC	pCi/L	0.2		0.2		0.3		-		0.3		-		0.3		0.2	
Radium 226	pCi/L	1	0.1	0.8	0.1	0.9	0.1	0.5	0.2	0.32	0.13	0.3	0.1	0.18	0.13	0.27	0.09
Radium 226 precision (±)	pCi/L	0.2		0.2		0.1		0.1		0.13		0.1		0.1		0.09	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		-		0.13		-		0.13		0.09	
Thorium 230	pCi/L	0.2	0.1	0.3	0.1	0.2	0.1	<0.2	0.2	<0.1	0.1	<0.2	0.2	<0.05	0.05	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.1		0.1		-		0.9		-		0.04		0.08	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		-		0.1		-		0.05		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	0.0012	0.0003	0.001	0.0003	0.001	0.0003	<0.0003	0.0003	0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	8.00E-10	2.00E-10	6.70E-10	2.00E-10	6.90E-10	2.00E-10	<2.00E-01	2.00E-01	2.10E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		CPW-2010-1		CPW-2010-1		CPW-2010-1		CPW-2010-1		CPW-2010-1		Monitor 4A		Monitor 4A		Monitor 4A	
Date Collected:		4/6/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	9	0.6	15.3	1.3	3.6	1	4.9	1.1	5.8	1	326	0.8	591	0.8	698	0.8
Lead 210 precision (±)	pCi/L	0.5		0.9		0.5		0.7		0.6		2.5		3.1		3.3	
Lead 210 MDC	pCi/L	0.6		1.3		-		1.1		-		0.8		0.8		0.8	
Polonium 210	pCi/L	1.7	0.7	6.6	0.6	<1.0	1	<0.5	0.5	<1.0	1	145	1.3	131	0.7	139	0.5
Polonium 210 precision (±)	pCi/L	0.9		2.2		-		0.3		-		46.1		27		28	
Polonium 210 MDC	pCi/L	0.7		0.6		-		0.5		-		1.3		0.7		0.5	
Radium 226	pCi/L	29	0.1	23	0.1	27.5	0.2	24	0.17	14.3	0.2	240	0.15	238	0.1	227	0.1
Radium 226 precision (±)	pCi/L	1		0.8		0.6		0.98		0.4		3.2		2.9		2.7	
Radium 226 MDC	pCi/L	0.1		0.1		-		0.17		-		0.15		0.1		0.1	
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	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.09		0.09		-		0.08		-		0.1		0.1		0.09	
Thorium 230 MDC	pCi/L	0.2		0.2		-		0.2		-		0.2		0.2		0.2	
Uranium	mg/L	0.0114	0.0003	0.0142	0.0003	0.0091	0.0003	0.009	0.0003	0.0037	0.0003	0.084	0.0003	0.0826	0.0003	0.0677	0.0003
Uranium Activity	uCi/mL	7.70E-09	2.00E-10	9.60E-09	2.00E-10	6.20E+00	2.00E-01	6.10E-09	2.00E-10	2.50E+00	2.00E-01	5.70E-08	2.00E-10	5.60E-08	2.00E-10	4.60E-08	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	4	0.8	1.5	0.9	5.6	1	2.3	0.9	6.4	1	62.1	0.9	36	0.8	34	0.9
Lead 210 precision (±)	pCi/L	0.6		0.6		0.6		0.6		0.7		1.2		0.9		0.9	
Lead 210 MDC	pCi/L	0.8		0.9		-		0.9		-		0.9		0.8		0.9	
Polonium 210	pCi/L	0.9	0.2	0.8	0.2	<1.0	1	0.3	0.3	<1.0	1	9.1	0.4	8.2	0.2	10	0.2
Polonium 210 precision (±)	pCi/L	0.4		0.4		-		0.3		-		3		1.8		2.2	
Polonium 210 MDC	pCi/L	0.2		0.2		-		0.3		-		0.4		0.2		0.2	
Radium 226	pCi/L	<0.1	0.1	1.6	0.1	1.7	0.1	2.2	0.12	3.5	0.1	0.77	0.12	0.7	0.1	0.7	0.1
Radium 226 precision (±)	pCi/L	0.05		0.2		0.2		0.26		0.2		0.17		0.2		0.2	
Radium 226 MDC	pCi/L	0.1		0.1		-		0.12		-		0.12		0.1		0.1	
Thorium 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.2	0.2	0.6	0.09	0.6	0.1	0.4	0.1
Thorium 230 precision (±)	pCi/L	0.1		0.06		-		0.06		-		0.2		0.2		0.2	
Thorium 230 MDC	pCi/L	0.2		0.1		-		0.1		-		0.09		0.1		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0013	0.0003	0.0016	0.0003	0.0013	0.0003
Uranium Activity	uCi/mL	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	8.90E-10	2.00E-10	1.10E-09	2.00E-10	8.70E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 4A		Monitor 4A		Monitor 4A		Monitor 4A		Monitor 5		Monitor 5		Monitor 5		Monitor 5	
Date Collected:		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	1130	1.3	591	1	604	1.1	540	1	1.1	0.9	1	0.7	<0.8	0.8	<0.8	0.8
Lead 210 precision (±)	pCi/L	4.6		5.3		4.1		5.4		0.5		0.4		0.5		0.5	
Lead 210 MDC	pCi/L	1.3		-		1.1		-		0.9		0.7		0.8		0.8	
Polonium 210	pCi/L	165	1.2	62.6	1	104	0.5	100	1	<0.6	0.6	1.2	0.7	<0.6	0.6	<0.7	0.7
Polonium 210 precision (±)	pCi/L	54		3.2		21.1		4.3		0.5		0.8		0.5		0.5	
Polonium 210 MDC	pCi/L	1.2		-		0.5		-		0.6		0.7		0.6		0.7	
Radium 226	pCi/L	262	0.1	321	0.2	390	0.17	348	0.2	0.35	0.13	2.3	0.1	2	0.1	3.5	0.1
Radium 226 precision (±)	pCi/L	3		2.2		4		2.3		0.14		0.3		0.3		0.3	
Radium 226 MDC	pCi/L	0.1		-		0.17		-		0.13		0.1		0.1		0.1	
Thorium 230	pCi/L	<0.2	0.2	0.07	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.1		0.2		0.9		-		0.1		0.07		0.07		0.1	
Thorium 230 MDC	pCi/L	0.2		-		0.2		-		0.2		0.1		0.2		0.2	
Uranium	mg/L	0.0771	0.0003	0.0457	0.0003	0.0475	0.0003	0.0346	0.0003	0.0006	0.0003	0.0004	0.0003	0.0009	0.0003	0.0007	0.0003
Uranium Activity	uCi/mL	5.20E-08	2.00E-10	3.09E+01	2.00E-01	3.20E-08	2.00E-10	3.00E-01	2.00E-01	4.30E-10	2.00E-10	3.00E-10	2.00E-10	6.40E-10	2.00E-10	4.60E-10	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	22	0.9	49.7	1	17.6	0.8	60.4	1	<0.9	0.9	<0.8	0.8	<0.9	0.9	<0.9	0.9
Lead 210 precision (±)	pCi/L	0.9		1.5		0.7		2.2		0.5		0.5		0.5		0.6	
Lead 210 MDC	pCi/L	0.9		-		0.8		-		0.9		0.8		0.9		0.9	
Polonium 210	pCi/L	6.2	0.2	39.7	1	4.5	0.3	17.2	1	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2
Polonium 210 precision (±)	pCi/L	1.4		2.6		1.6		1.5		0.1		0.1		0.09		0.1	
Polonium 210 MDC	pCi/L	0.2		-		0.3		-		0.3		0.2		0.2		0.2	
Radium 226	pCi/L	0.9	0.1	0.5	0.2	0.32	0.13	0.3	0.1	<0.12	0.12	<0.1	0.1	<0.1	0.1	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.1		0.1		0.11		0.1		0.05		0.07		0.04		0.05	
Radium 226 MDC	pCi/L	0.1		-		0.11		-		0.12		0.1		0.1		0.1	
Thorium 230	pCi/L	0.3	0.1	<0.2	0.2	0.4	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.1		-		0.1		-		0.09		0.07		0.06		0.06	
Thorium 230 MDC	pCi/L	0.1		-		0.1		-		0.1		0.1		0.1		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	0.0008	0.0003	<0.0003	0.0003	0.0005	0.0003	0.0004	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	5.60E-10	2.00E-10	<2.00E-01	2.00E-01	3.60E-10	2.00E-10	3.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 5		Monitor 5		Monitor 5		Monitor 6		Monitor 6		Monitor 6		Monitor 6		Monitor 6	
Date Collected:		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	<1.0	1	<0.8	0.8	1.6	1	1	0.8	2.4	1.1	2.2	1.3	<0.8	0.8	1.6	1
Lead 210 precision (±)	pCi/L	-		0.5		0.4		0.5		0.7		0.8		0.5		0.4	
Lead 210 MDC	pCi/L	-		0.8		-		0.8		1.1		1.3		0.8		-	
Polonium 210	pCi/L	<1.0	1	<0.5	0.5	<1.0	1	0.9	0.7	1	0.7	0.9	0.8	<0.7	0.7	<1.0	1
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.7		0.7		0.9		0.5		-	
Polonium 210 MDC	pCi/L	-		0.5		-		0.7		0.7		0.8		0.7		-	
Radium 226	pCi/L	0.9	0.2	3.4	0.17	5.5	0.2	2.4	0.13	1.4	0.1	1.9	0.1	3.5	0.1	1.8	0.2
Radium 226 precision (±)	pCi/L	0.1		0.39		0.4		0.31		0.2		0.3		0.3		0.2	
Radium 226 MDC	pCi/L	-		0.17		-		0.13		0.1		0.1		0.1		-	
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2	0.4	0.2
Thorium 230 precision (±)	pCi/L	-		0.07		-		0.07		0.08		0.09		0.1		0.2	
Thorium 230 MDC	pCi/L	-		0.2		-		0.1		0.1		0.2		0.2		-	
Uranium	mg/L	<0.0003	0.0003	0.0006	0.0003	0.0004	0.0003	0.0027	0.0003	0.0028	0.0003	0.0014	0.0003	0.0007	0.0003	0.0011	0.0003
Uranium Activity	uCi/mL	<2.00E-01	2.00E-01	3.90E-10	2.00E-10	3.00E-01	2.00E-01	1.80E-09	2.00E-10	1.90E-09	2.00E-10	9.50E-10	2.00E-10	4.60E-10	2.00E-10	7.00E-01	2.00E-01
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	<1.0	1	<0.8	0.8	<1.0	1	<0.9	0.9	<0.8	0.8	<0.9	0.9	<0.9	0.9	1.4	1
Lead 210 precision (±)	pCi/L	-		0.5		-		0.5		0.5		0.6		0.6		0.4	
Lead 210 MDC	pCi/L	-		0.8		-		0.9		0.8		0.9		0.9		-	
Polonium 210	pCi/L	<1.0	1	<0.3	0.3	<1.0	1	<0.2	0.2	<0.3	0.3	<0.2	0.2	<0.2	0.2	<1.0	1
Polonium 210 precision (±)	pCi/L	-		0.3		-		0.2		0.2		0.2		0.1		-	
Polonium 210 MDC	pCi/L	-		0.3		-		0.2		0.3		0.2		0.2		-	
Radium 226	pCi/L	<0.2	0.2	<0.13	0.13	<0.1	0.1	<0.12	0.12	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2
Radium 226 precision (±)	pCi/L	-		0.7		-		0.05		0.07		0.03		0.05		-	
Radium 226 MDC	pCi/L	-		0.13		-		0.12		0.1		0.1		0.1		-	
Thorium 230	pCi/L	<0.2	0.2	<0.09	0.09	<0.2	0.2	<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	-		0.07		-		0.09		0.08		0.07		0.06		-	
Thorium 230 MDC	pCi/L	-		0.09		-		0.1		0.1		0.1		0.1		-	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	0.0004	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	3.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 6		Monitor 6		Monitor 7		Monitor 7		Monitor 7		Monitor 7		Monitor 7		Monitor 7	
Date Collected:		6/4/2012		8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	<0.8	0.8	1.5	1	<0.9	0.9	<0.8	0.8	<0.8	0.8	<0.8	0.8	<1.0	1	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.5		0.4		0.5		0.5		0.5		0.5		-		0.5	
Lead 210 MDC	pCi/L	0.8		-		0.9		0.8		0.8		0.8		-		0.8	
Polonium 210	pCi/L	<0.9	0.9	<1.0	1	<0.9	0.9	<0.7	0.7	<0.5	0.5	<0.7	0.7	<1.0	1	1.6	0.6
Polonium 210 precision (±)	pCi/L	0.4		-		0.3		0.3		0.4		0.4		-		0.9	
Polonium 210 MDC	pCi/L	0.9		-		0.9		0.7		0.5		0.7		-		0.6	
Radium 226	pCi/L	9	0.17	2.7	0.2	0.79	0.14	1.1	0.1	0.3	0.1	0.9	0.1	0.3	0.2	0.53	0.17
Radium 226 precision (±)	pCi/L	0.61		0.2		0.19		0.2		0.1		0.2		0.1		0.17	
Radium 226 MDC	pCi/L	0.17		-		0.14		0.1		0.1		0.1		-		0.17	
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.09		-		0.08		0.09		0.08		0.1		-		0.06	
Thorium 230 MDC	pCi/L	0.2		-		0.1		0.1		0.2		0.2		-		0.2	
Uranium	mg/L	0.0011	0.0003	0.0011	0.0003	0.0008	0.0003	0.0006	0.0003	0.0005	0.0003	0.0005	0.0003	0.0004	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	7.30E-10	2.00E-10	7.00E-01	2.00E-01	5.30E-10	2.00E-10	4.10E-10	2.00E-10	3.20E-10	2.00E-10	3.10E-10	2.00E-10	3.00E-01	2.00E-01	<2.00E-10	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	<0.8	0.8	<1.0	1	<0.9	0.9	<0.8	0.8	<0.8	0.8	<0.9	0.9	1.2	1	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.4		-		0.5		0.5		0.5		0.5		0.4		0.5	
Lead 210 MDC	pCi/L	0.8		-		0.9		0.8		0.8		0.9		-		0.8	
Polonium 210	pCi/L	<0.5	0.5	<1.0	1	<0.3	0.3	<0.2	0.2	<0.2	0.2	<0.2	0.2	<1.0	1	<0.3	0.3
Polonium 210 precision (±)	pCi/L	0.2		-		0.1		0.1		0.1		0.2		-		0.2	
Polonium 210 MDC	pCi/L	0.5		-		0.3		0.2		0.2		0.2		-		0.3	
Radium 226	pCi/L	<0.12	0.12	<0.1	0.1	<0.13	0.13	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.13	0.13
Radium 226 precision (±)	pCi/L	0.09		-		0.08		0.07		0.04		0.05		-		0.08	
Radium 226 MDC	pCi/L	0.12		-		0.13		0.1		0.1		0.1		-		0.13	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.08		-		0.07		0.07		0.07		0.05		-		0.09	
Thorium 230 MDC	pCi/L	0.1		-		0.1		0.1		0.1		0.1		-		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

	Location ID:	Monitor 7		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8		Monitor 8	
	Date Collected:	8/20/2012		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012	
	Formation:	CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	<1.0	1	1	0.8	<0.8	0.8	<0.8	0.8	<0.8	0.8	1.1	1	<0.8	0.8	1.2	1
Lead 210 precision (±)	pCi/L	-		0.5		0.5		0.5		0.5		0.4		0.5		0.4	
Lead 210 MDC	pCi/L	-		0.8		0.8		0.8		0.8		-		0.8		-	
Polonium 210	pCi/L	<1.0	1	<0.7	0.7	<0.6	0.6	<0.6	0.6	1	0.5	<1.0	1	<0.7	0.7	<1.0	1
Polonium 210 precision (±)	pCi/L	-		0.5		0.3		0.4		0.7		-		0.4		-	
Polonium 210 MDC	pCi/L	-		0.7		0.6		0.6		0.5		-		0.7		-	
Radium 226	pCi/L	0.9	0.2	0.5	0.14	0.4	0.1	1	0.1	2.3	0.1	0.4	0.2	2.1	0.17	0.5	0.2
Radium 226 precision (±)	pCi/L	0.1		0.16		0.1		0.2		0.3		0.1		0.31		0.1	
Radium 226 MDC	pCi/L	-		0.14		0.1		0.1		0.1		-		0.17		-	
Thorium 230	pCi/L	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.2	0.2
Thorium 230 precision (±)	pCi/L	-		0.07		0.09		0.1		0.1		-		0.5		-	
Thorium 230 MDC	pCi/L	-		0.1		0.1		0.2		0.2		-		0.1		-	
Uranium	mg/L	<0.0003	0.0003	0.0007	0.0003	0.0005	0.0003	0.0003	0.0003	0.0006	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-01	2.00E-01	4.80E-10	2.00E-10	3.40E-10	2.00E-10	2.30E-10	2.00E-10	4.10E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	1.5	1	<0.8	0.8	<0.8	0.8	<0.8	0.8	<0.9	0.9	<1.0	1	<0.8	0.8	1.2	1
Lead 210 precision (±)	pCi/L	0.4		0.5		0.5		0.5		0.5		-		0.5		0.4	
Lead 210 MDC	pCi/L	-		0.8		0.8		0.8		0.9		-		0.8		-	
Polonium 210	pCi/L	<1.0	1	<0.2	0.2	<0.2	0.2	<0.2	0.2	0.2	0.2	<1.0	1	<0.4	0.4	<1.0	1
Polonium 210 precision (±)	pCi/L	-		0.1		0.07		0.1		0.2		-		0.3		-	
Polonium 210 MDC	pCi/L	-		0.2		0.2		0.2		0.2		-		0.4		-	
Radium 226	pCi/L	<0.1	0.1	<0.13	0.13	<0.1	0.1	<0.1	0.1	0.2	0.1	<0.2	0.2	<0.13	0.13	<0.1	0.1
Radium 226 precision (±)	pCi/L	-		0.07		0.08		0.05		0.07		-		0.09		-	
Radium 226 MDC	pCi/L	-		0.13		0.1		0.1		0.1		-		0.13		-	
Thorium 230	pCi/L	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.2	<0.1	0.1	0.3	0.2
Thorium 230 precision (±)	pCi/L	-		0.08		0.08		0.08		0.06		0.1		0.05		0.2	
Thorium 230 MDC	pCi/L	-		0.2		0.1		0.1		0.1		-		0.1		-	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 9		Monitor 10	
Date Collected:		3/12/2011		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	1	0.8	<0.8	0.8	1	0.8	1.3	1.3	1.9	1	<0.8	0.8	2.9	1	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.5		0.5		0.5		0.8		0.4		0.5		0.5		0.5	
Lead 210 MDC	pCi/L	0.8		0.8		0.8		1.3		-		0.8		-		0.8	
Polonium 210	pCi/L	<0.6	0.6	<0.9	0.9	<0.5	0.5	0.9	0.7	<1.0	1	0.8	0.5	<1.0	1	<0.7	0.7
Polonium 210 precision (±)	pCi/L	0.5		0.6		0.2		0.7		-		0.6		-		0.3	
Polonium 210 MDC	pCi/L	0.6		0.9		0.5		0.7		-		0.5		-		0.7	
Radium 226	pCi/L	0.83	0.14	0.2	0.1	0.5	0.1	0.3	0.1	0.3	0.2	1.5	0.17	0.8	0.2	0.36	0.13
Radium 226 precision (±)	pCi/L	0.2		0.1		0.1		0.1		0.1		0.26		0.1		0.14	
Radium 226 MDC	pCi/L	0.14		0.1		0.1		0.1		-		0.17		-		0.13	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.07		0.08		0.1		0.09		-		0.07		-		0.08	
Thorium 230 MDC	pCi/L	0.1		0.2		0.2		0.2		-		0.2		-		0.1	
Uranium	mg/L	0.0133	0.0003	0.0127	0.0003	0.0073	0.0003	0.004	0.0003	0.0022	0.0003	0.0021	0.0003	0.0015	0.0003	0.0011	0.0003
Uranium Activity	uCi/mL	9.00E-09	2.00E-10	8.60E-09	2.00E-10	4.90E-09	2.00E-10	2.70E-09	2.00E-10	1.50E+00	2.00E-01	1.40E-09	2.00E-10	1.00E+00	2.00E-01	7.50E-10	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	<0.8	0.8	<0.8	0.8	<0.8	0.8	<0.9	0.9	1.4	1	<0.7	0.7	14.3	1	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.5		0.5		0.5		0.6		0.4		0.5		1		0.5	
Lead 210 MDC	pCi/L	0.8		0.8		0.8		0.9		-		0.7		-		0.8	
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.3	0.3	<1.0	1	<0.3	0.3	<1.0	1	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.1		0.1		0.1		0.2		-		0.2		-		0.09	
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		0.3		-		0.3		-		0.2	
Radium 226	pCi/L	<0.13	0.13	<0.1	0.1	0.3	0.1	<0.1	0.1	<0.2	0.2	<0.11	0.11	<0.1	0.1	<0.14	0.14
Radium 226 precision (±)	pCi/L	0.06		0.05		0.1		0.04		-		0.07		-		0.05	
Radium 226 MDC	pCi/L	0.13		0.1		0.1		0.1		-		0.11		-		0.14	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.2	<0.1	0.1	<0.2	0.2	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.09		0.06		0.08		0.06		0.1		0.07		-		0.08	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		0.1		-		0.1		-		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 10		Monitor 11		Monitor 11	
Date Collected:		3/28/2011		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012		3/12/2011		3/28/2011	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED																	
Lead 210	pCi/L	<0.8	0.8	<0.8	0.8	<0.8	0.8	<1.0	1	<0.8	0.8	<1.0	1	<0.9	0.9	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.5		0.5		0.5		-		0.5		-		0.5		0.5	
Lead 210 MDC	pCi/L	0.8		0.8		0.8		-		0.8		-		0.9		0.8	
Polonium 210	pCi/L	1.2	0.7	<0.7	0.7	<0.6	0.6	<1.0	1	2.1	0.5	<1.0	1	<0.5	0.5	<0.6	0.6
Polonium 210 precision (±)	pCi/L	0.8		0.3		0.3		-		1		-		0.3		0.5	
Polonium 210 MDC	pCi/L	0.7		0.7		0.6		-		0.5		-		0.5		0.6	
Radium 226	pCi/L	<0.1	0.1	0.4	0.1	0.8	0.1	0.5	0.2	6.6	0.17	0.6	0.2	0.25	0.14	<0.2	0.2
Radium 226 precision (±)	pCi/L	0.07		0.1		0.2		0.1		0.53		0.1		0.12		0.1	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		-		0.17		-		0.14		0.2	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.06		0.1		0.09		-		0.07		-		0.1		0.07	
Thorium 230 MDC	pCi/L	0.1		0.2		0.2		-		0.2		-		0.1		0.1	
Uranium	mg/L	0.0009	0.0003	0.0006	0.0003	0.0005	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	0.0008	0.0003	0.0013	0.0003
Uranium Activity	uCi/mL	6.00E-10	2.00E-10	4.30E-10	2.00E-10	3.40E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	5.10E-10	2.00E-10	8.80E-10	2.00E-10
RADIONUCLIDES-SUSPENDED																	
Lead 210	pCi/L	<0.8	0.8	<0.8	0.8	<0.9	0.9	<1.0	1	<0.8	0.8	3	1	<0.9	0.9	<0.8	0.8
Lead 210 precision (±)	pCi/L	0.5		0.5		0.6		-		0.5		0.6		0.5		0.5	
Lead 210 MDC	pCi/L	0.8		0.8		0.9		-		0.8		-		0.9		0.8	
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<0.2	0.2	<1.0	1	<0.4	0.4	<1.0	1	<0.2	0.2	<0.2	0.2
Polonium 210 precision (±)	pCi/L	0.1		0.1		0.1		-		0.2		-		0.1		0.1	
Polonium 210 MDC	pCi/L	0.2		0.2		0.2		-		0.4		-		0.2		0.2	
Radium 226	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2	0.11	0.11	<0.1	0.1	<0.13	0.13	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.06		0.06		0.03		-		0.08		-		0.05		0.06	
Radium 226 MDC	pCi/L	0.1		0.1		0.1		-		0.11		-		0.13		0.1	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.2	0.2	0.2	0.08	<0.2	0.2	<0.1	0.1	<0.1	0.1
Thorium 230 precision (±)	pCi/L	0.09		0.07		0.04		-		0.1		-		0.07		0.08	
Thorium 230 MDC	pCi/L	0.1		0.1		0.1		-		0.08		-		0.1		0.1	
METALS, SUSPENDED																	
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10

Table 6.1-11 Marsland Expansion Area Radiological Analytical Results (March to May 2011) - Chadron Wells

Location ID:		Monitor 11		Monitor 11		Monitor 11		Monitor 11		Monitor 11	
Date Collected:		4/11/2011		11/7/2011		2/13/2012		6/4/2012		8/20/2012	
Formation:		CHADRON		CHADRON		CHADRON		CHADRON		CHADRON	
	UNITS	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
RADIONUCLIDES-DISSOLVED											
Lead 210	pCi/L	<0.8	0.8	<0.8	0.8	<1.0	1	<0.8	0.8	1.3	1
Lead 210 precision (±)	pCi/L	0.5		0.5		-		0.5		0.4	
Lead 210 MDC	pCi/L	0.8		0.8		-		0.8		-	
Polonium 210	pCi/L	<0.6	0.6	<0.7	0.7	<1.0	1	<0.5	0.5	<1.0	1
Polonium 210 precision (±)	pCi/L	0.4		0.4		-		0.3		-	
Polonium 210 MDC	pCi/L	0.6		0.7		-		0.5		-	
Radium 226	pCi/L	<0.1	0.1	0.4	0.1	0.2	0.2	2.4	0.17	0.4	0.2
Radium 226 precision (±)	pCi/L	0.08		0.1		0.1		0.32		0.1	
Radium 226 MDC	pCi/L	0.1		0.1		-		0.17		-	
Thorium 230	pCi/L	<0.1	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.2	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.06		0.09		-		0.07		-	
Thorium 230 MDC	pCi/L	0.1		0.2		-		0.2		-	
Uranium	mg/L	0.0008	0.0003	0.0014	0.0003	0.0008	0.0003	0.002	0.0003	0.0005	0.0003
Uranium Activity	uCi/mL	5.70E-10	2.00E-10	9.30E-10	2.00E-10	5.00E-01	2.00E-01	4.80E-10	2.00E-10	3.00E-01	2.00E-01
RADIONUCLIDES-SUSPENDED											
Lead 210	pCi/L	<0.9	0.9	<0.9	0.9	<1.0	1	<0.8	0.8	15.5	1
Lead 210 precision (±)	pCi/L	0.5		0.5		-		0.5		1	
Lead 210 MDC	pCi/L	0.9		0.9		-		0.8		-	
Polonium 210	pCi/L	<0.2	0.2	<0.2	0.2	<1.0	1	<0.4	0.4	<1.0	1
Polonium 210 precision (±)	pCi/L	0.1		0.1		-		0.1		-	
Polonium 210 MDC	pCi/L	0.2		0.2		-		0.4		-	
Radium 226	pCi/L	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.12	0.12	<0.1	0.1
Radium 226 precision (±)	pCi/L	0.04		0.04		-		0.07		-	
Radium 226 MDC	pCi/L	0.1		0.1		-		0.12		-	
Thorium 230	pCi/L	<0.1	0.1	<0.1	0.1	<0.2	0.2	<0.09	0.09	<0.2	0.2
Thorium 230 precision (±)	pCi/L	0.06		0.05		-		0.06		-	
Thorium 230 MDC	pCi/L	0.1		0.1		-		0.09		-	
METALS, SUSPENDED											
Uranium	mg/L	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003	<0.0003	0.0003
Uranium Activity	uCi/mL	<2.00E-10	2.00E-10	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01	<2.00E-10	2.00E-10	<2.00E-01	2.00E-01

Table 6.1-12 Stream Gaging Stations on Niobrara River in Vicinity of Headwaters of Niobrara River

Table 6.1-12 Stream Gaging Stations on Niobrara River in Vicinity of Headwaters of Niobrara River

Identification No.[a]	Latitude/Longitude		Township/Range Section	Location Description
06454000	42º 39' 10"	104º 03' 07"	T31N R57W Section 19 (NE1/4NE1/4)	1 mile downstream from Van Tassel on county road and 0.1 mile from WY-NE State line
06454100	42º 25' 22"	103º 47' 28"	T28N R55W Section 6 (SW1/4)	0.2 mile north of Agate and 14.5 miles upstream from Whistle Creek.
06454500 SNI4NIOBR402	42º 27' 35"	103º 10' 15"	T29N R50W Section 27 (NE1/4)	1 mile upstream of from high water line of Box Butte Reservoir and 1 mile east of Marsland
06455500 SNI4NIOBRA20	42º 27' 25"	103º 04' 05"	T29N R49W Section 28 (SE1/4)	0.2 mile downstream from Box Butte Reservoir and 9 miles north of Hemingford
06455000	42º 27' 30"	103º 04' 03"	T29N R49W Section 28 (SW1/4NE1)	Box Butte Reservoir

Gage: Continuous stage recorders

[a] USGS stream designation numbers are "064…" series) and NDEQ station numbers are "SNI4IO… series.

Note: Data for stream gaging station of Niobrara River at Agate not included. Period of record is discontinuous (1957 – 1992; 2007 – current).

Source: NDEQ 2011b

Table 6.1-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Table 6.1-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Stream Sampling Location	Flow (cubic feet per second [cfs])		
	Average Flow	Minimum Flow	Maximum Flow
Niobrara River at Wyoming State Line 06454000	3.03 (1.7 – 4.4)	2.4 (0.6 – 5.3)	4.2 (1.6 – 13.0)
Niobrara River at Agate 06454100 Stream flow data for 2006 – 2010.	10.5 (5.4 – 17.9)	8.1 (0.9 – 20.0)	14.0 (4.8 – 55.0)
Niobrara River above Box Butte Reservoir 06454500	19.6 (10.1 – 34.9)	14.5 (3.8 – 40.0)	28.3 (8.1 – 129)
Niobrara River below Box Butte Reservoir 06455500	14.5 (0.7 – 87)	3.8 (0.4 – 84.0)	29.7 (0.54 – 180.0)

Extremes for Period of Record and By Year (1999 – 2012[l])

Peak Discharge			Minimum Discharge		Drainage Area
Date	Flow ft3/sec	Gage Height feet	Date	ft3/sec	Square Miles
Niobrara River at Wyoming State Line (USGS 06454000)					455
3/06/2012	115	Information Not Available	7/11/2012	1.75	
3/11/2011	451	Information Not Available	2/09/2011	2.32	
12/31/2010	10.2	Information Not Available	10/01/2010	2.09	
7/02/2009	11.2	4.56	9/12/2009	1.59	
5/03/2008	18.0	4.80	8/28/2008	1.1	
4/02/2007	7.1	3.34	7/25/2007		
3/30/2006	7.5	3.22	8/24/2006	0.96	
6/13/2005	13.0	4.38	7/23/2005	1.4	
9/05/2004	21.0	3,61[e]	9/02/2004	0.57	
4/29/2003	8.6	3.10[f]	8/22-23/2003	1.3	
4/26/2002	12.0	2.94[g]	8/17-18/2002	1.4	
5/06/2001	11.0	2.76[i]	9/05/2001	1.6	
2/22/2000	21	3.69	9/18/2000	1.3	
4/28/1999	9.9	2.37[j]	9/15-16/1999	1.4	
8/16/1977	2,120	8.28	8/09/1975	0.54	

Table 6.1-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Peak Discharge			Minimum Discharge	Drainage Area	
Date	**Flow ft3/sec**	**Gage Height feet**	**Date**	**ft3/sec**	**Square Miles**
Niobrara River at Agate (USGS 06454100) [a]					840
3/11/2012	35.8	Information Not Available	8/23/2012	1.08	
3/14/2011	223	Information Not Available	8/18/2011	3.32	
2/26/2010	278	Information Not Available	8/14/2010	3.7	
6/14/2009	63	6.18	12/27/2009	5.1	
3/04/2008	23	4.05	8/02-4/2008	3.0	
3/08/2007	20	4.02	5/29/2007	9.6	
7/02/2006	24.6	Information Not Available	2/25/2006	0.83	
12/29/2005	13.5	Information Not Available	11/28/2005	5.48	
2004	ND				
2003	ND				
2002	ND				
2001	ND				
1999	ND				
Niobrara River above Box Butte Reservoir (USGS 06454500)					1,400
1/12/2012	100	Information Not Available	9/02/2012	2.2	
2/01/2011	108	Information Not Available	7/21/2011	5.7	
12/31/2010	57.3	--	12/11//2010	6.3	
7/23/2009	187	5.78	8/21/2009	8.5	
7/09/2008	384	7.26	10/03/2008	8.0	
7/28/2007	41	4.18	7/26/2007	3.8	
11/28/2006	167	5.53[b]	6/06-07/2006	6.7	
6/13/2005	80	4.41[c]	5/29/2005	9.6	
3/09/2004	51	3.75[d]	6/15-16/2004	6.2	
3/20/2003	43	3.58	8/15/2003	5.8	
3/29/2002	53	3.76[h]	7/31 – 8/02/2002	4.1	
3/14/2001	52	3.79	7/08-09/2001	7.9	
7/11/2000	202	5.59	8/24/2000	8.7	
4/13/1999	45	3.63[k]	8/13-30/1999	11.0	
7/28/1951	4,950	10.3	9/26/1953	1.6	
Niobrara River below Box Butte Reservoir (USGS 06455500)					460
7/20/2012	160	Information Not Available	5/18/2012	0.63	
7/14/2011	148	Information Not Available	10/30/2011	0.80	
12/31/2010	0.935	--	10/01/2010	0.72	
7/17/2009	157	4.29	11/05/2009	0.56	
7/30/2008	165	4.29	11/05-06/2008	0.56	

Table 6.1-13 Summary of Niobrara River Flow Measurements 1999 - 2012

Peak Discharge			Minimum Discharge	Drainage Area	
Date	**Flow ft3/sec**	**Gage Height feet**	**Date**	**ft3/sec**	**Square Miles**
7/15/2007	153	4.23	11/15-16/2007	0.40	
7/17/2006	164	4.26	8/23/2006	0.70	
7/24/2005	143	4.16	10/11/2005	0.63	
7/20/2004	152	4.20	9/12/2004	0.65	
7/16/2003	151	4.14	8/27/2003	0.47	
6/30/2002	170	4.32	9/02-07/2002	0.52	
7/02/1968	616	5.04	Many days in 1947 & 1951	0.1	
8/01/2001	148	4.26	9/27-30/2001	0.64	
7/09/2000	148	4.21	9/14/2000	0.75	
7/27/1999	195	4.43	10/01/1999	0.87	
Period of Record					
Niobrara River at Wyoming State Line (USGS 06454000)			1955 to Quarter 3 2012		
Niobrara River at Agate (USGS 06454100)			3rd Quarter 2005 – Quarter 3 2012		
Niobrara River above Box Butte Reservoir (USGS 06454500)			Oct. 1946 to Quarter 3 2012		
Niobrara River below Box Butte reservoir (USGS 06455500)			Oct. 1946 to Quarter 3 2012		

[a] Stream flow data for 2006 – 2010 in Table 6.1-14; Records are fair, except estimated records are poor.
[b] Maximum gage height of 5.64 feet February 10 due to backwater from ice.
[c] Maximum gage height of 4.66 feet January 05 due to backwater from ice.
[d] Maximum gage height of 4.82 feet due to backwater from ice conditions.
[e] Maximum gage height of 4.59 feet due to backwater from ice conditions.
[f] Maximum gage height 3.34 feet February 3 due to backwater from ice conditions.
[g] Maximum gage height of 3.56 feet due to backwater from ice conditions.
[h] Maximum gage height of 4.67 feet on March 1 due to backwater from ice conditions.
[i] Maximum gage height of 3.01 feet December 16 due to backwater from ice conditions.
[j] Maximum gage height of 2.64 feet from a high water mark.
[k] Maximum gage height of 5.07 feet December 20 due to backwater from ice.
[l] 2012 data is for Quarters 1 through 3; Quarter 4 data not yet available.
ND = No data
ft^3/sec = cubic feet per second
USGS = U.S. Geological survey
Sources: NDNR. 2013.
Williams.2013

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River at Wyoming State Line (USGS 06454000)												
1999												
Mean	4.03	4.40	5.08	6.85	5.02	5.48	3.24	1.95	2.47	2.94	3.44	3.64
Maximum	4.3	4.40	7.5	8.4	7.7	6.8	6.0	2.8	4.2	3.4	4.6	4.1
Minimum	3.5	3.9	4.2	5.3	3.9	4.1	2.3	1.4	1.6	2.7	2.8	3.2
2000												
Mean	3.66	5.12	5.94	6.79	5.51	3.00	1.97	1.77	1.80	2.54	3.09	2.85
Maximum	4.1	13.0	9.0	12.0	8.9	4.5	2.6	2.1	2.5	3.2	4.8	3.0
Minimum	3.3	3.4	4.8	4.4	4.1	2.5	1.5	1.5	1.3	2.3	2.7	2.6
2001												
Mean	3.08	3.26	5.50	6.07	4.68	3.11	2.36	1.78	2.03	2.56	3.37	3.20
Maximum	3.4	3.7	6.8	9.5	9.0	4.9	3.4	2.0	2.7	2.9	3.9	4.0
Minimum	2.9	2.9	3.6	4.9	3.2	2.5	1.9	1.6	1.6	2.0	2.8	2.7
2002												
Mean	3.36	3.54	3.77	5.09	3.63	2.64	1.98	1.54	1.94	1.86	2.54	3.17
Maximum	3.7	3.8	6.1	7.1	5.1	3.5	2.5	1.6	2.4	2.3	3.4	3.4
Minimum	2.6	3.2	3.2	4.2	3.0	2.0	1.6	1.4	1.5	1.5	1.4	2.9
2003												
Mean	3.23	3.52	4.56	4.66	4.41	3.03	1.87	1.58	2.37	2.45	2.6	2.65
Maximum	3.6	3.8	6.0	6.8	5.6	4.2	2.5	2.5	3.4	2.9	2.6	2.8
Minimum	2.9	3.3	3.5	3.9	3.7	2.3	1.5	1.3	2.0	2.4	2.6	2.6
2004												
Mean	2.85	3.08	3.79	3.12	2.81	1.72	2.18	1.40	2.17	2.6	3.0	3.3
Maximum	3.1	4.0	5.5	3.6	3.3	2.7	6.4	2.1	11.0	3.4	3.3	3.5
Minimum	2.7	2.5	2.0	2.5	2.5	1.1	1.2	0.83	0.57	2.1	2.6	3.0
2005												
Mean	2.9	3.4	3.5	3.4	3.1	3.1	2.1	2.2	1.8	2.0	3.0	2.7
Maximum	3.5	3.6	4.0	5.3	6.3	12.0	3.1	5.3	2.2	2.6	3.3	3.0
Minimum	2.5	3.2	3.2	2.7	2.4	1.8	1.4	1.5	1.5	1.4	2.6	2.2

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	2.9	3.0	4.2	3.5	3.2	2.2	1.9	1.5	2.0	2.7	2.8	2.9
Maximum	3.3	4.3	6.7	5.5	4.2	4.3	4.1	3.0	3.1	3.0	3.2	3.3
Minimum	2.6	2.7	3.5	2.6	2.7	1.5	1.4	0.96	1.7	2.3	2.4	2.5
2007												
Mean	2.8	2.9	3.4	3.7	2.9	1.9	1.6	1.3	1.5	2.2	2.3	2.0
Maximum	3.4	3.5	5.3	6.2	3.1	2.2	2.8	1.7	1.9	2.7	2.8	2.3
Minimum	2.4	2.3	2.8	3.2	2.3	1.6	0.82	1.0	1.1	1.6	1.7	1.7
2008												
Mean	2.3	3.2	3.0	2.9	4.1	2.9	2.2	1.7	1.7	2.0	2.4	2.6
Maximum	3.0	4.1	4.2	4.1	6.9	4.9	2.8	2.6	2.5	2.5	2.8	3.2
Minimum	1.4	2.0	2.4	2.3	2.4	2.1	1.8	1.1	1.3	1.6	2.1	2.2
2009												
Mean	2.6	3.2	6.6	3.6	3.3	3.7	3.4	2.2	1.8	2.2	2.6	2.7
Maximum	3.7	3.8	12.0	4.6	4.5	4.9	6.7	2.5	2.0	1.9	2.5	2.6
Minimum	1.9	2.1	3.5	3.0	2.9	2.3	2.0	2.0	1.6	2.5	2.7	3.1
2010 [a]												
Mean	2.9	2.9	3.6	3.5	3.9	4.0	2.3	2.0	1.8	2.4	2.8	2.9
Maximum	3.0	4.5	4.6	3.7	4.6	7.4	2.9	2.1	2.1	2.11	2.7	2.8
Minimum	2.4	2.4	3.4	3.4	3.2	2.5	2.0	1.9	1.9	2.73	2.9	3.0
2011 [a]												
Mean	3.3	17.6	16.6	5.1	7.3	5.4	3.4	2.8	2.7	3.2	3.7	3.7
Maximum	4.5	136	142	5.7	11.4	8.1	4.5	2.9	2.8	3.6	3.8	3.9
Minimum	2.8	3.1	5.2	4.9	4.7	4.3	2.7	2.7	2.5	2.9	3.4	3.2
2012 [a, b]												
Mean	3.8	3.9	7.2	3.5	3.1	2.2	2.0	2.1	2.2	NA	NA	NA
Maximum	3.9	4.3	46.3	3.8	3.7	2.7	2.2	2.3	2.5	NA	NA	NA
Minimum	3.6	3.7	3.7	3.0	2.6	1.9	1.8	2.0	1.9	NA	NA	NA

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River at Agate (USGS 06454100)												
2006												
Mean	13.0	13.6	19.0	14.7	9.3	5.9	6.0	4.1	6.0	6.1	9.5	9.9
Maximum	14.0	17.0	21.0	20.0	13.0	10.0	14.0	5.9	7.9	7.4	12.0	11.0
Minimum	11.0	0.9	17.0	12.0	5.1	3.8	2.1	3.0	4.5	5.1	5.7	8.2
2007												
Mean	9.7	9.6	14.7	13.3	8.3	6.2	3.4	4.1	5.5	6.8	8.3	7.7
Maximum	10.0	14.0	17.0	18.0	11.0	8.4	4.8	5.6	6.2	8.0	9.0	9.0
Minimum	9.0	8.0	11.0	11.0	6.1	2.9	2.2	2.8	4.7	6.0	7.0	7.0
2008												
Mean	7.0	8.1	14.8	10.9	9.4	10.8	5.4	4.9	7.8	8.0	8.8	7.1
Maximum	7.0	14.0	18.0	13.0	17.0	16.0	8.0	7.0	9.0	9.2	11.0	10.0
Minimum	7.0	7.0	13.0	7.0	6.0	8.0	4.0	3.0	6.0	6.8	7.0	5.1
2009												
Mean	6.2	10.1	15.3	19.6	12.1	21.2	9.9	8.1	8.6	14.1	15.4	10.2
Maximum	7.3	15.0	18.0	28.0	19.0	55.0	15.0	5.7	9.7	19.0	22.0	12.0
Minimum	5.2	7.3	15.0	15.0	5.3	9.4	6.5	11.0	7.4	10.0	11.0	11.0
2010 [a]												
Mean	10.7	12.1	25.7	24.1	20.5	17.5	8.5	5.8	6.6	8.7	11.3	12.7
Maximum	11.0	20.0	31.0	31.0	27.0	33.0	11.0	7.0	8.0	7.0	8.0	10.0
Minimum	10.0	11.0	20.0	19.0	11.0	8.0	7.0	4.0	6.0	12.0	14.0	15.0
2011												
Mean	12.6	22.9	32.3	18.2	24.8	14.8	7.5	5.9	7.2	10.4	14.3	11.6
Maximum	16	63	102	22	36	25	10	9	10	13.3	15.7	14.4
Minimum	10	12	20	16	17	9	6	4	6	6.86	12.4	10.1
2012 [b]												
Mean	9.6	6.2	11.6	6.2	3.7	3.5	2.5	2.9	3.6	N/A	N/A	N/A
Maximum	11.8	7.1	31.4	8.6	4.9	5.1	3.7	4.1	5.2	N/A	N/A	N/A
Minimum	7.2	5.3	6.9	4.8	2.3	2.1	2.0	1.6	2.6	N/A	N/A	N/A

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River above Box Butte Reservoir (USGS 06454500)												
1999												
Mean	26.9	34.1	34.4	36.6	26.3	22.2	18.3	12.5	18.9	21.9	24.9	26.5
Maximum	30	39	37	43	37	31	26	17	22	25	28	29
Minimum	19	28	32	40	15	14	13	11	14	18	21	24
2000												
Mean	28.1	32.3	42.7	43.1	47.7	15.0	15.6	11.2	11.4	19.8	22.9	18.4
Maximum	31	40	60	65	74	24	44	17	15	33	29	22
Minimum	20	20	36	33	30	8.8	11	8.7	9.3	10	18	16
2001												
Mean	22.7	25.6	40.8	43.0	28.8	15.8	13.9	9.04	10.9	16.7	20.1	21.9
Maximum	28	28	48	48	47	22	28	11	14	19	22	24
Minimum	19	23	29	38	11	11	9.4	7.9	8.2	11	18	17
2002												
Mean	22.1	25.7	32.2	35.7	19.5	9.47	6.33	6.27	10.1	11.2	16.8	19.9
Maximum	25	32	47	45	31	11	8.7	8.1	15	14	21	22
Minimum	19	21	21	21	10	8.2	4.1	4.1	6.4	10	14	19
2003												
Mean	20.1	23.8	31.9	28.0	22.6	12.2	9.18	7.84	8.48	10.4	14.0	16.4
Maximum	23	26	41	39	31	15	12	9.5	9.7	12	15	18
Minimum	18	20	23	21	13	9.8	7.6	5.8	7.0	9.1	12	15
2004												
Mean	17.5	19.7	31.4	19.8	10.5	8.6	10.2	10.0	13.1	17.0	16.8	17.4
Maximum	19	37	46	26	16	15	14	16	16	18	18	18
Minimum	16	16	24	15	7.1	6.2	7.1	6.9	8.8	16	15	17
2005												
Mean	18.9	26.3	27.5	32.4	23.6	33.4	12.3	14.2	13.6	16.5	18.9	16.3
Maximum	24	28	30	49	43	72	17	17	15	19	23	21
Minimum	15	24	26	28	9.6	14	9.7	10	13	14	14	12

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	19.9	22.8	35.9	29.0	15.6	11.0	9.6	8.1	10.1	11.1	15.0	13.6
Maximum	26	27	42	39	34	22	13	11	12	13	17	15
Minimum	12	19	23	11	10	6.7	8.1	6.9	8.7	10	11	13
2007												
Mean	15.9	18.4	26.8	22.9	13.4	8.3	8.4	6.4	6.7	9.4	10.8	10.9
Maximum	19	22	30	27	20	18	20	8.6	14	10	14	16
Minimum	14	15	22	19	7.8	4.2	3.8	4.5	5.4	8	9.9	10
2008												
Mean	11.2	12.4	25.2	27.6	24.0	16.0	13.5	9.0	10.9	11.3	14.4	11.8
Maximum	15	19	33	42	110	28	50	9	12	13	18	14
Minimum	9.7	11	20	10	13	12	10	9	9.8	9.7	13	9.6
2009												
Mean	12.5	16.4	24.2	57.1	24.5	28.0	29.6	14.7	13.4	23.2 [a]	29.2 [a]	20.7 [a]
Maximum	16	20	30	129	41	50	92	28	19	35 [a]	42 [a]	23 [a]
Minimum	9.8	13	21	28	9.8	9.3	11	8.5	9.3	14 [a]	21 [a]	16 [a]
2010 [a]												
Mean	15.8	13.9	52.1	43.5	43.0	41.2	18.8	11.7	9.8	13.1	22.4	22.2
Maximum	23	35	104	75	82	76	28	21	11	9.1	17.8	18.4
Minimum	13	9	36	28	23	14	12	8	9	22.3	27.0	26.0
2011 [a]												
Mean	17.9	20.9	49.5	36.8	48.4	34.7	12.5	10.7	12.1	16.1	12.3	26.4
Maximum	26.7	26	68.1	43.3	95.2	59	25.7	13	31.4	19	26.7	42.1
Minimum	12.7	14	37.4	32	26	24.7	7.23	6.99	6.88	12.6	2.26	21.3
2012 [a, b]												
Mean	27.4	24.6	40.1	27.5	11.2	7.5	5.8	5.7	5.8	N/A	N/A	N/A
Maximum	83.2	38.9	49.1	45.8	13.6	8.8	6.9	6.4	7.0	N/A	N/A	N/A
Minimum	15.2	17.4	23.5	12.3	8.4	6.9	5.2	5.0	3.3	N/A	N/A	N/A

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
Niobrara River below Box Butte Reservoir (USGS 06455500)												
1999												
Mean	1.14	1.25	1.30	1.41	1.27	1.11	96.6	104	7.23	0.93	0.93	0.93
Maximum	1.2	1.4	1.4	1.7	1.4	1.3	180	128	89	1.0	1.0	.95
Minimum	1.1	1.1	1.2	1.3	1.2	1.0	1.0	64	0.95	0.85	0.86	0.87
2000												
Mean	0.94	0.99	1.15	1.22	1.23	13.7	116	84.5	3.55	0.74	0.79	0.72
Maximum	0.97	1.1	1.3	1.9	1.6	110	145	122	64	0.84	0.82	0.78
Minimum	0.90	0.93	1.1	1.1	1.1	1.1	84	61	0.75	0.70	0.75	0.67
2001												
Mean	0.71	0.70	0.74	0.79	0.87	0.79	83.1	105	14.4	0.65	0.66	0.66
Maximum	0.73	0.72	0.76	0.86	0.97	1.1	144	146	67	0.80	0.74	0.70
Minimum	0.67	0.70	0.72	0.72	0.82	0.72	0.76	68	0.64	0.60	0.64	0.64
2002												
Mean	0.71	0.69	0.74	0.79	0.78	18.9	121	57.4	0.59	0.54	0.56	0.54
Maximum	0.73	0.72	0.79	0.92	0.92	148	161	108	0.91	0.54	0.62	0.57
Minimum	0.64	0.66	0.70	0.76	0.73	0.70	76	0.53	0.52	0.52	0.54	0.52
2003												
Mean	0.53	0.56	0.60	0.71	0.72	0.71	96.9	77.3	0.86	0.77	0.75	0.74
Maximum	0.54	0.57	0.67	0.96	0.82	0.76	146	125	3.4	0.85	0.77	0.78
Minimum	0.52	0.54	0.57	0.64	0.67	0.67	0.63	0.47	0.49	0.72	0.71	0.70
2004												
Mean	0.77	0.77	0.82	0.88	0.84	0.86	71.8	65.9	2.21	0.71	0.71	0.72
Maximum	0.79	0.84	1.0	0.93	0.89	0.93	143	119	45	0.85	0.74	0.77
Minimum	0.74	0.74	0.73	0.85	0.77	0.76	0.87	0.75	0.65	0.63	0.66	0.69
2005												
Mean	0.76	0.79	0.82	0.93	0.95	1.0	76	76.3	13.1	0.77	0.79	0.83
Maximum	0.82	0.89	0.87	1.4	1.2	1.5	140	129	104	0.89	1.1	1.1
Minimum	0.69	0.72	0.79	0.83	0.79	0.94	0.88	0.87	0.69	0.74	0.74	0.79

Table 6.1-14 Water Flow Measurements for Upper Reaches of Niobrara River – 1999 to 2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	cubic feet per second (cfs) - Mean											
2006												
Mean	0.77	0.82	0.85	0.92	0.93	9.3	111.6	47	14.0	0.54	0.46	0.60
Maximum	0.84	1.1	0.87	1.0	1.1	69	158	109	77	0.61	0.58	0.64
Minimum	0.72	0.80	0.81	0.85	0.86	0.85	70	0.70	0.72	0.45	0.40	0.53
2007												
Mean	0.66	0.73	0.87	0.77	0.79	1.2	94.6	24.7	0.59	0.63	0.68	0.67
Maximum	0.80	0.83	1.0	0.87	0.86	9.7	147	127	0.62	0.69	0.79	0.80
Minimum	0.63	0.65	0.74	0.69	0.72	0.76	1.2	0.63	0.56	0.58	0.56	0.62
2008												
Mean	0.64	0.63	0.75	0.87	0.97	0.95	70.0	30.6	0.67	0.63	0.69	0.67
Maximum	0.68	0.69	0.83	0.94	1.2	1.1	157	140	0.84	0.74	0.80	0.78
Minimum	0.59	0.60	0.69	0.80	0.90	0.90	0.75	0.64	0.61	0.62	0.61	0.60
2009												
Mean	0.64	0.67	0.72	0.95	0.98	1.0	60.2	69.0	6.24	0.79 [a]	0.82 [a]	0.80 [a]
Maximum	0.69	0.68	0.80	1.3	1.1	1.2	135	132	29	0.9 [a]	0.85 [a]	0.93 [a]
Minimum	0.62	0.65	0.68	0.77	0.88	0.96	0.90	0.85	0.72	0.75 [a]	0.78 [a]	0.83 [a]
2010 [a]												
Mean	0.77	0.81	0.87	0.78	1.1	1.24	45.8	108.7	0.75	0.78	0.81	0.83
Maximum	0.79	0.86	0.89	1.41	1.2	1.88	165	165	0.96	0.74	0.78	0.80
Minimum	0.73	0.78	0.84	0.90	0.95	1.02	1.23	18.6	0.73	0.83	0.83	0.90
2011 [a]												
Mean	0.9	0.9	0.9	1.0	1.1	1.3	100	76.8	20	2.4	0.9	0.9
Maximum	0.9	0.9	1.0	1.1	2.1	2.3	138	115	109	31.2	0.9	0.9
Minimum	0.8	0.8	0.9	0.9	1.0	1.2	1.1	1.0	0.9	0.8	0.9	0.9
2012 [a, b]												
Mean	0.9	1.0	0.9	0.9	3.5	15.9	141.5	46.2	0.7	N/A	N/A	N/A
Maximum	0.9	1.0	1.1	1.0	30.8	88.7	157	142	0.8	N/A	N/A	N/A
Minimum	0.9	0.9	0.8	0.7	0.6	0.8	95.1	0.7	0.7	N/A	N/A	N/A

Notes:
[a] Provisional data starting 10/01/2010 – no QA/QC by the NDNR at the time of posting (Williams 2013).
[b] Data only available for January through September, 2013 (Williams 2013).
N/A = Not Available from NDNR (Williams 2013).

USGS = U.S. Geological Survey
NDNR = Nebraska Department of Natural Resources
QA/QC = quality assurance/quality control
Source: NDNR 2011a; Lindeman 2011; Williams 2013

Table 6.1-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Table 6.1-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
1/2/2002 12:40:00 PM	pH-Field	8.08	s.u.
1/3/2002 10:30:00 AM	pH-Field	8.06	s.u.
1/3/2002 12:14:00 PM	pH-Field	8.06	s.u.
1/7/2002 8:45:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
1/8/2002 2:30:00 PM	pH-Field	8.1	s.u.
1/10/2002 2:35:00 PM	pH-Field	8.1	s.u.
2/5/2002 7:30:00 AM	pH-Field	8.05	s.u.
2/5/2002 3:15:00 PM	pH-Field	8.1	s.u.
2/5/2002 4:15:00 PM	pH-Field	8.0	s.u.
2/5/2002 4:30:00 PM	pH-Field	8.0	s.u.
3/4/2002 10:15:00 AM	pH-Field	8.0	s.u.
3/5/2002 10:45:00 AM	pH-Field	8.07	s.u.
3/5/2002 11:00:00 AM	pH-Field	8.08	s.u.
3/5/2002 12:35:00 PM	pH-Field	8.07	s.u.
3/7/2002 8:20:00 AM	pH-Field	8.09	s.u.
4/1/2002 10:45:00 AM	pH-Field	8.05	s.u.
4/3/2002 3:00:00 PM	pH-Field	8.09	s.u.
5/7/2002 8:36:00 AM	pH-Field	8.05	s.u.
5/7/2002 9:00:00 AM	pH-Field	8.01	s.u.
5/7/2002 10:30:00 AM	pH-Field	8.07	s.u.
5/7/2002 10:59:00 AM	pH-Field	8.05	s.u.
5/9/2002 11:00:00 AM	pH-Field	8.04	s.u.
6/11/2002 11:40:00 AM	Dissolved Oxygen (Winkler)	8.03	mg/L
6/12/2002 11:00:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
6/12/2002 11:30:00 AM	Dissolved Oxygen (Winkler)	8.09	mg/L
6/12/2002 1:35:00 PM	pH-Field	8.0	s.u.
6/17/2002	pH-Field	8.0	s.u.
6/18/2002 9:25:00 AM	pH-Field	8.07	s.u.
6/18/2002 9:51:00 AM	pH-Field	8.02	s.u.
7/8/2002 9:10:00 AM	Dissolved Oxygen (Winkler)	8.0	mg/L
7/9/2002 8:45:00 AM	pH-Field	8.07	s.u.
7/9/2002 5:15:00 PM	pH-Field	8.06	s.u.
7/9/2002 6:20:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/10/2002 2:15:00 PM	pH-Field	8.04	s.u.
7/16/2002 9:18:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 12:50:00 PM	pH-Field	8.08	s.u.
7/16/2002 1:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
7/16/2002 1:00:00 PM	pH-Field	8.03	s.u.
7/18/2002 10:25:00 AM	pH-Field	8.06	s.u.
8/5/2002 2:45:00 PM	pH-Field	8.08	s.u.

Table 6.1-15 NDEQ 2002 Field Measurements of pH and Dissolved Oxygen for Station Number SNI4NIOBR402 (Niobrara River above Box Butte Reservoir)

Measurement Date/Time	Parameter	Result	Units
8/6/2002 11:45:00 AM	pH-Field	8.06	s.u.
8/6/2002 12:00:00 PM	Dissolved Oxygen (Winkler)	8.06	mg/L
8/7/2002 2:30:00 PM	Dissolved Oxygen (Winkler)	8.01	mg/L
9/3/2002 7:25:00 AM	pH-Field	8.0	s.u.
9/3/2002 11:45:00 AM	pH-Field	8.02	s.u.
9/3/2002 2:00:00 PM	pH-Field	8.05	s.u.
9/10/2002 11:45:00 AM	pH-Field	8.04	s.u.
9/11/2002 9:45:00 AM	Dissolved Oxygen (Winkler)	8.06	mg/L
9/11/2002 10:15:00 AM	pH-Field	8.02	s.u.
10/7/2002 11:20:00 AM	pH-Field	8.04	s.u.
10/7/2002 1:00:00 PM	pH-Field	8.06	s.u.
10/7/2002 1:45:00 PM	pH-Field	8.07	s.u.
10/7/2002 2:40:00 PM	pH-Field	8.0	s.u.
10/8/2002 12:00:00 PM	pH-Field	8.08	s.u.
11/4/2002 9:45:00 AM	pH-Field	8.02	s.u.
11/4/2002 11:00:00 AM	pH-Field	8.09	s.u.
11/5/2002 10:30:00 AM	pH-Field	8.01	s.u.
11/5/2002 2:30:00 PM	pH-Field	8.01	s.u.
11/5/2002 3:00:00 PM	pH-Field	8.05	s.u.
11/8/2002 8:45:00 AM	pH-Field	8.0	s.u.
12/2/2002 8:05:00 AM	pH-Field	8.09	s.u.
12/2/2002 9:15:00 AM	pH-Field	8.03	s.u.
12/2/2002 10:30:00 AM	pH-Field	8.04	s.u.
12/2/2002 12:20:00 PM	pH-Field	8.01	s.u.
12/2/2002 12:30:00 PM	pH-Field	8.06	s.u.
12/2/2002 1:30:00 PM	pH-Field	8.04	s.u.
12/2/2002 3:00:00 PM	pH-Field	8.06	s.u.
12/3/2002 10:00:00 AM	pH-Field	8.07	s.u.

Notes:
mg/L = milligrams per liter
NDEQ = Nebraska Department of Environmental Quality
s.u. = standard unit
Source: Ihrie 2013a

Table 6.1-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Table 6.1-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2022	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Major Ions									
Calcium, Dissolved	mg/L	ND	45.7	ND	ND	44.6	ND	ND	0.15
Chloride, Total	mg/L	4.01	3.90	4.09	4.05	4.44	4.88	4.97	0.15
Magnesium, Dissolved as Mg	mg/L	ND	7.65	ND	ND	7.79	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.059	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.95	1.03	0.84	0.80	1.22	1.37	1.23	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	0.059	<0.04	0.041	0.043	<0.04	0.046	<0.04	0.04
Sodium, Dissolved	mg/L	ND	23.2	ND	ND	23.3	ND	ND	0.15
Physical Properties									
Specific Conductance	µmhos/cm @25°C	367	244	369	368	361	397	410	N/A
Alkalinity, Total	mg/L	176	162	170	172	169	184	193	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	<12	<12	<12	12.5	12
Dissolved Oxygen, Field	mg/L	9.31	7.89	9.4	10.46	9.73	12.66	12.06	N/A
pH, Field	s.u.	8.34	7.5	8.11	8.22	8.29	8.48	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.5	14	11.5	5.5	18.5	33	20	N/A
Temperature, Water (Field)	°C	22.7	29	20.8	16.9	16.4	3.54	3.84	N/A
Turbidity, Lab	NTU	6.64	8.73	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	ND	ND	5.7	6.2	10.8	17	13.5	N/A
Metals									
Arsenic, Dissolved	ug/L	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Copper	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	<1	ND	ND	<1	ND	ND	1

Table 6.1-16 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2002

Constituent	Unit	6/07/2022	7/08/2002	8/06/2002	9/03/2002	10/07/2002	11/04/2002	12/02/2002	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	3.07	3.0	3.0	3.02	3.11	3.18	3.29	N/A
Stream Discharge	cfs	ND	ND	ND	ND	ND	ND	ND	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
RL = reporting limit
Source: Ihrie 2013a

Table 6.1-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2003

Table 6.1-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Major Ions														
Calcium, Dissolved	mg/L	58.2	ND	ND	54.7	ND	ND	46.3	ND	47.8	ND	ND	ND	0.15
Chloride, Total	mg/L	4.5	4.6	5.2	5.7	6.1	5.0	4.8	4.8	4.3	4.6	4.68	5.2	1.0
Magnesium, Dissolved	mg/L	9.18	ND	ND	10.3	ND	ND	7.99	ND	ND	8.28	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.08	0.05	0.05	<0.05	0.11	<0.05	0.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.34	1.26	1.26	0.48	0.59	0.76	0.97	1.00	1.11	1.14	1.18	1.13	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.05	0.53	0.56	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	<0.04	0.06	0.04	0.04	<0.04	0.05	0.08	0.07	0.04	0.06	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.4	ND	ND	25.2	ND	ND	24.6	ND	ND	24.6	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	400	377	402	429	440	388	374	343	ND	384	383	420	N/A
Alkalinity	mg/L	207	180	199	212	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	<12	<12	<12	20.3	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	12.19	11.52	11.69	9.72	9.57	8.65	8.27	8.06	ND	9.41	9.88	9.9	N/A
pH, Field	s.u.	8.2	7.76	8.17	8.36	8.37	8.45	8.1	8.2	ND	8.18	8.0	8.17	N/A
Suspended Solids, Total (TSS)	mg/L	9.0	23.5	13.0	18.5	20.0	12.5	35.0	36.0	12.0	22.5	5.0	8.0	N/A
Temperature, Water (Field)	°C	3.84	3.92	4.02	10.55	11.11	21.09	22.26	24.52	ND	10.49	4.17	3.76	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	6.01	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	0.2	16.1	6.6	10	12.4	10.5	24.8	41.9	ND	35.3	8.9	8.5	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Chromium, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Copper, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	<10	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	<1	ND	ND	<1	ND	ND	1

Table 6.1-17 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2003

Constituent	Unit	Jan 13	Feb 1	Mar 7	Apr 8	May 5	Jun 9	Jul 7	Aug 5	Sept 8	Oct 6	Nov 3	Dec 1	RL
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	<10	ND	ND	<10	ND	ND	10
Stream Flow														
Gage Height	inches	3.25	3.35	3.3	3.49	3.33	ND	3.07	3.05	3.05	3.11	3.14	3.19	N/A
Stream Discharge	cfs	ND	27	23.3	39	25.5	13.6	10.3	9.04	9.44	11.8	13.6	16.3	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
RL = reporting limit
Source: Ihrie 2013a

Table 6.1-18 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2004

Table 6.1-18 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2004

Parameter	Unit	Jan 12	Feb 2	Feb 29	Apr 5	Apr 19	May 2	May 17	Jun 7	Jun 21	July 6	Jul 19	Reporting Limit
Major Ions													
Calcium, Dissolved	mg/L	51.3	ND	ND	55.6	ND	ND	ND	ND	ND	43.1	ND	0.15
Chloride, Total	mg/L	5.2	4.59	5.08	5.44	5.29	4.92	4.33	4.32	4.06	3.92	4.30	1
Magnesium, Dissolved as Mg	mg/L	9.3	ND	ND	11	ND	ND	ND	ND	ND	8.07	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	<0.05	<0.05	0.060	<0.05	<0.05	1.05	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.36	1.28	0.606	0.469	0.679	0.908	1.03	0.882	0.896	0.964	0.963	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	0.603	0.528	<0.5	0.635	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	<0.04	<0.04	0.073	0.045	<0.04	0.13	<0.04	<0.04	<0.04	0.053	<0.04	0.04
Sodium, Dissolved	mg/L	24.3	ND	ND	ND	ND	ND	ND	ND	ND	24.5	ND	0.15
Physical Properties													
Specific Conductance	µmhos/cm @25^{o}C	408	408	345	377	364	359	314	345	364	348	336	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	9.32	8.64	6.1	9.09	9.55	8.98	9.15	8.93	9.48	8.39	8.22	N/A
pH, Field	s.u.	8.05	7.59	7.8	8.15	8.26	8.48	8.43	8.35	8.3	8.19	8.11	N/A
Suspended Solids, Total (TSS)	mg/L	10.5	8.5	33	11.5	5	<5	5.5	<5	<5	23	19	5
Temperature, Water (Field)	^{o}C	4.7	0.82	0.69	10.17	10.23	15.23	12.61	16.13	13.79	17	19.21	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	5.6	11.5	41.7	10.4	4.3	3.8	3.2	8.5	85.4	21.4	20.9	N/A
Metals, Dissolved													
Arsenic, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Chromium, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Copper, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Lead, Dissolved	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Mercury, Dissolved as Hg	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Nickel, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver, Dissolved	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Zinc, Dissolved	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Stream Flow													
Gage Height	inches	ND	ND	3.5	3.38	3.27	3.22	ND	3.08	3.11	3.12	3.08	N/A
Stream Discharge	cfs	18.7	19.3	40	29.4	21.3	18.1	11.12	10.3	12.1	12.6	10.7	N/A

Table 6.1-18 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2004

Parameter	Concentration	Aug 1	Aug 16	Sept 6	Sept 20	Oct 4	Nov 2	Dec 6	Reporting Limit
Major Ions	Suspended								
Calcium, Dissolved	mg/L	ND	ND	ND	ND	53	ND	ND	0.15
Chloride, Total	mg/L	4.24	4.64	6.52	5.25	4.82	5.34	5.13	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	8.86	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.054	<0.05	0.070	<0.05	0.212	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.962	0.927	0.920	0.837	0.790	0.896	1.10	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.678	0.770	1.13	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total	mg/L	0.061	0.074	0.119	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	25	ND	ND	0.15
Physical Properties									
Specific Conductance	µmhos/cm @25°C	331	356	382	387	357	383	421	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	7.17	8.42	8.83	8.14	9.27	10.22	10.55	N/A
pH, Field	s.u.	8.18	7.96	7.09	7.17	8.03	8.05	7.77	N/A
Suspended Solids, Total (TSS)	mg/L	25	36	61.5	20	25.5	9	6.5	5
Temperature, Water (Field)	°C	26.45	16.45	14.98	16.46	10.21	3.96	1.67	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	4.23	N/A
Turbidity, Field	NTU	17.7	207	94.1	14.8	23.3	15.2	ND	N/A
Metals, Dissolved									
Arsenic, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	<`1	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Mercury, Dissolved as Hg	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Selenium, Total	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Stream Flow									
Gage Height	inches	3.05	3.12	3.22	3.18	3.21	3.22	3.23	N/A
Stream Discharge	cfs	9.44	12.6	18.1	15.8	17.5	16.9	18.7	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-19 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2005

Table 6.1-19 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2005

Parameter	Concentration	Jan 10	Feb 7	Mar 7	Apr 4	Apr 18	May 1	May 16	Jun 6	Jun 20	July 11	Jul 25	Reporting Limit
Major Ions	Suspended												
Calcium	mg/L	49.8	ND	ND	52.3	ND	ND	ND	ND	ND	50.4	ND	0.15
Chloride, Total	mg/L	4.76	4.44	4.69	5.24	5.1	6.4	4.94	5.22	7.21	5.46	4.58	1
Magnesium, Dissolved as Mg	mg/L	9.14	ND	ND	10.7	ND	ND	ND	ND	ND	9.7	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.064	<0.05	<0.05	<0.05	0.173	<0.05	<0.05	0.089	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.279	0.670	0.431	0.393	0.427	0.330	0.297	0.323	0.194	0.658	0.917	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	0.637	0.680	0.672	0.804	1.102	0.598	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.047	0.054	0.708	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.8	ND	ND	26.1	ND	ND	ND	ND	ND	24.4		
Physical Properties													
Dissolved Oxygen, Field	mg/L	9.39	8.93	7.37	7.28	5.39	5.1	9.13	9.17	8.42	8.35	7.64	N/A
pH, Field	s.u.	7.81	7.84	7.5	8.12	8.21	8.26	8.24	8.06	8.33	8.14	7.94	N/A
Total Suspended Solids (TSS)	mg/L	7.0	10.5	8	5	<5	5	12.5	21	19.5	24	20	5
Specific Conductance, Field	µmhos/cm @25^{o}C	360	381	404	416	428	470	432	454	347	340	368	N/A
Temperature, Field (Celsius)	^{o}C	2.01	0.24	4.41	9.39	13.28	9.43	14.86	16.87	18.92	21.25	21.25	N/A
Turbidity, Lab	NTU	ND	ND	14.8	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	8	59.4	14.8	2.3	2.7	2.5	7.7	11.8	7.8	17.1	18.3	N/A
Metals, Dissolved													
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Chromium	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Copper	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Lead	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Mercury	µg/L	<l	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Nickel	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Mercury	µg/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver	Ug/L	<1	ND	ND	<1	ND	ND	ND	ND	ND	<1	ND	1
Zinc	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Stream Flow													
Gage height	inches	3.2	3.37	3.51	3.79	3.69	3.97	3.78	3.73	ND	ND	3.1	N/A
Stream discharge	cfs	16.9	28.6	40.6	58.6	50.9	68.1	56.2	53.2	0.351	16.3	11.6	N/A

Table 6.1-19 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2005

Parameter	Concentration	Aug 8	Aug 22	Sept 11	Sept 26	Oct 11	Nov 07	Dec 5	Reporting Limit
Major Ions	Suspended								
Calcium	mg/L	ND	ND	ND	ND	49.3	ND	ND	0.15
Chloride, Total	mg/L	4.30	5.28	5.26	4.91	6.79	4.49	4.95	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	9.17	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.071	<0.05	<0.05	0.075	0.102	0.078	0.058	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.961	0.560	0.785	0.976	0.925	0.907	1.266	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	1.206	<0.5	<0.5	<0.5	1.130	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	0.047	0.050	0.048	<0.04	0.052	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	26.2	ND	ND	5
Physical Properties									
Dissolved Oxygen, Field	mg/L	7.98	7.9	8	9.1	9.32	10.15	10.57	N/A
pH, Field	s.u.	8.19	8.18	8	8.08	8.1	8.05	8.27	N/A
Total Suspended Solids, TSS	mg/L	21	40.5	30.5	27.5	21	17	6	5
Specific Conductance, Field	µmhos/cm @25°C	367	409	353	389	413	402	418	N/A
Temperature, Field (Celsius),	°C	18.41	17.97	22.47	10.16	9.04	6.35	-0.25	N/A
Turbidity, Lab	NTU	ND	ND	43.9	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	15.5	24.6	26.1	28.8	19.4	15.5	11.4	N/A
Metals, Dissolved									
Arsenic	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	<1	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Selenium	µg/L	ND	ND	ND	ND	<5	ND	ND	5
Silver	Ug/L	ND	ND	ND	ND	<1	ND	ND	1
Zinc	µg/L	ND	ND	ND	ND	<10	ND	ND	10
Stream Flow									
Gage height	inches	3.1	3.2	3.2	3.21	3.27	3.27	4.0	N/A
Stream discharge	cfs	11.6	16.9	16.9	17.5	21.3	21	70	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-20 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2006

Table 6.1-20 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2006

Parameter	Unit	Jan 9	Feb 6	Mar 8	Apr 3	Apr 17	May 1	May 15	Jun 5	Jun 20	July 10	Aug 8	Reporting Limit
Major Ions, Suspended													
Calcium	mg/L	50.5	ND	ND	56.3	ND	ND	ND	ND	ND	44.8	ND	1
Chloride, Total	mg/L	4.90	4.50	14.83	6.31	5.17	5.30	3.61	3.75	3.42	4.09	4.14	1
Magnesium, Dissolved as Mg	mg/L	9.3	ND	ND	11.3	ND	ND	ND	ND	ND	8.09	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.065	0.195	0.053	0.091	<0.05	0.154	0.071	<0.05	0.058	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.005	1.063	0.379	0.257	0.301	0.165	0.468	0.544	1.012	0.997	1.012	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	<0.50	<0.50	0.581	0.652	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	0.045	0.04
Sodium, Dissolved	mg/L	24.4	ND	ND	34.3	ND	ND	ND	ND	ND	23.27	ND	5
Physical Properties													
Dissolved Oxygen, Field	mg/L	10.3	11.0	8.9	8.71	7.49	8.88	7.69	6.86	6.09	5.37	4.78	N/A
pH, Field	s.u.	7.48	7.94	8.01	7.83	8.05	8.08	8.18	8.24	8.39	7.98	8.22	N/A
Total Suspended Solids, TSS	mg/L	5	6	9	9.0	12.0	8.5	15.5	10.0	20.0	28.5	32.5	5
Specific Conductance, Field	µmhos/cm @ 25^{o}C	359	361	394	407	439	423	405	360	345	329	362	N/A
Temperature, Field (Celsius)	°C	1.47	1.68	5.75	7	13.66	12.96	13.7	16.62	17.47	16.36	19.51	N/A
Turbidity, Field	NTU	6	14.2	7.7	6.3	6.8	5.3	ND	18.1	30	41.2	35.1	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	10.1	ND	ND	ND	ND	N/A
Metals, Dissolved													
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	<10	ND	10
Cadmium	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	<5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Mercury	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	<5	ND	5
Silver	µg/L	<1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc	µg/L	<10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow													
Gage Height	inches	4.21	3.94	4.31	4.34	4.11	4.12	3.68	3.23	3.15	3.13	3.09	N/A
Stream discharge	cfs	85	66.2	92.5	94.8	ND	77.7	50.3	18.7	14.1	0.3	11.2	N/A

Table 6.1-20 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2006

Parameter	Unit	Aug 21	Sept 11	Sept 25	Oct 2	Nov 6	Dec 4	Reporting Limit
Major Ions, Suspended								
Calcium	mg/L	ND	ND	ND	47.5	ND	ND	0.15
Chloride	mg/L	4.25	4.49	3.84	4.09	4.41	5.14	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	8.2	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.050	0.064	0.081	<0.05	0.099	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N) (mg/L)	mg/L	1.130	1.153	1.30	1.220	1.166	1.376	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	0.664	<0.50	0.86	<0.50	<0.50	0.5
Phosphorus, Total as P	mg/L	<0.04	0.092	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	24.05	ND	ND	5
Physical Properties								
Dissolved Oxygen	mg/L	8.1	8.62	9.36	8.61	9.69	11.18	N/A
pH	s.u.	7.83	7.93	7.82	7.88	7.87	7.96	N/A
Total Suspended Solids, TSS	mg/L	30.5	25	31.5	32.5	31	7.0	5
Specific Conductance	µmhos/cm @ 25°C	357	340	363	355	390	404	N/A
Temperature, Celsius	°C	16.27	13.51	10.04	11.37	5.06	1.16	N/A
Turbidity, Field	NTU	27.2	28.5	30	25.9	28.5	24.8	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	
Metals, Dissolved								
Arsenic	µg/L	ND	ND	ND	<1	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	10
Mercury	µg/L	ND	ND	ND	ND	ND	ND	1
Selenium	µg/L	ND	ND	ND	<5	ND	ND	5
Silver	µg/L	ND	ND	ND	ND	ND	ND	1
Zinc	µg/L	ND	ND	ND	ND	ND	ND	10
Stream Flow								
Gage Height	inches	3.1	3.14	3.14	3.11	3.22	3.24	N/A
Stream discharge	cfs	11.6	13.6	13.6	12.1	18.1	19.3	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-21 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2007

Table 6.1-21 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2007

Parameter	Concentration	Jan 8	Feb 5	Mar 5	Apr 2	Apr 16	May 7	May 21	Jun 4	Jun 11	Jul 9	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	55.17	ND	ND	53.61	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.98	ND	4.79	5.95	5.13	4.80	4.26	4.10	3.77	4.64	1
Magnesium, Dissolved as Mg	mg/L	9.51	ND	ND	10.63	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.10	<0.05	<0.05	0.05	<0.05	0.07	ND	<0.05	0.05	0.06	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.37	1.58	0.85	0.23	0.36	0.46	0.56	0.80	0.84	0.67	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	0.534	0.508	<0.5	<0.5	<0.5	0.77	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.050	0.217	<0.04	0.057	0.04
Sodium, Dissolved	mg/L	25.44	ND	ND	28.34	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	9.8	9.5	9.6	9.6	9.1	ND	7.1	8.1	8.2	6.2	N/A
pH, Field	s.u.	7.73	7.3	7.2	7.75	7.95	ND	9.92	7.81	8.14	7.61	N/A
Total Suspended Solids, TSS	mg/L	<5	<5	<5	<5	<5	<5	<5	5	<5	25.5	5
Specific Conductance	µmhos/cm @ 25°C	385	372	338	416	419	ND	362	374	371	368	N/A
Temperature, Water (Field)	°C	1.5	0.2	1.0	8.6	9.5	ND	15.1	14.4	17.2	18.9	N/A
Turbidity, Field	NTU	8.2	23.5	29.9	0.9	14.3	ND	37.8	14.6	25.3	63.3	N/A
Metals, Dissolved												
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height		3.88	4.63	5.25	5.56	4.49	ND	4.86	4.09	4.85	3.98	N/A
Stream Discharge		62.4	117.8	172.1	201.6	194.8	ND	137.1	76.3	136.3	68.7	N/A

Table 6.1-21 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2007

Parameter	Concentration	Jul 23	Aug 6	Aug 20	Sept 10	Sept 24	Oct 1	Nov 5	Dec 3	Reporting Limit
Major Ions, Suspended										
Calcium	mg/L	ND	48.84	ND	ND	ND	45.21	ND	ND	0.15
Chloride	mg/L	3.65	3.92	4.03	3.81	3.63	3.83	4.22	4.21	1
Magnesium, Dissolved as Mg	mg/L	ND	8.35	ND	ND	ND	7.94	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.23	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.88	0.93	0.96	1.12	1.08	1.12	1.21	1.38	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.056	<0.04	0.053	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	23.87	ND	ND	ND	ND	22.32	ND	ND	0.15
Physical Properties										
Dissolved Oxygen, Field	mg/L	6.6	7.0	7.3	8.5	7.9	9.0	8.3	8.5	N/A
pH, Field	s.u.	7.74	7.76	7.84	7.38	7.66	7.38	7.36	7.63	N/A
Total Suspended Solids, TSS	mg/L	33.0	26.5	25.5	18.0	24.0	18.5	13.5	9.0	5
Specific Conductance	µmhos/cm @ 25°C	369	364	356	356	342	341	340	349	N/A
Temperature, Water (Field)	°C	19.7	19.6	18.4	11.6	12.9	10.6	5.5	2.0	N/A
Turbidity, Field	NTU	37.5	22.9	15.7	21.7	42.1	30.9	28.6	--	N/A
Metals, Dissolved										
Arsenic	µg/L	<10	ND	<10	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	<5	ND	ND	<5	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow										
Gage Height	inches	3.68	3.53	3.72	3.09	3.00	3.04	3.04	10.7	N/A
Stream Discharge	cfs	50.3	41.7	37.2	11.2	7.5	9.0	9.0	10.7	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ – Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-22 Summary of NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2003-2008

Table 6.1-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Jan 7	Feb 4	Mar 3	Apr 7	May 5	May 12	May 19	May 27	Jun 2	Jun 9	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	42.82	ND	ND	52.23	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.47	3.95	5.01	5.12	4.81	6.59	4.81	4.41	6.33	4.54	1
Magnesium, Dissolved as Mg	mg/L	8.33	ND	ND	10.39	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.09	0.14	0.07	<0.05	0.08	<0.05	0.08	<0.05	0.06	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.34	1.4	0.64	0.31	0.72	0.3	0.44	0.53	0.51	0.36	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	0.77	0.53	<0.5	0.8	0.69	0.53	0.97	0.69	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.06	0.04	<0.04	0.05	0.06	<0.04	0.06	0.06	0.04
Sodium, Dissolved	mg/L	24.56	ND	ND	26.53	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	11.43	11.23	11.71	9.63	9.39	9.38	8.44	9.78	8.25	9.38	N/A
pH, Field	s.u.	8.58	8.46	8.42	7.88	8.15	8.26	8.12	8.07	8.13	8.38	N/A
Total Suspended Solids, TSS	mg/L	17	6	37.5	16	6.5	27.5	22	14	38	14.5	5
Specific Conductance	µmhos/cm @ 25^{o}C	396	328	334	395	356	410	100	374	471	464	N/A
Temperature, Water (Field)	^{o}C	1.52	1.64	2.32	5	10.5	11.97	15.14	10.3	14.8	14.47	N/A
Turbidity, Field	NTU	ND	ND	ND	ND	13.6	10.6	9.2	11.3	27.7	13.2	N/A
Metals, Dissolved												
Arsenic	µg/L	<10	ND	ND	<10	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height	inches	3.12	3.09	3.51	3.53	3.28	3.36	3.19	3.22	3.20	3.2	N/A
Stream Discharge	cfs	12.6	11.2	40.6	41.7	78.2	27.8	16.3	18.1	16.9	16.9	N/A

Table 6.1-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Jun 16	Jun 23	Jun 30	Jul 7	Jul 14	Jul 21	Jul 28	Aug 4	Aug 11	Aug 18	Reporting Limit
Major Ions, Suspended												
Calcium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	4.15	4.52	4.08	4.3	ND	ND	ND	ND	3.46	3.58	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.09	0.07	<0.05	<0.05	<0.05	ND	ND	ND	<0.05	0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.54	0.3	0.59	0.7	0.82	ND	ND	ND	ND	0.91	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.64	1.41	0.55	0.62	<0.5	ND	ND	ND	0.62	<0.5	0.5
Phosphorus, Total as P	mg/L	0.07	0.17	0.04	0.05	<0.04	ND	ND	ND	0.05	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.15
Physical Properties												
Dissolved Oxygen, Field	mg/L	8.91	8.53	8.45	8.10	8.23	7.71	7.69	7.84	8.14	8.50	N/A
pH, Field	s.u.	8.11	8.21	8.36	8.07	8.14	8.19	7.99	8.19	7.92	8.07	N/A
Total Suspended Solids, TSS	mg/L	30.5	177	38	45	26	ND	ND	ND	ND	41.5	5
Specific Conductance	µmhos/cm @ 25°C	539	503	489	393	391	378	458	456	490	502	N/A
Temperature, Water (Field)	°C	14.47	19.0	16.82	18.21	16.68	18.56	18.6	18.2	18.1	15.5	N/A
Turbidity, Lab, Field	NTU	13.3	117	83.8	39.6	48.2	34	34.5	39.7	32.7	28.7	N/A
Metals, Dissolved												
Arsenic	µg/L	ND	ND	<10	ND	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	ND	ND	<5	ND	ND	<5	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow												
Gage Height	inches	3.11	3.14	3.11	3.11	2.99	3.1	3.05	2.87	2.77	2.81	N/A
Stream Discharge	cfs	12.1	13.6	12.1	12.1	7.24	11.6	9.44	4.42	2.54	3.24	N/A

Table 6.1-22 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir - 2008

Parameter	Concentration	Aug 25	Sept 1	Sept 8	Sept 15	Sept 22	Sept 29	Oct 6	Nov 3	Dec 01	Reporting Limit
Major Ions, Suspended											
Calcium	mg/L	ND	ND	ND	ND	ND	ND	44.43	ND	ND	0.15
Chloride	mg/L	4.31	4.32	5.19	4.75	ND	4.96	4.64	4.67	5.32	1
Magnesium, Dissolved as Mg	mg/L	ND	ND	ND	ND	ND	ND	7.91	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.08	<0.05	<0.05	ND	0.05	0.07	0.13	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.04	1.25	0.91	0.89	ND	0.98	1.01	1.06	1.01	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	ND	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	0.04	0.04	<0.04	0.04	ND	0.04	0.13	0.06	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	23.87	ND	ND	0.15
Physical Properties											
Dissolved Oxygen, Field	mg/L	8.34	8.32	9.03	9.12	ND	9.17	8.92	6.29	ND	N/A
pH, Field	s.u.	7.79	8.14	8.17	8.37	ND	7.98	8.15	8.11	8.01	N/A
Total Suspended Solids, TSS	mg/L	35	14.5	23.5	15.5	ND	21.5	15.5	10	5.5	5
Specific Conductance	Umhos/cm @ 25°C	349	343	348	366	ND	363	352	359	374	N/A
Temperature, Water (Field)	°C	17.79	15.7	10.4	11	ND	10.5	12.2	8.7	1.48	N/A
Turbidity, Field	NTU	21.6	19	20.6	15.5	ND	35.4	122	9.5	5.3	N/A
Metals, Dissolved											
Arsenic	µg/L	ND	ND	ND	ND	ND	ND	5.41	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	ND	ND	ND	ND	ND	ND	<5	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow											
Gage Height	inches	2.76	3.49	3.78	3.5	ND	3.58	3.08	3.12	3.19	N/A
Stream Discharge	cfs	2.38	39	56.2	40	ND	41.7	10.7	14.7	16.3	N/A

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
ND = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-23 NDEQ Water Quality Data for Niobrara River Below Box Butte Reservoir - 2009

Table 6.1-23 NDEQ Water Quality Data for the Niobrara River Above Box Butte Reservoir - 2009

Parameter	Concentration	Jan 5	Feb 2	Mar 2	Apr 6	Apr 7	May 4	Jun 2	Reporting Limit
Major Ions, Suspended									
Calcium	mg/L	48.96	ND	ND	ND	46.68	ND	ND	0.15
Chloride, Total	mg/L	4.56	4.30	4.41	ND	6.34	5.96	4.21	1
Magnesium, Dissolved	mg/L	8.60	ND	ND	ND	11.54	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	0.08	<0.05	ND	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.50	1.05	0.44	ND	0.41	0.16	0.39	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	ND	0.83	0.63	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	<0.04	0.04	ND	<0.04	0.05	0.26	0.04
Sodium, Dissolved	mg/L	25.71	ND	ND	ND	40.55	ND	ND	ND
Physical Properties									
Dissolved Oxygen, Field	mg/L	ND	ND	6.85	3.34	ND	5.40	ND	N/A
pH, Field	s.u.	7.81	8.02	8.01	8.09	ND	ND	8.87	N/A
Total Suspended Solids, TSS	mg/L	8.5	8	<5	ND	18.5	<5	14.5	5
Specific Conductance	µmhos/cm @ 25°C	395	371	378	428	ND	465	409	N/A
Temperature, Water (Field)	°C	-0.22	0.44	3.01	-0.24	ND	9.68	13.65	N/A
Turbidity, Field	NTU	4.2	36.8	6.1	60	ND	2.7	10.6	N/A
Metals, Dissolved									
Arsenic	µg/L	5.69	ND	ND	ND	<10	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	4.03	3.29	3.57	ND	ND	4.04	3.65	N/A
Stream Discharge	cfs	72.1	22.6	43.9	ND	ND	72.8	48.5	N/A

Table 6.1-23 NDEQ Water Quality Data for the Niobrara River Above Box Butte Reservoir - 2009

Parameter	Concentration	Jul 21	Aug 10	Sept 8	Oct 5	Nov 2	Nov 3	Dec 7	Reporting Limit
Major Ions, Suspended									
Calcium	mg/L	53.07	ND	ND	ND	ND	ND	ND	0.15
Chloride, Total	mg/L	3.99	4.13	4.92	6.10	ND	7.35	5.57	1
Magnesium, Dissolved	mg/L	11.27	ND	ND	ND	ND	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.08	<0.05	<0.05	<0.05	ND	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.60	0.58	0.84	0.78	ND	0.34	0.87	0.05
Nitrogen as N, Total Kjeldahl	mg/L	1.03	0.75	<0.5	<0.5	ND	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	0.08	0.10	0.05	0.05	ND	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	29.44	ND	ND	ND	ND	ND	ND	ND
Physical Properties									
Dissolved Oxygen, Field	mg/L	8.12	8.33	8.83	9.81	11.10	ND	11.94	N/A
pH, Field	s.u.	8.24	8.18	8.18	8.86	8.42	ND	8.23	N/A
Total Suspended Solids, TSS	mg/L	52	51.5	28	28.5	ND	22	12	5
Specific Conductance	µmhos/cm @ 25^{o}C	431	383	363	377	424	ND	433	N/A
Temperature, Water (Field)	^{o}C	17.8	16.58	17.53	7.84	5.51	ND	-0.25	N/A
Turbidity, Field	NTU	21.8	24.9	24.1	16.6	14.3	ND	34	N/A
Metals, Dissolved									
Arsenic	µg/L	7.26	ND	ND	ND	ND	ND	ND	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Selenium	µg/L	<5	ND	ND	ND	ND	ND	ND	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	10
Stream Flow									
Gage Height	inches	3.31	3.36	3.14	3.32	3.47	ND	4.12	N/A
Stream Discharge	cfs	24.0	27.8	13.6	24.8	37.2	ND	78.5	N/A

Source: Ihrie 2013a; Ihrie 2011. cfs = cubic feet per second µg/L = micrograms per liter mg/L = milligrams per Liter NTU = Nephelometric Turbidity Units s.u. = standard unit umhos/cm = micromhos per centimeter < = less than NA = No data N/A = not applicable ND = not detected NDEQ = Nebraska Department of Environmental Quality

Table 6.1-24 Summary of NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir 2010

Table 6.1-24 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2010

Constituent	Unit	Jan 4	Feb 1	Mar 1	Apr 5	May 3	Jun 7	Jul 19	Aug 3	Sept 7	Oct 11	Nov 1	Dec 6	RL
Major Ions														
Calcium, Dissolved	mg/L	53.75	ND	ND	52	ND	ND	48.1	ND	ND	43.2	ND	ND	0.15
Chloride, Total	mg/L	5.35	5.44	5.15	5.98	6.15	4.27	3.97	5.01	4.13	4.73	5.23	5.78	1.0
Magnesium, Dissolved	mg/L	10.12	ND	ND	<0.15	ND	ND	<0.15	ND	ND	8.0	ND		0.15
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	0.196	<0.05	<0.05	0.0879	<0.05	<0.05	0.068	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.392	1.323	0.725	0.205	0.226	0.329	1.09	1.2	1.07	1.09	0.961	1.4	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	<0.50	1.734	0.607	0.778	1.02	1.15	1.08	<0.50	<0.50	0.518	<0.50	0.5
Phosphorus, Total	mg/L	<0.04	<0.04	0.201	<0.04	<0.04	0.074	0.179	0.183	<0.04	0.065	0.077	<0.04	0.04
Sodium, Dissolved	mg/L	26.97	ND	ND	25.8	ND	ND	25.3	ND	ND	22.3	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	385	385	297	458	353	ND	414	408	337	379	395	410	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	12.14	9.97	9.56	10.48	10.83	ND	7.11	7.8	ND	11.47	11.31	11.21	N/A
pH, Field	s.u.	8.45	8.43	8.57	8.25	8.26	ND	8.19	8.27	8.46	8.59	8.65	8.43	N/A
Suspended Solids, Total (TSS)	mg/L	21	18	32	10	15	41.5	129	114	30	23.5	55.5	38.5	5
Temperature, Water (Field)	°C	0.96	0.82	1.62	5.72	10.92	ND	18.63	20.16	11.66	10.76	7.77	1.39	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	233	19.9	26.2	9.5	40.3	ND	ND	ND	ND	24.2	44	24.9	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	<10	ND	ND	4.98	ND	ND	7.19	ND	ND	5.47	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10

Table 6.1-24 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2010

Constituent	Unit	Jan 4	Feb 1	Mar 1	Apr 5	May 3	Jun 7	Jul 19	Aug 3	Sept 7	Oct 11	Nov 1	Dec 6	RL
Stream Flow														
Gage Height	inches	3.42	3.46	3.95	4.05	2.29	3.71	3.25	3.11	3.11	3.17	3.38	3.41	N/A
Stream Discharge	cfs	32.7	36.2	66.8	73.5	24.2	52	20	12.1	12.1	15.2	29.4	31.9	N/A

cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
umhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
RL = reporting limit
Source: Ihrie 2013a

Table 6.1-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) - 2011

Table 6.1-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2011

Constituent	Unit	Jan 3	Feb 14	Mar 6	Apr 11	May 3	Jun 6	Jul 18	Aug 1	Sept 6	Oct 3	Nov 7	Dec 5	RL
Major Ions														
Calcium, Dissolved	mg/L	49.2	ND	ND	49.6	ND	ND	45.6	ND	ND	46.5	ND	ND	0.15
Chloride, Total	mg/L	4.88	4.95	4.75	5.63	4.57	5.2	4.96	4.74	4.0	4.43	4.89	5.14	1.0
Magnesium, Dissolved	mg/L	9.2	ND	ND	9.67	ND	ND	8.26	ND	ND	8.0	ND	ND	0.15
Nitrogen, Total Ammonia as N	mg/L	0.070	0.066	0.094	<0.05	<0.05	<0.05	0.086	<0.05	<0.05	0.068	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	1.5	1.34	0.276	0.43	0.351	0.27	1.16	1.07	1.16	1.18	1.09	1.34	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.50	0.732	0.89	<0.50	<0.50	0.884	2.17	0.571	<0.50	<0.50	<0.50	<0.50	0.5
Phosphorus, Total	mg/L	<0.04	0.099	0.081	0.041	<0.04	0.071	0.45	0.090	0.045	0.048	<0.04	0.163	0.04
Sodium, Dissolved	mg/L	24	ND	ND	21.4	ND	ND	23.1	ND	ND	24.4	ND	ND	0.15
Physical Properties														
Specific Conductance	µmhos/cm @25°C	388	405	347	441	437	501	401	396	388	358	435	528	N/A
Alkalinity	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Chemical Oxygen Demand (COD)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12
Dissolved Oxygen, Field	mg/L	8.94	10.94	12.78	12.62	13.06	7.61	6.9	10.31	10.2	10.24	12.43	12.92	N/A
pH, Field	s.u.	8.32	8.53	8.18	8.0	8.48	8.31	8.3	8.23	8.32	8.23	9.04	8.54	N/A
Suspended Solids, Total (TSS)	mg/L	11.5	77	59	36.5	16.5	49.5	297	61	34	36.3	32.5	57.5	5
Temperature, Water (Field)	°C	0.06	3.1	1.66	8.25	10.79	20.37	24.79	20.71	15.89	14.02	3.36	-0.26	N/A
Turbidity, Lab	NTU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N/A
Turbidity, Field	NTU	17.5	34.6	29.4	20.7	12.1	36.5	193	61.4	29.9	36.9	22.9	12.6	N/A
Metals, Dissolved														
Arsenic, Dissolved	µg/L	5.81	ND	ND	6.46	ND	ND	7.33	ND	ND	5.57	ND	ND	10
Cadmium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Chromium, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Copper, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Lead, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5
Mercury, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Nickel, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Selenium, Total	µg/L	<5	ND	ND	<5	ND	ND	<5	ND	ND	<5	ND	ND	5
Silver, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Zinc, Dissolved	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10

Table 6.1-25 NDEQ Water Quality Data for Niobrara River Above Box Butte Reservoir (SNI4NIOBR402) – 2011

Constituent	Unit	Jan 3	Feb 14	Mar 6	Apr 11	May 3	Jun 6	Jul 18	Aug 1	Sept 6	Oct 3	Nov 7	Dec 5	RL
Stream Flow														
Gage Height	inches	4.42	3.49	4.17	3.8	3.8	3.93	3.3	3.1	3.14	3.14	3.3	3.72	N/A
Stream Discharge	cfs	101	39	82.1	57.5	57.5	65.5	23.3	11.7	13.6	13.6	23.3	52.6	N/A

cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
RL = reporting limit
Source: Ihrie 2013a

Table 6.1-26 Summary of NDEQ Non-Radiological Water QWuality Data for Niobrara River Above Box Butte Reservoir – 2003-2011

Table 6.1-26 Summary of NDEQ Non-Radiological Water Quality Data for Niobrara River Above Box Butte Reservoir 2003 - 2011

Constituent	Unit	Average Value	Minimum Value	Maximum Value	Total Observations	Number of Values Less Than RL	RL
Major Ions							
Calcium, Dissolved	mg/L	49.95	42.82	58.2	36	0	0.15
Chloride	mg/L	4.83	3.46	7.35	131	0	1.0
Magnesium, Dissolved	mg/L	8.92	<0.15	11.54	35	1	0.15
Nitrogen, Total Ammonia as N	mg/L	0.06	<0.05 [a]	1.05	150	90	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	0.85	0.16	1.58	146	0	0.05
Nitrogen as N, Total Kjeldahl	mg/L	0.44	0.5 [a]	2.17	151	100	0.5
Phosphorus, Total	mg/L	0.05	<0.04 [a]	0.71	152	78	0.04
Sodium, Dissolved	mg/L	25.5	21.4	40.6	35	0	0.15
Physical Properties							
Alkalinity	mg/L	184	162	212	13	--	--
Dissolved Oxygen	mg/L	8.85	3.34	12.9	139	--	--
Chemical Oxygen Demand (COD)	mg/L	7.9	<12 [a]	20.3	12	9	12
pH	s.u.	8.09	7.1	9.92	211	--	--
Specific Conductance	µmhos/cm @25°C	386	100	539	151	--	--
Suspended Solids, Total (TSS)	mg/L	24.7	<5 [a]	297	150	14	5.0
Temperature	°C	11.13	-0.26	29.0	142	--	--
Turbidity, Field	NTU	27.7	0.2	233	139	--	--
Metals, Dissolved							
Arsenic, Dissolved [b]	µg/L	5.93	<10 [a]	7.33	39	29	10
Cadmium, Dissolved	µg/L	<1	<1	<1	16	16	1
Chromium, Dissolved	µg/L	<10	<10	<10	16	16	10
Copper, Dissolved	µg/L	<10	<10	<10	16	16	10
Lead , Dissolved	µg/L	<5	<5	<5	16	16	5
Mercury, Dissolved as Hg	µg/L	<1	<1	<1	16	16	1
Nickel, Dissolved	µg/L	<10	<10	<10	16	16	10
Selenium, Total	µg/L	<5	<5	<5	39	39	5
Silver, Dissolved	µg/L	<1	<1	<1	16	16	1
Zinc, Dissolved	µg/L	<10	<10	<10	16	16	10
Stream Flow							
Gage Height	inches	3.5	2.3	10.7	144	--	--
Stream Discharge	cfs	36.3	0.35	201.6	142	--	

Source: Ihrie 2013a RL = Reporting Limit cfs = cubic feet per second µg/L = micrograms per Liter mg/L = milligrams per Liter NTU = Nephelometric Turbidity Units
s.u. = standard unit µmhos/cm = micromhos per centimeter < = less than NDEQ = Nebraska Department of Environmental Quality

[a] Value of one-half of Less Than Reporting Limit used for calculating average values.

[b] Arsenic values were below the RL of 10 ug/L for 2002 – 2007, with detected values for years 2008 through 2011.

Table 6.1-27 NDEQ Water Quality Data for Niobrara River Below Box Butte Reservoir – 2008

Table 6.1-27 NDEQ Water Quality Data for Niobrara River Below Box Butte Reservoir - 2008

Parameter	Concentration	May 12	May 19	May 27	Jun 2	Jun 9	Jun16	Jun 23	Jun 30	Jul 7	Jul 14	Aug 11	Aug 18	Aug 25	Sept 1	Sept 8	Sept 15	Sept 29	Reporting Limit
Major Ions, Suspended																			
Calcium	mg/L																		0.15
Chloride	mg/L	5.66	--	3.53	3.63	4.11	3.61	3.63	3.8	3.97	--	4.09	3.28	4.31	4.56	4.06	4.16	4.47	1
Magnesium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND		--								1
Nitrogen, Total Ammonia as N	mg/L	<0.05	<0.05	<0.05	<0.05	0.1	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	0.05
Nitrogen, Total (Nitrate + Nitrite as N)	mg/L	<0.05	0.57	0.51	0.4	0.42	0.37	0.3	0.39	0.36	<0.05	--	0.9	0.93	0.91	0.7	0.85	0.82	0.05
Nitrogen as N, Total Kjeldahl	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.51	<0.5	0.7	<0.5	0.73	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Phosphorus, Total as P	mg/L	<0.04	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.04
Sodium, Dissolved	mg/L	ND	ND	ND	ND	ND	ND	ND	ND										
Physical Properties																			
Dissolved Oxygen, Field	mg/L	9.04	7.21	10.57	8.71	10.07	8.69	8.77	9.22	7.75	7.13	--	--	--	--	--	--	--	N/A
pH, Field	s.u.	8.04	8.05	8.15	8.17	8.33	-8.13	8.19	8.3	8.03	8.31	--	--	--	--	--	--	--	N/A
Total Suspended Solids, TSS	mg/L	5	<5	<5	8	<5	<5	6.5	<5	5.5	27.5	--	6.0	5.0	5.0	<5	<5	<5	5
Specific Conductance	µmhos/cm @ 25°C	408	312	325	357	380	440	431	434	360	348	--	--	--	--	--	--	--	N/A
Temperature, Water (Field)	°C	9.82	13.97	9.09	14.99	13.45	14.89	18.88	16.23	18.48	20.2	--	--	--	--	--	--	--	N/A
Turbidity, Field	NTU	1.0	4.5	4.5	9.8	2.6	39.1	17.1	5.9	55.9	20.4	--	--	--	--	--	--	--	N/A
Metals, Dissolved																			
Arsenic	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Cadmium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	1
Chromium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Copper	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Lead	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	5
Mercury	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	1
Nickel	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Selenium	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	5
Zinc	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	--	--	--	--	--	--	10
Stream Flow																			
Gage Height	inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND								
Stream Discharge	cfs	0.9	0.9	1	1	1	0.9	0.9	0.9	0.9	127								

Notes:
cfs = cubic feet per second
µg/L = micrograms per liter
mg/L = milligrams per Liter
NTU = Nephelometric Turbidity Units
s.u. = standard unit
µmhos/cm = micromhos per centimeter
< = less than
NA = No data
N/A = not applicable
ND = not detected
NDEQ = Nebraska Department of Environmental Quality
Source: Ihrie 2013a

Table 6.1-28 NDEQ Water Quality for Niobrara River Below Box Butte Reservoir – 2008 (Range Values)

Table 6.1-28 Summary of NDEQ Water Quality for Niobrara River Below Box Butte Reservoir 2008

Parameter	Minimum	Maximum
	mg/L	
Chloride	3.28	5.66
Nitrogen, Total Ammonia as N[a]	<0.05	0.16
Nitrogen, Total (Nitrate + Nitrite as N)[b]	<0.05	0.93
Nitrogen as N, Total Kjeldahl	<0.05	0.73
Phosphorus, Total[c]	<0.04	0.05
Suspended Solids, Total (TSS)[d]	<5.0	27.5

[a] 15 of 17 measurements <0.05 mg/L
[b] 14 of 17 measurements <0.05 mg/L
[c] 15 of 17 measurements below <0.04 mg/L
[d] 15 of 16 measurements below 8.0 mg/L
mg/L = milligrams per liter
NDEQ = Nebraska Department of Environmental Quality

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte (2011-2012)

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
January 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8	--	0.8	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.7 U	0.7	<0.7 U	0.7
Polonium 210 MDC	0.7	--	0.7	--
Polonium 210 precision (±)	0.5	--	0.4	--
Radium 226	1.3	0.16	1.3	0.14
Radium 226 MDC	0.16	--	0.14	--
Radium 226 precision (±)	0.25	--	0.24	--
Thorium 230	<0.2 U	0.2	<0.1 U	0.1
Thorium 230 MDC	0.2	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.05	--
Uranium Activity (uCi/ml)	5.9E-09	2.0E-10	5.1E-09	2.0E-10
Uranium (metal) (mg/l)	8.7E-03	3.0E-04	7.6E-03	3.0E-04
February 2011				
Lead 210	<1 U	1.2	<1 U	1.2
Lead 210 MDC	1.2	--	1.2	--
Lead 210 precision (±)	0.7	--	0.7	--
Polonium 210	0.8	0.5	<1 U	0.9
Polonium 210 MDC	0.5	--	0.9	--
Polonium 210 precision (±)	0.6	--	0.3	--
Radium 226	1.3	0.09	0.46	0.11
Radium 226 MDC	0.09	--	0.11	--
Radium 226 precision (±)	0.2	--	0.14	--
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2	--	0.2	--
Thorium 230 precision (±)	0.08	--	0.07	--
Uranium Activity (uCi/ml)	5.4E-09	2.0E-10	4.9E-09	2.0E-10
Uranium (metal) (mg/l)	7.9E-03	3.0E-04	7.3E-03	3.0E-04
March 2011				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9	--	0.9	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6	--	0.6	--
Polonium 210 precision (±)	0.3	--	0.4	--
Radium 226	0.56	0.12	1	0.12

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Radium 226 MDC	0.12	--	0.12	--
Radium 226 precision (±)	0.15	--	0.19	--
Thorium 230	<0.3 U	0.3	<0.1 U	0.1
Thorium 230 MDC	0.3	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.07	--
Uranium Activity (uCi/ml)	5.0E-09	2.0E-10	5.4E-09	2.0E-10
Uranium (metal) (mg/l)	7.4E-03	3.0E-04	8.0E-03	3.0E-04
April 2011				
Lead 210	<1.6	1.6	<0.8	0.8
Lead 210 MDC	1.6	--	0.8	--
Lead 210 precision (±)	1	--	0.5	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.5	--	0.6	--
Polonium 210 precision (±)	0.4	--	0.3	--
Radium 226	0.2	0.1	<0.1	0.1
Radium 226 MDC	0.1	--	0.1	--
Radium 226 precision (±)	0.09	--	0.04	--
Thorium 230	<0.2	0.2	<0.8	0.8
Thorium 230 MDC	0.2	--	0.8	--
Thorium 230 precision (±)	0.1	--	0.4	--
Uranium Activity (uCi/ml)	7.0E-09	2.0E-10	5.9E-09	2.0E-10
Uranium (metal) (mg/l)	1.04E-02	3.0E-04	8.8E-03	3.0E-04
May 2011				
Lead 210	<1.2 U	1.2	<1.2 U	1.2
Lead 210 MDC	1.2	--	1.2	--
Lead 210 precision (±)	0.7	--	0.7	--
Polonium 210	<0.6 U	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6	--	0.6	--
Polonium 210 precision (±)	0.4	--	0.3	--
Radium 226	0.3	0.1	<0.2 U	0.2
Radium 226 MDC	0.1	--	0.2	--
Radium 226 precision (±)	0.1	--	0.08	--
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2	--	0.2	--
Thorium 230 precision (±)	0.1	--	0.1	--
Uranium Activity (uCi/ml)	5.8E-09	2.0E-10	5.0E-09	2.0E-10
Uranium (metal) (mg/l)	8.5E-03	3.0E-04	7.3E-03	3.0E-04

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
June 2011				
Lead 210	<1.1 U	1.1	<1.1 U	1.1
Lead 210 MDC	1.1	--	1.1	--
Lead 210 precision (±)	0.6	--	0.7	--
Polonium 210	<0.4 U	0.4	<0.4 U	0.4
Polonium 210 MDC	0.4	--	0.4	--
Polonium 210 precision (±)	0.2	--	0.2	--
Radium 226	0.27	0.15	0.17	0.16
Radium 226 MDC	0.15	--	0.16	--
Radium 226 precision (±)	0.13	--	0.12	--
Thorium 230	<0.1 U	0.1	<0.3 U	0.3
Thorium 230 MDC	0.1	--	0.3	--
Thorium 230 precision (±)	0.04	--	0.2	--
Uranium Activity (uCi/ml)	1.2E-09	2.0E-10	3.3E-09	2.0E-10
Uranium (metal) (mg/l)	6.3E-03	3.0E-04	4.8E-03	3.0E-04
July 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8		0.8	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	<0.7U	0.7	<0.8 U	0.8
Polonium 210 MDC	0.7		0.8	
Polonium 210 precision (±)	0.4		0.6	
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.07	
Thorium 230	<0.1 U	0.1	<0.4 U	0.4
Thorium 230 MDC	0.1		0.4	
Thorium 230 precision (±)	0.08		0.2	
Uranium Activity (uCi/ml)	4.8E-09	2.0E-10	3.6E-09	2.0E-10
Uranium (metal) (mg/l)	7.1E-03	3.0E-04	5.3E-03	3.0E-04
August 2011				
Lead 210	<0.6 U	0.6	<0.6 U	0.6
Lead 210 MDC	0.6		0.6	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.6 U	0.6
Polonium 210 MDC	0.4		0.6	
Polonium 210 precision (±)	0.2		0.2	
Radium 226	0.52	0.15	<0.14 U	0.14

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Radium 226 MDC	0.15		0.14	
Radium 226 precision (±)	0.15		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.07		0.08	
Uranium Activity (uCi/ml)	2.4E-10	2.0E-10	5.2E-09	2.0E-10
Uranium (metal) (mg/l)	4.0E-04	3.0E-04	7.7E-03	3.0E-04
September 2011				
Lead 210	<0.7 U	0.7	<0.7 U	0.7
Lead 210 MDC	0.7		0.7	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.6 U	0.6
Polonium 210 MDC	0.4		0.6	
Polonium 210 precision (±)	0.2		0.5	
Radium 226	0.52	0.15	<0.14 U	0.14
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	0.2		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.07		0.06	
Uranium Activity (uCi/ml)	5.0E-09	2.0E-10	4.5E-09	2.0E-10
Uranium (metal) (mg/l)	7.3E-03	3.0E-04	6.6E-03	3.0E-04
October 2011				
Lead 210	<0.8 U	0.8	<0.8 U	0.8
Lead 210 MDC	0.8		0.8	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	<0.9 U	0.9	3.2	0.6
Polonium 210 MDC	0.9		0.6	
Polonium 210 precision (±)	0.5		1.3	
Radium 226	1	0.1	0.1	0.09
Radium 226 MDC	0.1		0.09	
Radium 226 precision (±)	0.2		0.07	
Thorium 230	<0.3 U	0.3	<0.1 U	0.1
Thorium 230 MDC	0.3		0.1	
Thorium 230 precision (±)	0.1		0.07	
Uranium Activity (uCi/ml)	6.8E-09	2.0E-10	6.1E-09	2.0E-10
Uranium (metal) (mg/l)	1.0E-02	3.0E-04	9.0E-03	3.0E-04

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
November 2011				
Lead 210	<1.0 U	1	<1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.7		0.7	
Polonium 210	<0.5 U	0.5	4.6	0.5
Polonium 210 MDC	0.5		0.5	
Polonium 210 precision (±)	0.3		1.6	
Radium 226	1.2	0.1	0.2	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.2		0.1	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	0.08		0.09	
Uranium Activity (uCi/ml)	6.1E-09	2.0E-10	5.0E-09	2.0E-10
Uranium (metal) (mg/l)	9.0E-03	3.0E-04	7.5E-03	3.0E-04
January 2012				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9		0.9	
Lead 210 precision (±)	0.5		0.5	
Polonium 210	0.8	0.6	<0.6 U	0.6
Polonium 210 MDC	0.6		0.6	
Polonium 210 precision (±)	0.7		0.4	
Radium 226	1.7	0.1	0.2	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.3		0.1	
Thorium 230	<0.1 U	0.1	<0.2 U	0.2
Thorium 230 MDC	0.1		0.2	
Thorium 230 precision (±)	0.06		0.06	
Uranium Activity (uCi/ml)	1.2E-09	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	1.8E-03	3.0E-04	<3.0E-04	3.0E-04

Table 6.1-29 Niobrara River Dissolved Radiological Water Quality Baseline Data Collected by Crow Butte

Radionuclide	Sampling Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
February 2012				
Lead 210	< 1.0 U	1	50	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	NA		2.2	
Polonium 210	< 1.0 U	1	< 1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	< 0.2 U	0.2	< 0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	< 0.2 U	0.2	< 0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/ml)	4.3E+00	2.00E-01	4.6E+00	2.00E-01
Uranium (metal) (mg/l)	6.4E-03	3.0E-04	6.8E-03	3.0E-04
March 2012				
Lead 210	1.7	1	< 1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.6		NA	
Polonium 210	< 1.0 U	1	< 1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	< 0.2 U	0.2	< 0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	< 0.2 U	0.2	< 0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/ml)	4.4E+00	2.00E-01	4.9E+00	2.00E-01
Uranium (metal) (mg/l)	6.5E-03	3.0E-04	7.2E-03	3.0E-04

Notes:

MDC = minimum detectable concentration

mg/l = milligrams per liter

pCi/l = picoCuries per liter

RL = reporting limit

U = Not detected at minimum detectable concentration

uCi/l = microCuries per liter

NA = Not Applicable, not detected below the RL

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte (2011-2012)

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
January 2011				
Lead 210	<1.0 U	1	<1.1U	1.1
Lead 210 MDC	1	--	1.1	--
Lead 210 precision (±)	0.6	--	0.6	--
Polonium 210	<0.3 U	0.3	<0.3 U	0.3
Polonium 210 MDC	0.3	--	0.3	--
Polonium 210 precision (±)	0.1	--	0.1	--
Radium 226	<0.18 U	0.18	<0.13 U	0.13
Radium 226 MDC	0.18	--	0.13	--
Radium 226 precision (±)	0.08	--	0.07	--
Thorium 230	<0.2 U	0.2	<0.06 U	0.06
Thorium 230 MDC	0.2	--	0.06	--
Thorium 230 precision (±)	0.2	--	0.04	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-07
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
February 2011				
Lead 210	1.4	1	<1 U	0.9
Lead 210 MDC	1	--	0.9	--
Lead 210 precision (±)	0.6	--	0.5	--
Polonium 210	<0.5 U	0.5	<0.2 U	0.2
Polonium 210 MDC	0.5	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.2	--
Radium 226	<0.2 U	0.19	<0.2 U	0.19
Radium 226 MDC	0.19	--	0.19	--
Radium 226 precision (±)	0.13	--	0.08	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.09	--	0.07	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
March 2011				
Lead 210	<0.9 U	0.9	<0.9 U	0.9
Lead 210 MDC	0.9	--	0.9	--
Lead 210 precision (±)	0.5	--	0.5	--
Polonium 210	<0.2 U	0.2	0.3	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.1	--	0.3	--
Radium 226	<0.13 U	0.13	<0.13 U	0.13
Radium 226 MDC	0.13	--	0.13	--
Radium 226 precision (±)	0.06	--	0.06	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.1	--	0.1	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	3.4E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	5.0E-04	3.0E-04

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
April 2011 No suspended analyses performed				
May 2011				
Lead 210	<1.1 U	1.1	<0.9 U	0.9
Lead 210 MDC	1.1	--	0.9	--
Lead 210 precision (±)	0.6	--	0.5	--
Polonium 210	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.1	--
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1	--	0.1	--
Radium 226 precision (±)	0.06	--	0.04	--
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1	--	0.1	--
Thorium 230 precision (±)	0.06	--	0.06	--
Uranium Activity (uCi/ml)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
June 2011				
Lead 210	<9.0 U	9	<0.8 U	0.8
Lead 210 MDC	9	--	0.8	--
Lead 210 precision (±)	5.3	--	0.5	--
Polonium 210	<0.2 U	0.2	<0.2 U	0.2
Polonium 210 MDC	0.2	--	0.2	--
Polonium 210 precision (±)	0.2	--	0.1	--
Radium 226	<0.13 U	0.13	<0.12 U	0.12
Radium 226 MDC	0.13	--	0.12	--
Radium 226 precision (±)	0.07	--	0.06	--
Thorium 230	0.07	0.05	<0.04 U	0.04
Thorium 230 MDC	0.05	--	0.04	--
Thorium 230 precision (±)	0.04	--	0.03	--
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
July 2011				
Lead 210	0.7	0.5	<0.5 U	0.5
Lead 210 MDC	0.5		0.5	
Lead 210 precision (±)	0.3		0.3	
Polonium 210	<0.2 U	0.7	<0.2 U	0.2
Polonium 210 MDC	0.2		0.2	
Polonium 210 precision (±)	0.2		0.1	
Radium 226	<0.1 U	0.2	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.06		0.09	
Thorium 230	<0.1 U	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.08		0.08	

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Uranium Activity (uCi/mL)	3.6E-09	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	5.0E-04	3.0E-04	<3.0E-04	3.0E-04
August 2011				
Lead 210	<0.8 U	<0.8	<0.7 U	0.7
Lead 210 MDC	0.8	0.8	0.7	
Lead 210 precision (±)	0.5	0.5	0.4	
Polonium 210	0.4	0.4	<0.3 U	0.3
Polonium 210 MDC	0.2	0.2	0.3	
Polonium 210 precision (±)	0.3	0.3	0.2	
Radium 226	0.14	0.14	<0.08 U	0.08
Radium 226 MDC	0.08	0.08	0.08	
Radium 226 precision (±)	0.07	0.07	0.05	
Thorium 230	0.1	0.1	0.1	0.07
Thorium 230 MDC	0.05	0.05	0.07	
Thorium 230 precision (±)	0.05	0.05	0.05	
Uranium Activity (uCi/mL)	2.4E-10	2.0E-10	2.2E-10	2.0E-10
Uranium (metal) (mg/l)	4.0E-04	3.0E-04	3.0E-04	3.0E-04
September 2011				
Lead 210	<0.6 U	0.6	<0.6 U	0.6
Lead 210 MDC	0.6		0.6	
Lead 210 precision (±)	0.3		0.3	
Polonium 210	<0.2 U	0.2	0.3	0.2
Polonium 210 MDC	0.2		0.2	
Polonium 210 precision (±)	0.1		0.2	
Radium 226	0.1	0.1	0.1	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.06		0.06	
Thorium 230	0.2	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.1		0.1	
Uranium Activity (uCi/mL)	2.2E-10	2.0E-10	4.5E-09	2.0E-10
Uranium (metal) (mg/l)	3.0E-04	3.0E-04	6.6E-03	3.0E-04
October 2011				
Lead 210	<0.5 U	0.5	<0.9 U	0.9
Lead 210 MDC	0.5		0.9	
Lead 210 precision (±)	0.3		0.6	
Polonium 210	0.3	0.3	0.3	0.3
Polonium 210 MDC	0.3		0.3	
Polonium 210 precision (±)	0.2		0.3	
Radium 226	<0.06 U	0.06	0.08	0.06
Radium 226 MDC	0.06		0.06	
Radium 226 precision (±)	0.03		0.05	
Thorium 230	0.2	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.1		0.1	

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
Uranium Activity (uCi/mL)	2.3E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	3.0E-04 B	3.0E-04	<3.0E-04	3.0E-04
November 2011				
Lead 210	<0.6 U	0.6	<0.7 U	0.7
Lead 210 MDC	0.6		0.7	
Lead 210 precision (±)	0.4		0.4	
Polonium 210	<0.4 U	0.4	<0.4 U	0.4
Polonium 210 MDC	0.4		0.4	
Polonium 210 precision (±)	0.2		0.3	
Radium 226	0.1	0.1	0.1	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.05	
Thorium 230	0.1	0.1	<0.1 U	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.07		0.07	
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
January 2012				
Lead 210	<0.7 U	0.7	<0.8 U	0.8
Lead 210 MDC	0.7		0.8	
Lead 210 precision (±)	0.4		0.5	
Polonium 210	<0.8 U	0.8	<0.8 U	0.8
Polonium 210 MDC	0.8		0.8	
Polonium 210 precision (±)	0.3		0.3	
Radium 226	<0.1 U	0.1	<0.1 U	0.1
Radium 226 MDC	0.1		0.1	
Radium 226 precision (±)	0.05		0.07	
Thorium 230	<0.1 U	0.1	0.2	0.1
Thorium 230 MDC	0.1		0.1	
Thorium 230 precision (±)	0.08		0.1	
Uranium Activity (uCi/mL)	<2.0E-10	2.0E-10	<2.0E-10	2.0E-10
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04

Table 6.1-30 Niobrara River Suspended Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte	Sample Locations			
	N1 (Niobrara River West Side)		N2 (Niobrara River East Side)	
	RESULTS	RL	RESULTS	RL
	pCi/l			
February 2012				
Lead 210	<1.0 U	1	<1.0 U	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	NA		NA	
Polonium 210	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	<0.2 U	0.2	<0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/mL)	<2.0E-01	2.0E-01	<2.0E-01	2.0E-01
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04
March 2012				
Lead 210	1.7	1	2.1	1
Lead 210 MDC	1		1	
Lead 210 precision (±)	0.6		0.5	
Polonium 210	<1.0 U	1	<1.0 U	1
Polonium 210 MDC	1		1	
Polonium 210 precision (±)	NA		NA	
Radium 226	<0.2 U	0.2	<0.2 U	0.2
Radium 226 MDC	0.2		0.2	
Radium 226 precision (±)	NA		NA	
Thorium 230	<0.2 U	0.2	<0.2 U	0.2
Thorium 230 MDC	0.2		0.2	
Thorium 230 precision (±)	NA		NA	
Uranium Activity (uCi/mL)	<2.0E-01	2.0E-01	<2.0E-01	2.0E-01
Uranium (metal) (mg/l)	<3.0E-04	3.0E-04	<3.0E-04	3.0E-04

Notes:

B = Analyte was detected in the method blank

U = Not detected at minimum detectable concentration

MDC = minimum detectable concentration

pCi/l = picoCuries per liter

RL = reporting limit

uCi/ml = microCuries per milliliter

NA = Not Applicable, not detected below the RL

Table 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crown Butte (2011-2012)

Table 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)		N1 (Niobrara River West Site)	
		2/11/2011		5/16/2011		6/24/2011		8/12/2011		11/28/2011		1/13/2012		2/21/2012	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Major Ions															
Alkalinity Total as CaCO3	mg/L	230	1	261	1	235	1	185	1	208	1	187	1	190	5
Bicarbonate as HCO3	mg/L	271	1	297	1	286	1	226	1	254	1	229	1	232	5
Carbonate as CO3	mg/L	5	1	10	1	<1	1	<1	1	<1	1	<1	1	<5	5
Calcium	mg/L	60	1	58	1	53	1	46	1	53	1	52	1	50	1
Chloride	mg/L	6	1	6	1	4	1	5	1	5	1	5	1	4	1
Fluoride	mg/L	0.7	0.1	0.8	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.6	0.1
Magnesium	mg/L	11	1	12	1	11	1	9	1	11	1	9	1	9	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	<0.1	0.1
Nitrogen Nitrate+Nitrite as N	mg/L	1.4	0.1	0.2	0.1	0.4	0.1	1	0.1	1.1	0.1	1.5	0.1	1	0.1
Potassium	mg/L	8	1	10	1	8	1	6	1	8	1	8	1	8	1
Silica	mg/L	62.4	0.2	41.3	0.2	45.2	0.2	58.1	0.2	53.1	0.2	58.1	0.2	51	1
Sodium	mg/L	22	1	38	1	25	1	24	1	23	1	22	1	22	1
Sulfate	mg/L	13	1	12	1	10	1	13	1	15	1	13	1	11	1
Physical Properties															
Conductivity @ 25 C	umhos/cm	460	1	498	1	443	1	388	1	440	1	422	1	420	1
pH	s.u.	8.11	0.01	8.38	0.01	8.16	0.01	8.2	0.01	8.05	0.01	8.13	0.01	7.9	0.1
Solids Total Dissolved TDS @ 180 C	mg/L	315	10	335	10	313	10	262	10	276	10	252	10	290	10
Metals Dissolved															
Aluminum	mg/L	<0.1	0.1	0.2	0.1	<0.1	0.1	0.2	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.006	0.001	0.008	0.001	0.006	0.001	0.007	0.001	0.006	0.001	<0.001	0.001	0.005	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
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
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	<0.1	0.1
Iron	mg/L	<0.03	0.03	0.2	0.03	0.07	0.03	0.27	0.03	0.04	0.03	<0.03	0.03	0.05	0.05
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	<0.05	0.05
Manganese	mg/L	<0.01	0.01	0.02	0.01	0.01	0.01	0.02	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	<0.05	0.05	<0.05	0.05
Selenium	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
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	<0.02	0.02
Zinc	mg/L	<0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01	<0.01	0.01	<0.01	0.01
Data Quality															
A/C Balance (± 5)	%	-0.594	--	1.1	--	-2.06		-0.351	--	-0.0267	--	1.95	--	1.61	--
Anions	meq/L	5.16	--	5.69	--	5.07		4.21	--	4.73	--	4.31	--	4.26	--
Cations	meq/L	5.1	--	5.82	--	4.87		4.18	--	4.72	--	4.48	--	4.40	--
Solids Total Dissolved Calculated	mg/L	344	--	342	--	312		292	--	312	--	302	--	270	--

Notes:

meq/L = milliequivalents per liter

mg/L = milligrams per liter

ND = not detected

RL = reporting limit

s.u. = standard units

umhos/cm = micromhos per centimeter

Table 6.1-31 Niobrara River Non-Radiological Water Quality Baseline Data Collected by Crow Butte

Analyte Group	Units	N2 (Niobrara River East Site) 2/11/2011		N2 (Niobrara River East Site) 5/16/2011		N2 (Niobrara River East Site) 6/24/2011		N2 (Niobrara River East Site) 8/12/2011		N2 (Niobrara River East Site) 11/28/2011		N2 (Niobrara River East Site) 1/13/2011		N2 (Niobrara River East Site) 2/21/2012	
		RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL	RESULTS	RL
Major Ions															
Alkalinity Total as CaCO3	mg/L	223	1	253	1	253	1	180	1	184	1	211	1	179	5
Bicarbonate as HCO3	mg/L	262	1	290	1	308	1	219	1	224	1	257	1	218	5
Carbonate as CO3	mg/L	5	1	9	1	<1	1	<1	1	<1	1	<1	1	<5	5
Calcium	mg/L	57	1	56	1	54	1	48	1	49	1	57	1	47	1
Chloride	mg/L	5	1	5	1	5	1	5	1	5	1	6	1	4	1
Fluoride	mg/L	0.7	0.1	0.8	0.1	0.8	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.6	0.1
Magnesium	mg/L	10	1	12	1	12	1	9	1	9	1	10	1	8	1
Nitrogen Ammonia as N	mg/L	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05	<1	0.05	<0.05	0.05	<0.1	0.1
Nitrogen Nitrate+Nitrite as N	mg/L	1.2	0.1	<0.1	0.1	<0.1	0.1	0.9	0.1	1.3	0.1	1.6	0.1	1	0.1
Potassium	mg/L	7	1	9	1	11	1	7	1	7	1	9	1	7	1
Silica	mg/L	59.1	0.2	41.6	0.2	48.4	0.2	64.8	0.2	58.6	0.2	63	0.2	49	1
Sodium	mg/L	20	1	36	1	29	1	24	1	23	1	23	1	21	1
Sulfate	mg/L	12	1	12	1	9	1	13	1	14	1	17	1	12	1
Physical Properties															
Conductivity @ 25 C	umhos/cm	437	1	478	1	481	1	387	1	406	1	475	1	398	1
pH	s.u.	7.91	0.01	8.3	0.01	7.84	0.01	8.21	0.01	8.16	0.01	7.92	0.01	7.90	1
Solids Total Dissolved TDS @ 180 C	mg/L	302	10	326	10	334	10	258	10	275	10	300	10	270	10
Metals Dissolved															
Aluminum	mg/L	<0.1	0.1	<0.1	0.1	<0.1	0.1	0.3	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Arsenic	mg/L	0.005	0.001	0.006	0.001	0.006	0.001	0.007	0.001	0.006	0.001	0.006	0.001	0.005	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	0.1	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
Cadmium	mg/L	<0.005	0.005	<0.005	0.005	<0.l05	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	<0.1	0.1
Iron	mg/L	0.04	0.03	0.08	0.03	0.04	0.03	0.3	0.03	0.03	0.03	0.04	0.03	<0.05	0.05
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	<0.05	0.05
Manganese	mg/L	0.02	0.01	<0.01	0.01	0.04	0.01	0.06	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	<0.05	0.05	<0.05	0.05
Selenium	mg/L	0.002	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
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	<0.02	0.02
Zinc	mg/L	<0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
Data Quality															
A/C Balance (± 5)	%	-2.5	--	0.802	--	-1.79	--	2.51	--	2.19	--	0.624	--	1.03	--
Anions	meq/L	4.95	--	5.5	--	5.42	--	4.11	--	4.22	--	4.9	--	4.03	--
Cations	meq/L	4.71	--	5.58	--	5.23	--	4.32	--	4.41	--	4.96	--	4.11	--
Solids Total Dissolved Calculated	mg/L	325	--	330	--	334	--	300	--	298	--	333	--	260	--

Notes:

MDC = Minimum detectable concentration

pCi/L - picocuries per liter

RL = reporting limit

mg/L = milligrams per liter

meq/L = milliequivalents per liter

s.u. = standard units

umhos/cm = micromhos per centimeter

Table 6.1-32 Summary of Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Table 6.1-32 Summary of Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Analyte	Concentration (pCi/L) [a]		Non-Detection Frequency [b]	Non-Detection Value [c]	
	Minimum	Maximum		Minimum	Maximum
NIOBRARA RIVER UPGRADIENT SAMPLING POINT N-1					
Dissolved Radiological Analytes					
Lead 210	<0.6	1.7	13/14	0.6	1.6
Polonium 210	<0.4	0.8	12/14	0.4	0.9
Radium 226	<0.1	1.7	3/14	0.09	0.16
Thorium 230	<0.1	<0.3	14/14	0.1	0.3
Uranium Activity µ(Ci/ml)	2.4E-10	4.4E+00	0/14	2.0E-10	2.0E-01
Uranium (mg/L)	4.0E-04	1.04E-02	0/14	3.0E-04	3.0E-04
Suspended Radiological Analytes					
Lead 210	<0.5	<9.0	10/13	0.5	9.0
Polonium 210	<0.2	0.4	10/13	0.2	1.0
Radium 226	<0.06	0.14	10/13	0.06	0.2
Thorium 230	<0.1	0.2	9/13	0.05	0.2
Uranium Activity (µCi/ml)	<2.0E-10	3.6E-09	9/13	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	5.0E-04	10/13	3.0E-04	3.0E-04
NIOBRARA RIVER DOWNGRADIENT SAMPLING POINT N-2					
Dissolved Radiological Analytes					
Lead 210	<0.6	50	13/14	0.6	1.2
Polonium 210	<0.4	4.6	12/14	0.4	0.9
Radium 226	<0.1	1.3	7/14	0.09	0.2
Thorium 230	<0.1	<0.8	14/14	0.1	0.8
Uranium Activity (µCi/ml)	<2.0E-10	4.9E+00	1/14	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	9.0E-03	1/14	3.0E-04	3.0E-04
Suspended Radiological Analytes					
Lead 210	<0.5	2.1	12/13	0.5	1.1
Polonium 210	<0.2	0.3	10/13	0.2	1.0
Radium 226	<0.08	0.1	10/13	0.01	0.2
Thorium 230	<0.04	0.2	9/13	0.04	0.2
Uranium Activity (µCi/ml)	<2.0E-10	4.5E-09	10/13	2.0E-10	2.0E-01
Uranium (mg/L)	<3.0E-04	6.6E-04	10/13	3.0E-04	3.0E-04

[a] Unless noted otherwise. Individual analytical results with RLs are presented in Tables 6.1-29 and 6.1-30.

[b] Number of samples with values less than the Non-Detection Limit; 5/6 = five of six samples with values below the detection limit.

[c] The minimum and maximum non-detection values for all samples during that testing period.
mg/L = milligrams per liter
pCi/L = picoCuries per liter
µCi/ml = microCuries per milliliter

Table 6.1-33 Summary of Non-Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Table 6.1-33 Summary of Non-Radiological Baseline Data for Niobrara River Near Marsland Expansion Area Collected by Crow Butte

Analytes	Units	Crow Butte Niobrara River Sampling Locations			
		N-1		N-2	
		Minimum	Maximum	Minimum	Maximum
Alkalinity	mg/L	185	261	179	253
Bicarbonate	mg/L	226	297	218	308
Carbonate	mg/L	<1	10	<1	9
Conductivity @ 25^{o} C	µmhos/cm	388	498	387	481
Calcium	mg/L	46	60	47	57
Chloride	mg/L	4	6	4	6
Fluoride	mg/L	0.6	0.8	0.6	0.8
Magnesium	mg/L	9	12	8	12
Nitrogen Ammonia as N	mg/L	<0.05	<0.1	<0.05	<1.0
Nitrogen Nitrate-Nitrite as N	mg/L	0.2	1.5	<0.1	1.6
Potassium	mg/L	6	10	7	11
Silicia	mg/L	41.3	62.4	41.6	64.8
Sodium	mg/L	22	38	20	36
Sulfate	mg/L	10	15	9	17
pH	s.u.	7.90	8.38	7.84	8.3
Total Dissolved Solids @ 180^{o} C	mg/L	252	335	258	334
Dissolved Metals	The majority of parameters were measured at or below the RL (see Table 2.9-28.				

Individual analytical results with RLs are presented in Table 6.1-31.
s.u. = standard unit
mg/L = milligrams per liter
RL = Reporting Limit
µmhos/cm = micromhos per centimeter

Table 6.1-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to 2013

Table 6.1-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to August 2013

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	Acre-feet											
2003												
Mean	8,489	9,899	11,053	12,365	13,503	13,380	11,134	5,236	4,151	4,841	5,587	6,376
Minimum	7,740	9,449	10,394	11,743	12,775	11,865	7,922	3,517	3,848	4,455	5,209	5,992
Maximum	9,390	10,359	11,818	13,167	14,000	14,588	14,051	7,805	4,434	5,176	5,974	6,950
2004												
Mean	7,182	8,138	9,232	9,969	11,743	11,610	9,468	4,779	4,018	5,142	6,205	7,266
Minimum	6,856	7,755	8,586	8,965	10,822	11,537	6,890	2,803	3,460	4,604	5,730	6,745
Maximum	7,683	8,775	9,976	11,158	11,865	11,715	11,658	7,137	4,566	5,695	6,712	7,769
2005												
Mean	8,285	9,482	10,710	12,018	13,504	14,668	12,782	7,578	5,691	6,752	7,668	8,662
Minimum	7,805	8,878	10,140	11,361	12,912	13,970	9,660	5,678	5,270	6,053	7,143	8,188
Maximum	8,839	10,089	11,324	12,872	13,949	15,158	15,137	9,593	6,035	7,110	8,151	9,169
2006												
Mean	9,811	10,956	12,473	14,207	14,968	14,703	9,481	4,465	3,891	4,084	4,497	4,815
Minimum	9,202	10,429	11,537	13,555	14,715	13,687	5,962	3,522	3,599	3,834	4,096	4,588
Maximum	10,385	11,500	13,475	14,683	15,094	14,936	13,535	5,968	4,366	4,229	4,802	5,081
2007												
Mean	5,381	6,102	6,791	--	--	11,312	7,073	3,603	3,830	4,311	4,912	5,559
Minimum	5,065	5,760	6,583	--	--	11,090	3,809	2,352	3,628	4,054	4,631	5,215
Maximum	5,730	6,524	7,063	--	--	11,445	11,213	4,721	4,019	4,609	5,192	5,895
2008												
Mean	5,019	5,570	6,636	7,923	9,034	9,502	7,200	4,212	4,308	4,699	5,474	6,130
Minimum	4,759	5,293	5,970	7,306	8,415	9,278	4,677	3,608	4,039	4,546	5,125	5,821
Maximum	5,275	5,914	7,272	8,361	9,220	9,572	9,563	4,999	4,536	4,875	5,797	6,375
2009												
Mean	6,682	7,375	8,360	10,159	11,859	12,619	11,155	7,021	6,273	7,029	8,508	9,733
Minimum	6,394	7,020	7,816	8,992	11,398	12,174	7,852	5,177	6,158	6,466	7,794	9,204
Maximum	7,000	7,765	8,943	11,313	12,095	12,950	13,512	8,562	6,446	7,743	9,171	10,213

Table 6.1-34 Daily Contents in Acre-Feet of Water for Box Butte Reservoir (USGS 06455000)– 2003 to August 2013

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec
	Acre-feet											
2010												
Mean	10,650	11,550	13,893	16,421	18,491	20,587	20,265	13,904	11,666	12,048	12,884	13,938
Minimum	10,240	11,096	12,363	15,293	17,669	19,479	16,939	11,303	11,560	11,782	12,403	13,396
Maximum	11,068	12,293	15,180	17,644	19,440	21,432	21,500	18,366	11,782	12,373	13,344	14,523
2011												
Mean	14,909	15,942	18,007	20,264	22,174	24,478	21,075	14,939	12,694	13,044	13,860	15,278
Minimum	14,512	15,407	16,569	19,427	21,147	23,930	17,546	12,695	12,164	12,644	13,470	15,090
Maximum	15,384	16,510	19,349	21,120	23,844	24,927	24,942	16,819	12,868	13,428	14,304	15,464
2012												
Mean	15,973	17,002	18,440	19,820	20,026	18,998	11,713	6,090	6,211	6.,680	7,311	7,969
Minimum	15,498	16,486	17,620	19,284	19,739	17,424	7,445	5,275	6,057	6,394	7,007	7,650
Maximum	16,463	17,583	19,272	20,291	20,318	19,726	16,939	7,142	6,388	6.986	7,628	8,308
2013												
Mean	8,648	9,329	10,229	11,497	12,336	12,965	12,412	6,541	5,295	ND	ND	ND
Minimum	8,338	9,000	9,699	10,837	5,322	12,960	8,855	5,209	5,121	ND	ND	ND
Maximum	8,976	9,673	10,800	12,393	12,981	12,971	12,971	8,280	5,977	ND	ND	ND
2003-2013 Summary												
Mean [a]	9,184	10,122	11,439	13,464	14,764	14,984	12,160	5,271	16,184	6,196	7,691	8,573
Minimum	4,759	5,293	5,970	7,306	5,322	9,278	3,809	2,352	3,460	3,834	4,096	4,588
Maximum	16,463	17,583	19,349	21,120	23,844	21,927	24,942	18,366	12,868	13,428	14,304	15,464

Source: USBR 2013 b
[a]Average of average values presented in table.
ND = No data
USGS = U.S. Geological Survey

Table 6.1-35 Range Values for Box Butte Reservoir Water Contents

Table 6.1-35 Range Values for Box Butte Reservoir Water Contents

Date	Average	Minimum	Maximum
	Acre-feet		
2003 – 2013	6,196 – 14,984	2,352 – 9,278	12,868 – 24,942

USGS Station 06455000
USGS = U.S. Geological Survey
Source: USBR 2011b

Table 6.1-36 Parameters Used to Estimate Wet-weight Vegetable Concentrations from Dry-weight Soil Concentrations

Table 6.1-36 Parameters Used to Estimate Wet-weight Vegetable Concentrations from Dry-weight Soil Concentrations

Parameter	Parameter Description	Plant Type	Radionuclide	Value	Unit
ML_v	Mass Loading factor	Root Vegetables	Parameter is not Radionuclide Specific	0.1	pCi/kg dry-weight plant per pCi/g dry-weight soil
		Leafy Vegetables			
		Fruits			
B_{jv}	Concentration Factor for Root Uptake	Root Vegetables	Natural Uranium	0.014	pCi/kg dry-weight plant per pCi/g dry-weight soil
			Thorium-230	0.00012	
			Radium-226	0.0032	
			Lead-210	0.0032	
			Polonium-210	0.009	
		Leafy Vegetables	Natural Uranium	0.017	
			Thorium-230	0.0025	
			Radium-226	0.075	
			Lead-210	0.0058	
			Polonium-210	0.0025	
		Fruits	Natural Uranium	0.004	
			Thorium-230	0.000085	
			Radium-226	0.0061	
			Lead-210	0.009	
			Polonium-210	0.0004	
W_v	Dry weight to Wet Weight Conversion Factor	Root Vegetables	Not Radionuclide Specific	0.2	Unitless
		Leafy Vegetables		0.25	
		Fruits		0.18	

ML_v = plant soil mass-loading factor for re-suspension of soil to plant v (pCi/kg dry-weight plant per pCi/g dry-weight soil)

B_{jv} = concentration factor for uptake of radionuclide j from the soil in plant v (pCi/kg dry-weight plant per pCi/g dry-weight soil)

W_v = dry to wet-weight conversion factor (unitless)

Table 6.1-37 Total Radionuclides and Metals in Tissue of Northern Pike Collected from Inlet of Box Butte Reservoir

Table 6.1-37 Total Radionuclides and Metals in Tissue of Northern Pike Collected from Inlet of Box Butte Reservoir

Radionuclide - Total	Result [a]	Units	Qualifiers	RL	Result	Units	Qualifiers	RL
	August 22, 2011				**May 25, 2012**			
Lead 210	<1E-06	uCi/kg	U	1E-06	7.9E-07	uCi/kg	U	7.9E-07
Lead 210 Precision (+)	7.0E-07	uCi/kg	--	--	8.1E-07	uCi/kg	--	--
Lead 210 MDC	1.0E-06	uCi/kg	--	--	1.0E-06	uCi/kg	--	--
Polonium 210	5.0E-07	uCi/kg	--	5.0E-07	2.8E-07	uCi/kg	U	2.8E-07
Polonium 210 Precision (+)	4.E-07	uCi/kg	--	--	1.0E-06	uCi/kg	--	--
Polonium 210 MDC	5.0E-07	uCi/kg	--	--	2.1E-06	uCi/kg	--	--
Radium 226	<2E-07	uCi/kg	U	2.0E-07	2.2E-07	uCi/kg	--	2.2E-07
Radium 226 Precision (+)	1.0E-07	uCi/kg	--	--	1.5E-07	uCi/kg	--	--
Radium 226 MDC	2.0E-07	uCi/kg	--	--	1.9E-07	uCi/kg	--	--
Thorium 230	1.0E-05	uCi/kg	--	8.0E-06	6.7E-08	uCi/kg	U	6.7E-08
Thorium 230 Precision (+)	6.0E-06	uCi/kg		--	5.8E-06	uCi/kg	--	--
Thorium 230 MDC	8.0E-06	uCi/kg	--	--	1.4E-05	uCi/kg	--	--
Metals - Total							--	--
Uranium, Total	<0.0003	mg/kg	--	0.0003	0.00099	mg/kg	D	0.00040
Uranium, Activity	<2E-07	uCi/kg	--	2.0E-07	6.7E-07	uCi/kg	D	2.7E-07

[a] Results reported on a wet weight basis (as received) for composite of two or more samples (digestion, radiochemistry)..

uCi/kg = microcuries per kilogram.

U = Not detected at the reporting limit.

D = RL increased due to sample matrix,

RL = Analyte reporting limit.

MDC = Minimum detectable concentration.

mg/kg – milligram per kilogram

Table 6.1-38 Radionuclide and Metal Analyses for Niobrara River Sample Locations N-1 and N-2 Sediments

Table 6.1-38 Radionuclide and Metal Analyses for Niobrara River Sample Locations N-1 and N-2 Sediment Samples

Radionuclide	Units	Result	Reporting Limit (RL)
		3/20/2013 (Collection Date)	
N - 1			
Lead-210	pCi/g - dry	0.3	0.2
Lead 210 precision (+)	pCi/g - dry	0.1	--
Lead 210 MDC	pCi/g - dry	0.2	--
Radium 226	pCi/g - dry	0.4	0.04
Radium 226 precision (+)	pCi/g - dry	0.06	--
Radium 226 MDC	pCi/g - dry	0.04	--
Thorium 230	pCi/g - dry	0.2	0.2
Thorium 230 precision (+)	pCi/g - dry	0.1	--
Thorium 230 MDC	pCi/g - dry	0.2	--
METALS			
Uranium	mg/kg - dry	0.4	0.3
Uranium Activity	pCi/g - dry	0.3	0.2
N - 2			
Lead-210	pCi/g - dry	0.3	0.2
Lead 210 precision (+)	pCi/g - dry	0.1	
Lead 210 MDC	pCi/g - dry	0.2	
Radium 226	pCi/g - dry	0.4	0.04
Radium 226 precision (+)	pCi/g - dry	0.06	
Radium 226 MDC	pCi/g - dry	0.04	
Thorium 230	pCi/g - dry	0.2	0.2
Thorium 230 precision (+)	pCi/g - dry	0.1	
Thorium 230 MDC	pCi/g - dry	0.2	
METALS			
Uranium	mg/kg - dry	0.4	0.3
Uranium Activity	pCi/g - dry	0.3	0.2

MED – Marsland Ephermeral Drainage
RL - Analyte reporting limit
MDC – Minimum detectable concentration
mg/kg-dry – milligram/kilogram-dry weight
pCi/g-dry – picocuries per gram -dry weight

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
MED - 1						
Lead-210	pCi/g-dry	0.2	0.2		<0.2	0.2
Lead 210 precision (+)	pCi/g-dry	0.1	--		0.1 U	
Lead 210 MDC	pCi/g-dry	0.2	--		0.2	
Radium 226	pCi/g-dry	0.3	0.02		0.2	0.04
Radium 226 precision (+)	pCi/g-dry	0.04	--		0.05	
Radium 226 MDC	pCi/g-dry	0.02	--		0.04	
Thorium 230	pCi/g-dry	0.4	0.1		<0.1 U	0.1
Thorium 230 precision (+)	pCi/g-dry	0.2	--		0.1	
Thorium 230 MDC	pCi/g-dry	0.1	--		0.1	
METALS						
Uranium	mg/kg-dry	0.5	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		<0.2	0.2
MED - 2						
Lead-210	pCi/g-dry	0.7	0.2		0.4	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.4	0.02		0.4	0.04
Radium 226 precision (+)	pCi/g-dry	0.04			0.06	
Radium 226 MDC	pCi/g-dry	0.02 U			0.04	
Thorium 230	pCi/g-dry	<0.2	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.5	0.3		0.4	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		0.3	0.2
MED - 3						
Lead-210	pCi/g-dry	0.6	0.2		0.3	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.4	0.02		0.3	0.04

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
Radium 226 precision (+)	pCi/g-dry	0.04			0.06	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.2	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.5	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.3	0.2		<0.2	0.2
MED - 4						
Lead-210	pCi/g-dry	1.3	0.2		0.9	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.8	0.02		0.7	0.04
Radium 226 precision (+)	pCi/g-dry	0.06			0.08	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.5	0.2		0.3	0.2
Thorium 230 precision (+)	pCi/g-dry	0.2			0.2	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	1.0	0.3		0.7	0.3
Uranium Activity	pCi/g-dry	0.7	0.2		0.5	0.2
MED - 5						
Lead-210	pCi/g-dry	1.5	0.2		0.9	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.8	0.02		0.5	0.04
Radium 226 precision (+)	pCi/g-dry	0.06			0.07	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.3	0.2		0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.2			0.1	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	

Table 6.1-39 Radionuclide and Metal Analyses for Marsland Ephemeral Drainage (MED) Sample Locations

Radionuclide	Units	Result	Reporting Limit (RL)		Result	Reporting Limit (RL)
		12/02/2011 (Collection Date)			3/20/2013 (Collection Date)	
METALS						
Uranium	mg/kg-dry	0.9	0.3		0.5	0.3
Uranium Activity	pCi/g-dry	0.6	0.2		0.3	0.2
MED - 6						
Lead-210	pCi/g-dry	1.3	0.2		0.4	0.2
Lead 210 precision (+)	pCi/g-dry	0.1			0.1	
Lead 210 MDC	pCi/g-dry	0.2			0.2	
Radium 226	pCi/g-dry	0.6	0.02		0.3	0.04
Radium 226 precision (+)	pCi/g-dry	0.05			0.06	
Radium 226 MDC	pCi/g-dry	0.02			0.04	
Thorium 230	pCi/g-dry	0.2	0.2		<0.2	0.2
Thorium 230 precision (+)	pCi/g-dry	0.1			0.07	
Thorium 230 MDC	pCi/g-dry	0.2			0.2	
METALS						
Uranium	mg/kg-dry	0.6	0.3		<0.3	0.3
Uranium Activity	pCi/g-dry	0.4	0.2		<0.2	0.2

MED - Marsland Ephermeral Drainage
RL - Analyte reporting limit
U – Not detected at the reporting limit
MDC - Minimum detectable concentration
mg/kg-dry - milligram/kilogram-dry weight
pCi/g-dry - picocuries per gram -dry weight

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Location	Exposure of Dosimeter (mRems ambient dose equivalent)		Net Cumulative Totals			Number of Dosimeters Reported
	Gross	Net	Calendar Quarter	Year to Date	Permanent	
	10/01/2011 – 12/31/2011					
Transient Control	13.9	-1.0	--	--	--	--
Deploy Control	15.0	0.0	--	--	--	--
MA-1	21.7	6.7	6.7	6.7	6.7	1
MA-2	21.6	6.7	6.7	6.7	6.7	1
MA-3	21.4	6.5	6.5	6.5	6.5	1
MA-4	19.9	5.0	5.0	5.0	5.0	1
MA-5	20.9	5.9	5.9	5.9	5.9	1
1/01/2012 – 3/31/2012						
Transient Control	25.7	-0.6	Q1	2012	--	--
Deploy Control	26.3	0	--	--	--	--
MA-1	32.8	6.5	6.5	6.5	13.2	1
MA-2	33.8	7.5	7.5	7.5	14.2	1
MA-3	31.4	5.1	5.1	5.1	11.6	1
MA-4	40.8	14.5	14.5	14.5	19.5	1
MA-5	32.5	6.2	6.2	6.2	12.1	1
4/01/2012 – 6/30/2012						
Transient Control	30.7	--	Q2	2012	--	--
Deploy Control	30.3	--	--	--	--	--
MA-1	40.0	9.6	9.6	16.1	22.8	1
MA-2	Lost Badge	--	--	7.5	14.2	1
MA-3	34.9	4.6	4.6	9.7	16.2	1
MA-4	40.9	10.5	10.5	25.0	30.0	1
MA-5	38.1	7.7	7.7	13.9	19.8	1
7/01/2012 – 9/30/2012						
Transient Control	--	--	Q3	2012	--	--
Deploy Control	28.8	--	--	--	--	--
MA-1	38.6	9.9	9.9	26.0	32.7	1
MA-2	39.2	10.4	10.4	17.9	24.6	1
MA-3	37.5	8.7	8.7	18.3	24.8	1
MA-4	39.2	10.4	10.4	35.5	40.5	1
MA-5	33.3	4.5	4.5	18.4	24.3	1
10/01/2012 – 12/31/2012						
Transient Control	--	--	Q4	2012	--	--
Deploy Control	27.3	--	--	--	--	--
MA-1	39.2	11.9	11.9	37.9	44.6	1
MA-2	36.8	9.5	9.5	27.4	34.1	1

Table 6.1-40 Marsland Expansion Area Gamma Exposure Results

Location	Exposure of Dosimeter (mRems ambient dose equivalent)		Net Cumulative Totals			Number of Dosimeters Reported
	Gross	Net	Calendar Quarter	Year to Date	Permanent	
MA-3	34.5	7.2	7.2	25.6	32.2	1
MA-4	37.3	10.0	10.0	45.5	50.5	1
MA-5	34.0	6.8	6.8	25.2	31.1	1

mRems – millirems
MA-1 air sampling locations
Minimum Detectable Dose = 0.1 mRems ambient dose equivalent

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	**Number**	**Location**	**Method**	**Frequency**	**Frequency**	**Type of Analysis**
Air Particulates	3	On MEA 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 MEA License Boundary	Continuous	Weekly filter change	Quarterly composites of weekly samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon Gas	3	On MEA northern boundary	Continuous	Quarterly	Quarterly	Rn-222
	1	Nearest Resident	Continuous	Quarterly	Quarterly	Rn-222
	1	Control background location east of MEA License Boundary	Continuous	Quarterly	Quarterly	Rn-222
Groundwater	1	Wells within MEA license boundary and 2 km radius: · Private Wells · Arikaree Wells · MEA Brule Wells · MEA Ore Zone Wells (See Figures 2.7-6 and 2.9-3)	Grab	Quarterly	Quarterly	Suspended & Dissolved Natural Uranium, Ra-226, Th-230, Th-230 Pb-210 & Po-210
Surface Water	2 [a]	Niobrara River (N-1 and N-2) Ephemeral Drainages	Grab	Monthly	Monthly	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 (alternate of garden soil sampling to be used)			1	

Table 6.1-41 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program

	Sample Collection				Sample Analysis	
Type of Sample	Number	Location	Method	Frequency	Frequency	Type of Analysis
Fish	Each Body of Water	Collection of fish from Niobrara River (headwaters of Box Butte Reservoir)	Grab	Semiannually	2	Natural Uranium, Ra-226, Th-230, Pb-210, & Po-210
Surface Soil [b]	Up to 40	300 meter intervals to a distance of 1500 meters in each of 8 directions from center-point of satellite facility; additional transects through wellfields	Grab	Once prior to construction. Repeat for location disturbed by excavation, leveling or contouring	1	All samples for Ra-226, 10% of 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 [c]	5	At center-point 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 samples)
Sediment [d]	1 from each stream (2) & ephemeral drainage (6) sampling points	Up and down gradient samples from ephemeral drainages (total of 6 samples) & Niobrara River (N-1 & N-2)	Grab (Composite samples)	Once following spring runoff & late summer following period of extended low flow	2	Natural Uranium, Ra-226, Th-230 & Pb-210
Direct Radiation (Survey)	Up to 80	150 meter intervals to a distance of 1500 meters in each of 8 directions from center-point 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

[a] Two samples from the Niobrara River per sampling event and one (1) from each sampling point (total of 6) located on ephemeral streams (**Figure 3.4-4**) . MEA = Marsland Expansion Area
[b] Surface soil samples collected to a depth of 5 cm using a consistent technique.
[c] Subsurface soil samples collected to a depth of 1 meter; samples divided into 3 equal sections for analysis.
[d] Sediment sample locations shown in Figure 3.4-4

Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

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Type of Sample	Sample Collection			Sample Analysis		
	Number	Location	Method	Frequency	Frequency	Type of Analysis
AIR						
Particulates	3	At or near site boundaries and in sector(s) having the highest predicted concentrations of airborne particulates[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
	1	At or close to nearest residence(s)[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
	1	Control or background location[a]	Continuous	Weekly filter change or more frequently as required by dust loading	Quarterly composites of weekly samples	Nat-Uranium, Ra-226, Th-230, Pb-210
Radon Gas	5	Same locations as air particulates[a]	Continuous using RadTrak type DRNF	Continuous	Continuous	Rn-222
WATER						
Groundwater	One each	Wells (within license boundary and 1 km radius [c] · Private wells · MEA Brule wells · MEA Ore Zone wells	Grab	Quarterly	Quarterly	Dissolved and suspended Nat-Uranium, Ra-226, Th-230, Pb-210, Po-210
Surface Water	Two from each of 3 designated ephemeral drainage sampling points (total of 6 samples)	Surface waters passing through license area (subject to available flow)[b, d]	Grab	Quarterly	Quarterly	Suspended and dissolved Nat-Uranium, Ra-226, Th-230, Pb-210, Po-210

Table 6.1-42 Marsland Expansion Area Operational Effluent and Environmental Monitoring Plan

Type of Sample	Sample Collection			Sample Analysis		
	Number	Location	Method	Frequency	Frequency	Type of Analysis
VEGETATION	None	N/A	N/A	N/A	N/A	N/A
FOOD	None	N/A	N/A	N/A	N/A	N/A
FISH	None	N/A	N/A	N/A	N/A	N/A
SOIL AND SEDIMENT						
Soil	5 or more	At same locations used for collection of air particulate samples[a]	Grab (0 to 5 cm)	Annually	Annually	Nat-Uranium, Ra-226, Pb-210
Sediment	Two from each ephemeral drainage sampling points (6)	Same as surface water sample locations[b, d]	Grab (minimum of 3 samples for each sample composite)	Annually	Annually	Nat-Uranium, Ra-226, Th-230, Pb-210
DIRECT RADIATION						
Continuous	One each	Air monitoring stations[a]	Dosimeter	Continuous	Quarterly	Gamma exposure rate, using Sodium Iodide scintillometer

[a] Figure 6.1-2
[b] Figure 3.4-4
[c] Figures 3.1-3 and 3.4-7
[d] upstream and downstream
N/A = not applicable
MEA = Marsland Expansion Area

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Figure 6.1-1 Marsland Preoperational/Preconstruction Monitoring Timeline

Task	Start	Finish [b]
Surface Water (Niobrara River)	9/16/2013	10/31/2014
Surface Water (Ephemeral Drainages) [a]	4/24/2013	7/01/2014
Vegetation (Forage)	7/01/2013	2/01/2014
Food (Fish)	1/01/2014	7/01/2014
Food (Livestock)	2/01/2014	7/01/2014
Food (Crops, Alternate Soil Sampling)	7/01/2013	2/01/2014
Soil	5/01/2014	7/01/2014
Sediment	9/18/2013	7/01/2014
Direct Radiation [c]	4/24/2013	7/01/2014

Notes:

[a] Sampling will be collected as water as water flow is available; through 12/15/2013 water has not been available.
[b] Data will be submitted to the NRC.
[c] Survey interval measurements pending; quarterly measurements at air particulate monitoring stations complete.

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FIGURE 6.1-1
REMAINING MARSLAND PRE-OP MONITORING PROGRAM TIMELINE

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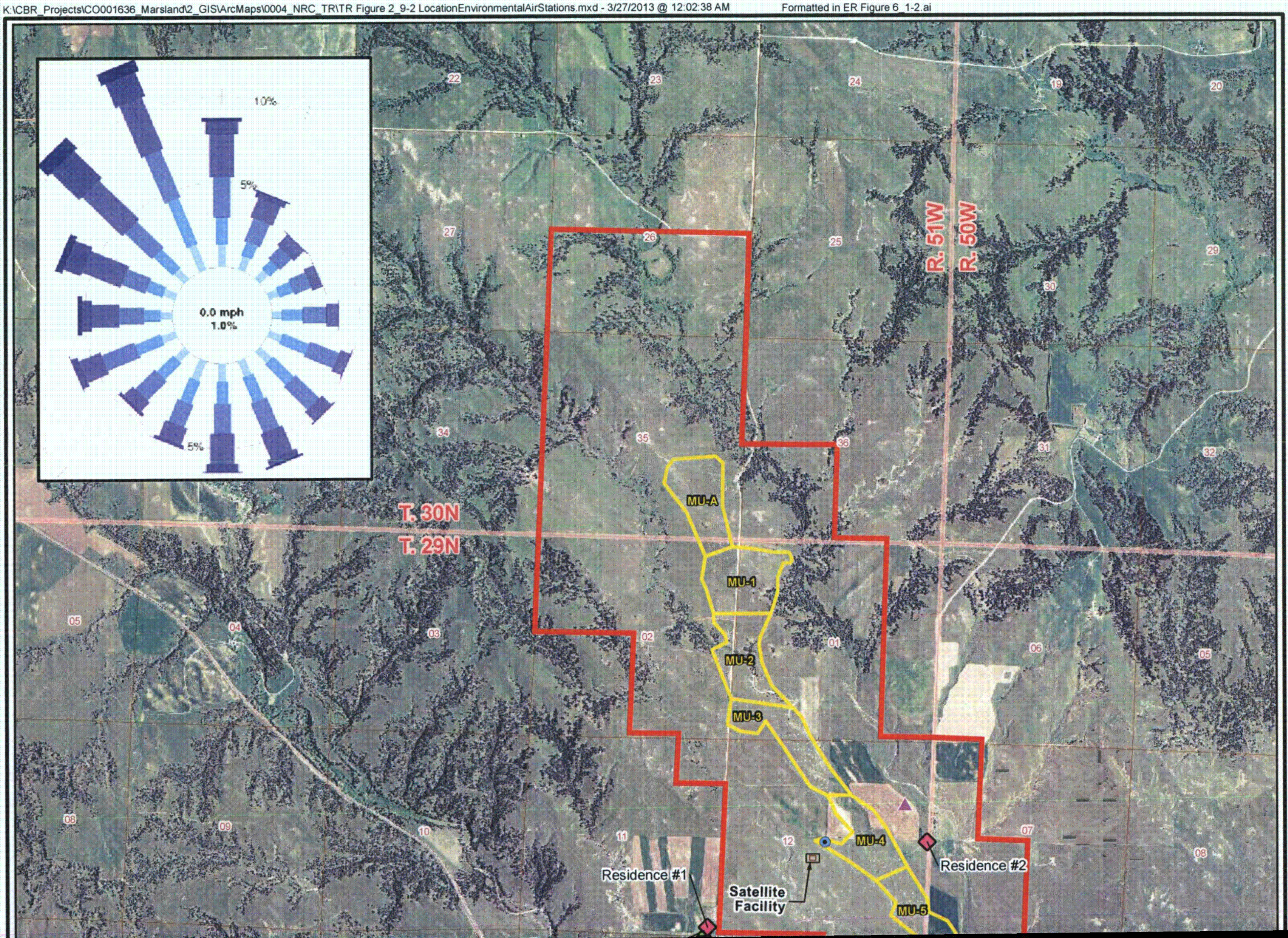
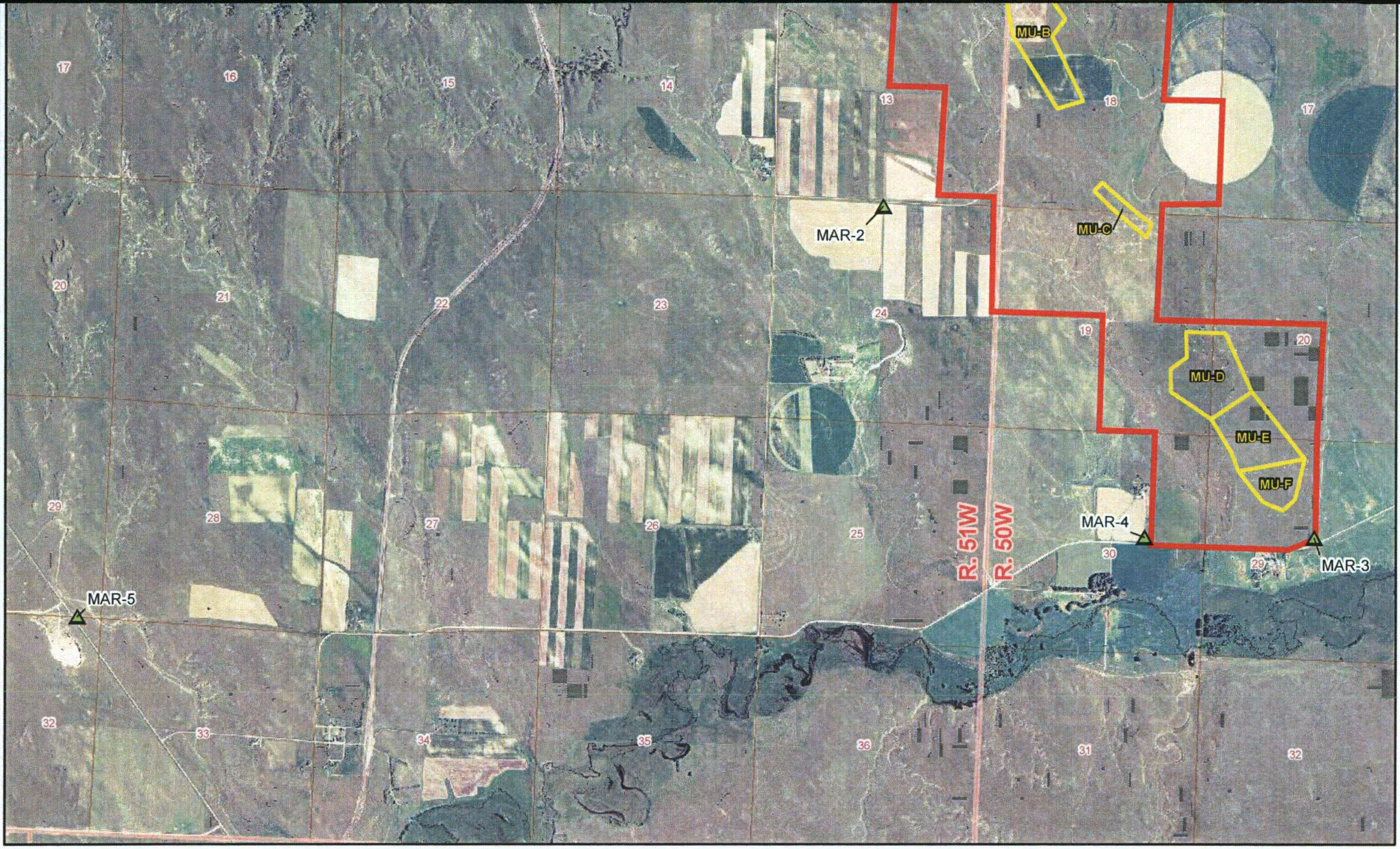
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator_ER\ER Figure 6_1-1 Remaining Marsland Pre-Op Monitoring Program Timeline.ai @ 1/8/2014

Figure 6.1-2 Location of Environmental Air Sampling Stations at Marsland Expansion Area

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_9-2 LocationEnvironmentalAirStations.mxd - 3/27/2013 @ 12:02:38 AM Formatted in ER Figure 6_1-2.ai





LEGEND

- Proposed Deep Disposal Well
- Air Sample Station
- Met Station
- Residence
- Mine Unit
- Proposed Marsland Expansion Area

N

0 3,000 6,000

Feet

PROJECTION: NAD1927,
STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

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FIGURE 6.1-2
LOCATION OF ENVIRONMENTAL AIR SAMPLING STATIONS AT MARSLAND EXPANSION AREA

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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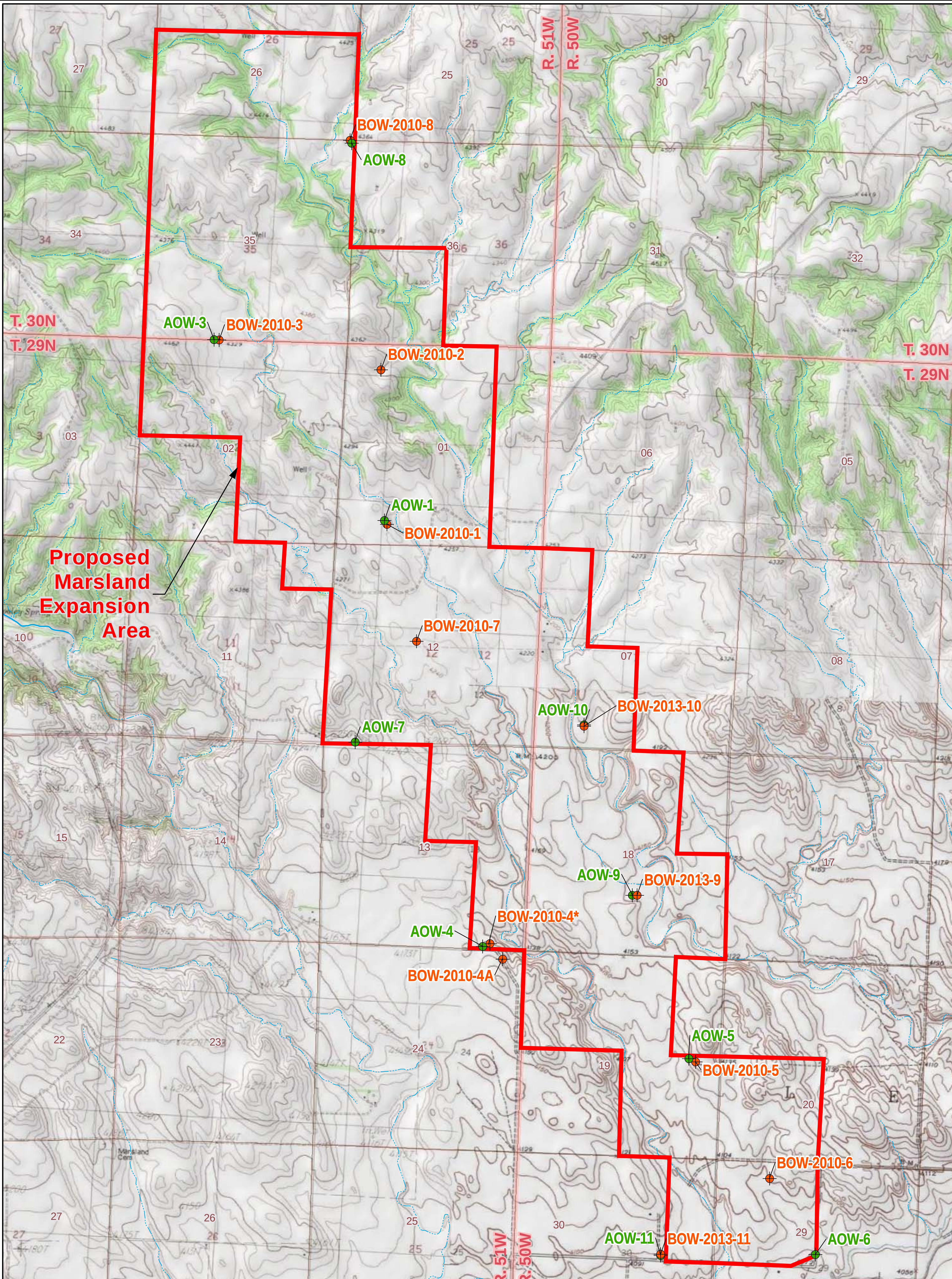
Figure 6.1-3 Arikaree and Brule Monitor Wells within MEA License Boundary

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-3_Crow Butte Arikaree and Brule Monitor Wells.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Arikaree Group Well
- Brule Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River

* BOW-2010-4 is inactive and scheduled to be abandoned.

N

0 1,250 2,500
Feet

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

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FIGURE 6.1-3
MARSLAND
ARIKAREE AND BRULE MONITOR WELLS

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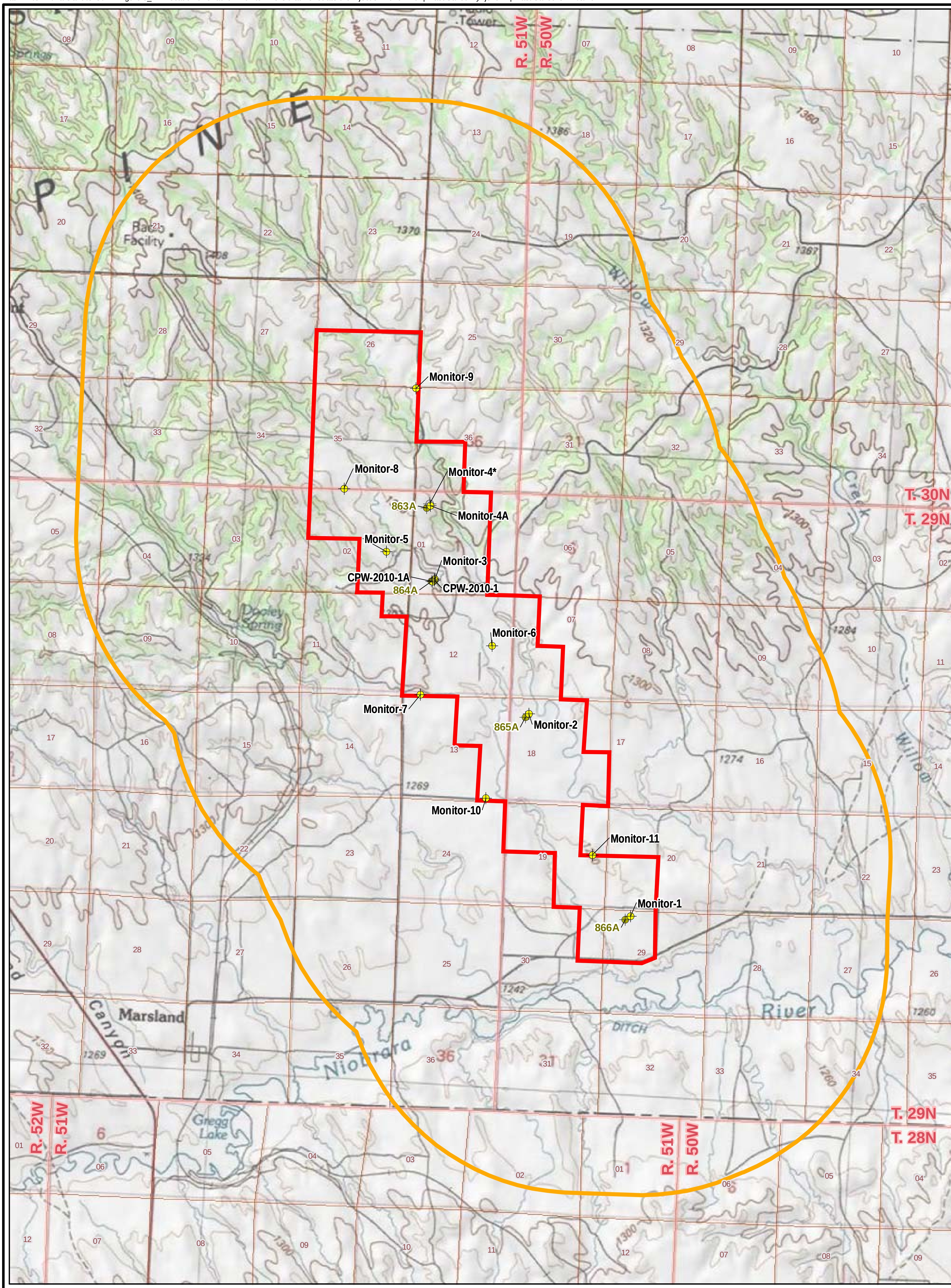
Figure 6.1-4 Location of MEA Active, Inactive, and Abandoned Chadron Monitor Wells that Penetrate the Injection Zone

Path: K:\CBR\Marsland\UIC\ ER Figure 6_1-4 Location of Chadron Monitor Wells that Penetrate the Injection Zone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

Proposed Marsland Expansion Area

Area of Review (AOR)

Pumping Test Monitoring Wells

Monitor-5 — Active Basal Sandstone of the Chadron Formation Well and Well ID

Monitor-4* — Inactive Basal Sandstone of the Chadron Formation Well and Well ID

865A — Abandoned Chadron Monitor Well and Well ID

N

0 0.5 1
Miles

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-4
LOCATION OF MEA ACTIVE, INACTIVE AND ABANDONED CHADRON MONITOR WELLS THAT PENETRATE THE INJECTION ZONE

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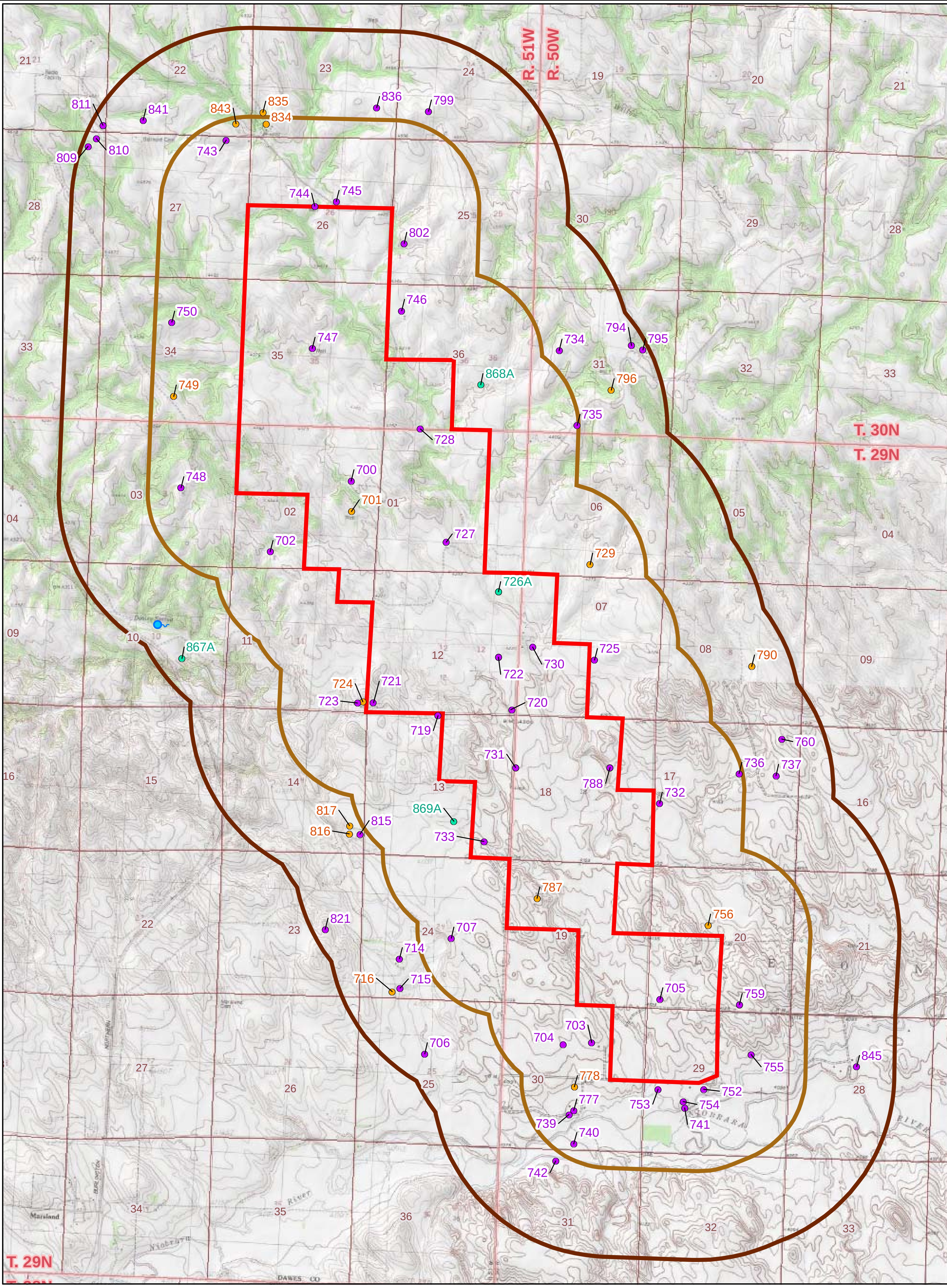
Figure 6.1-5 Private Wells Located within 1 and 2 Kilometers of the MEA License Boundary

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-5 Private Wells Located within Two Kilometers of the MEA License Boundary.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Proposed Marsland Expansion Area (MEA)
- 2-Kilometer Radius of MEA
- 1-Kilometer Radius of MEA
- Natural Spring

Private Water Supply Wells

- 733 Active Well
- 778 Inactive Well
- 869A Abandoned Well

N

0 1,750 3,500 Feet

0 500 1,000 Meters

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-5
PRIVATE WELLS LOCATED WITHIN ONE AND TWO KILOMETERS OF THE MEA LICENSE BOUNDARY

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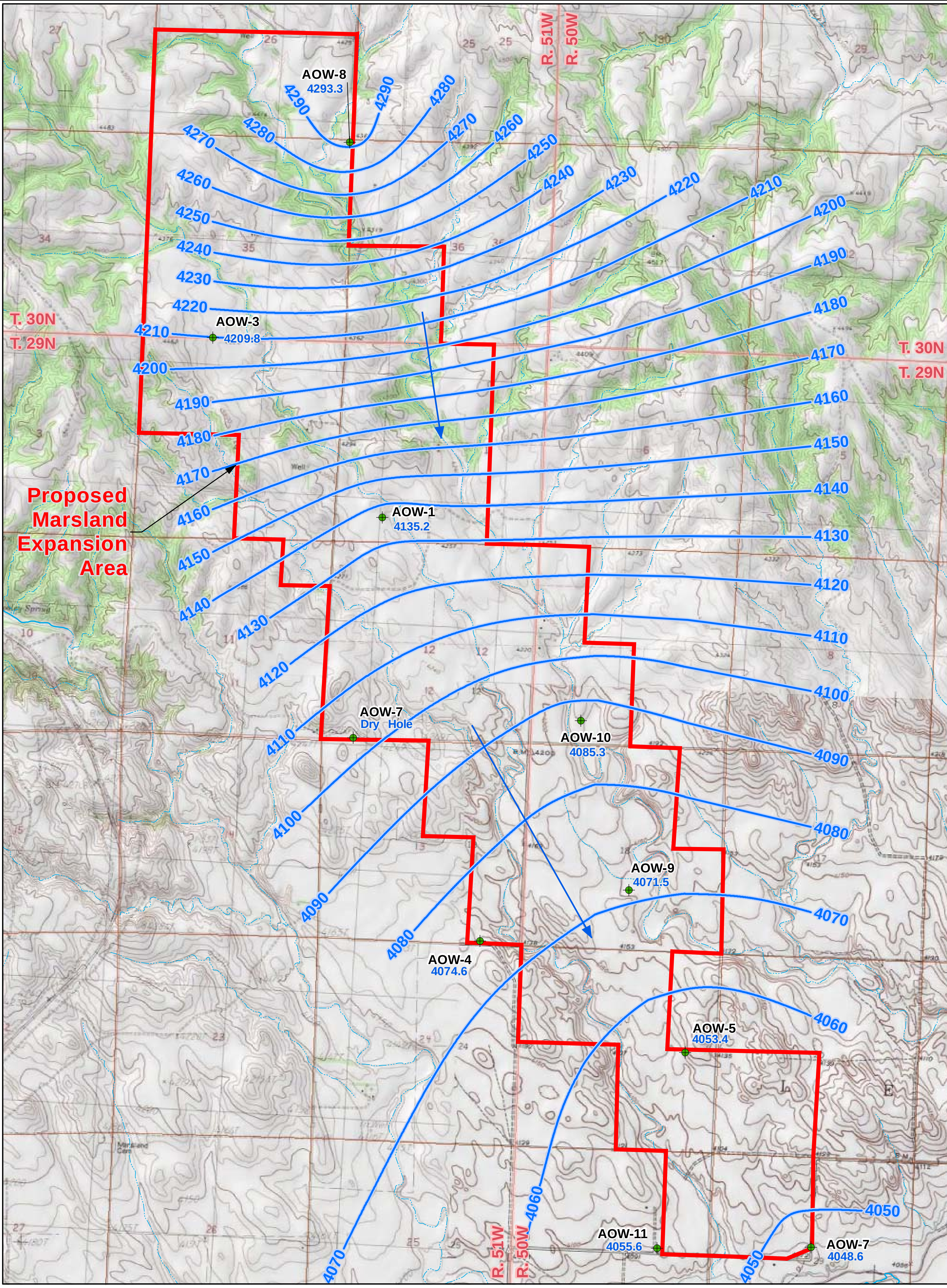
Figure 6.1-6 Marsland Expansion Area Potentiometric Surface Arikaree Group (10/17/2013)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-6_2013 WL_ArikareeGroup.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Arikaree Group Monitoring Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 4055.6 Water Level (feet-above mean sea level)
- Groundwater Flow Direction

N

0 1,250 2,500

Feet

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-6
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
ARIKAREE GROUP (10/17/2013)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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Figure 6.1-7a Marsland Expansion Area Potentiometric Surface Brule Formation (10/17/2013)

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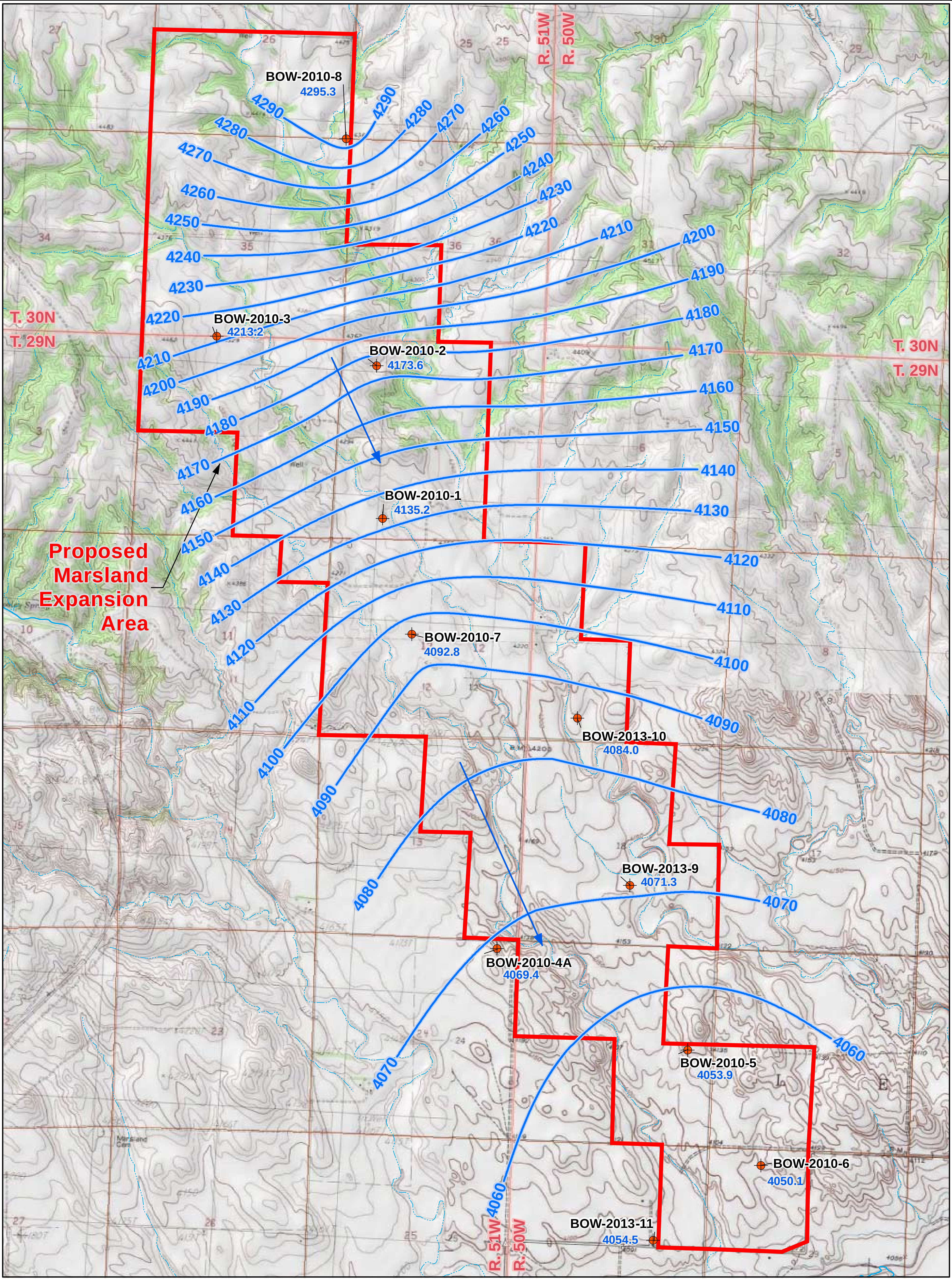

LEGEND

- Brule Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 4054.5 Water Level (feet-above mean sea level)
- Groundwater Flow Direction

N

0 1,250 2,500
Feet

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

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FIGURE 6.1-7a
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BRULE FORMATION (10/17/2013)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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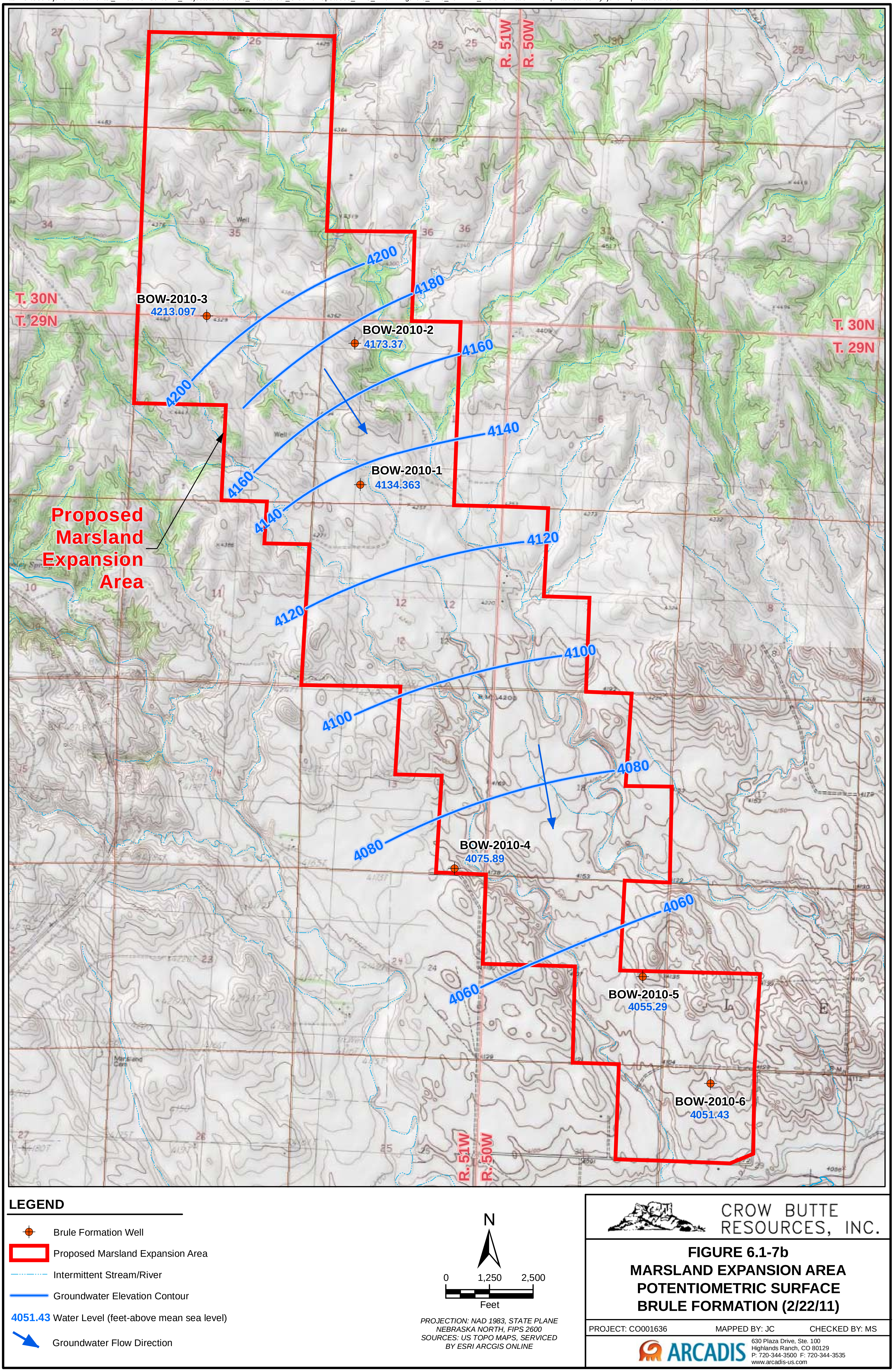
Figure 6.1-7b Marsland Expansion Area Potentiometric Surface Brule Formation (2/22/11)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-7b_2011 WL_BruleFormation.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

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FIGURE 6.1-7b
MARSLAND EXPANSION AREA POTENTIOMETRIC SURFACE BRULE FORMATION (2/22/11)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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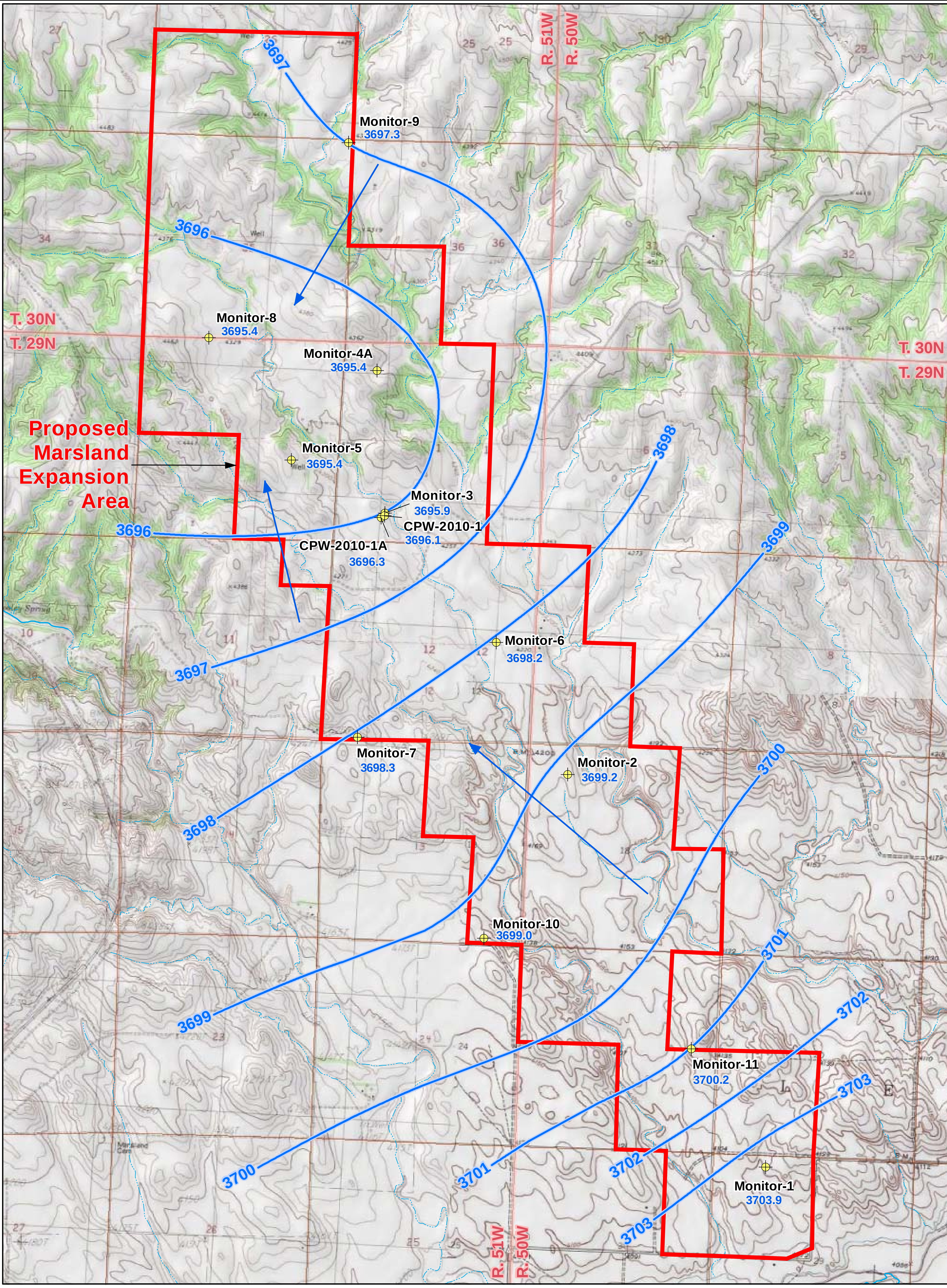
Figure 6.1-8a Marsland Expansion Area Potentiometric Surface Basal Chadron Sandstone (10/17/2013)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-8a_2013 WL_BasalChadronSandstone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Basal Sandstone of the Chadron Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 3703.9 Water Level (feet-above mean sea level)
- Groundwater Flow Direction

N

0 1,250 2,500

Feet

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-8a
MARSLAND EXPANSION AREA POTENTIOMETRIC SURFACE BASAL SANDSTONE OF THE CHADRON FORMATION (10/17/2013)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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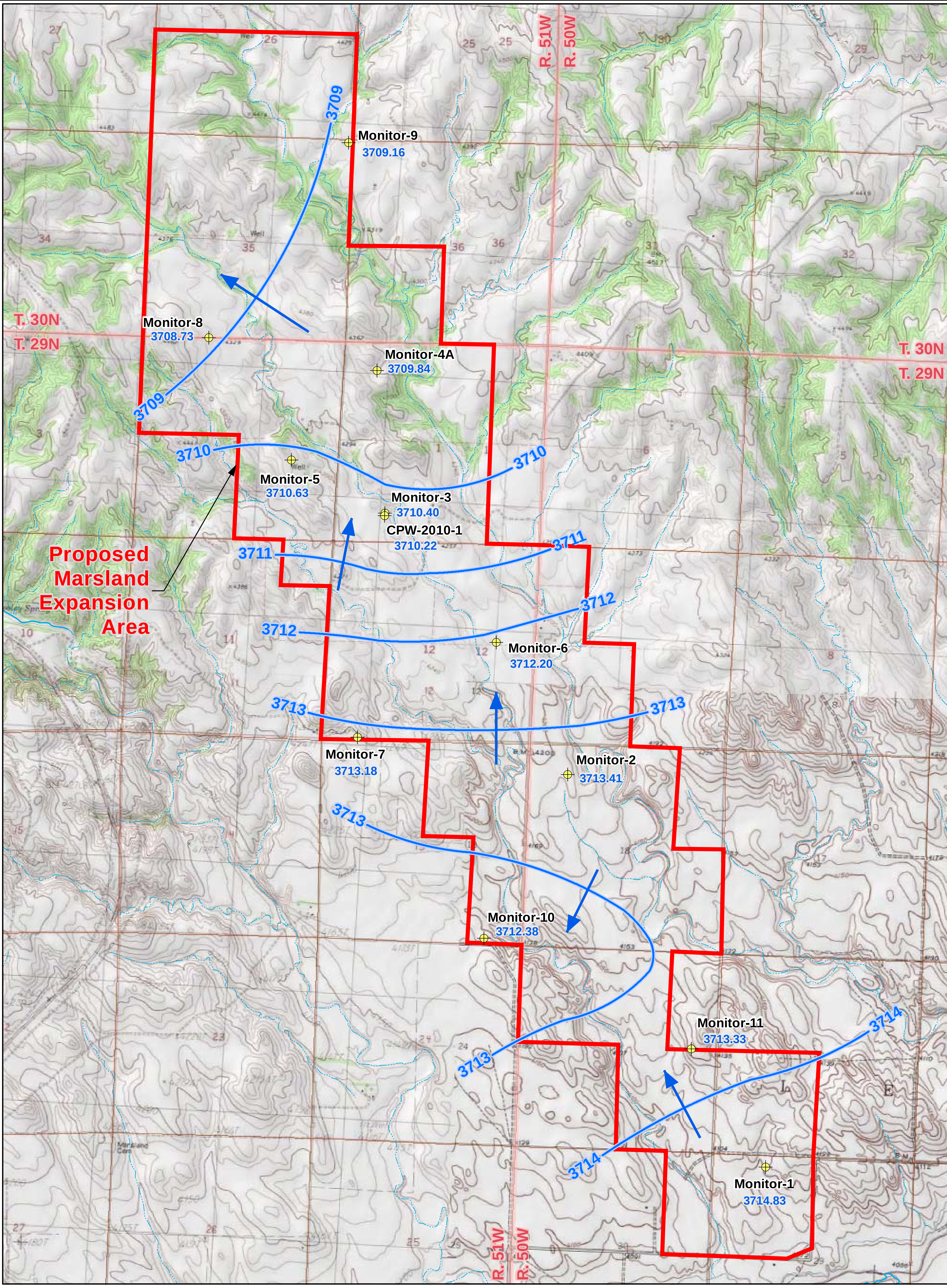
Figure 6.1-8b Marsland Expansion Area Potentiometric Surface Basal Chadron Sandstone (2/22/11)

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ER\ER Figure 6_1-8b 2011 WL_BasalChadronSandstone.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014



LEGEND

- Basal Sandstone of the Chadron Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River
- Groundwater Elevation Contour
- 3714.83 Water Level (feet-above mean sea level)
- Groundwater Flow Direction

N

0 1,250 2,500
Feet

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-8b
MARSLAND EXPANSION AREA
POTENTIOMETRIC SURFACE
BASAL SANDSTONE OF
THE CHADRON FORMATION (2/22/11)

PROJECT: CO001636 | MAPPED BY: JC | CHECKED BY: MS

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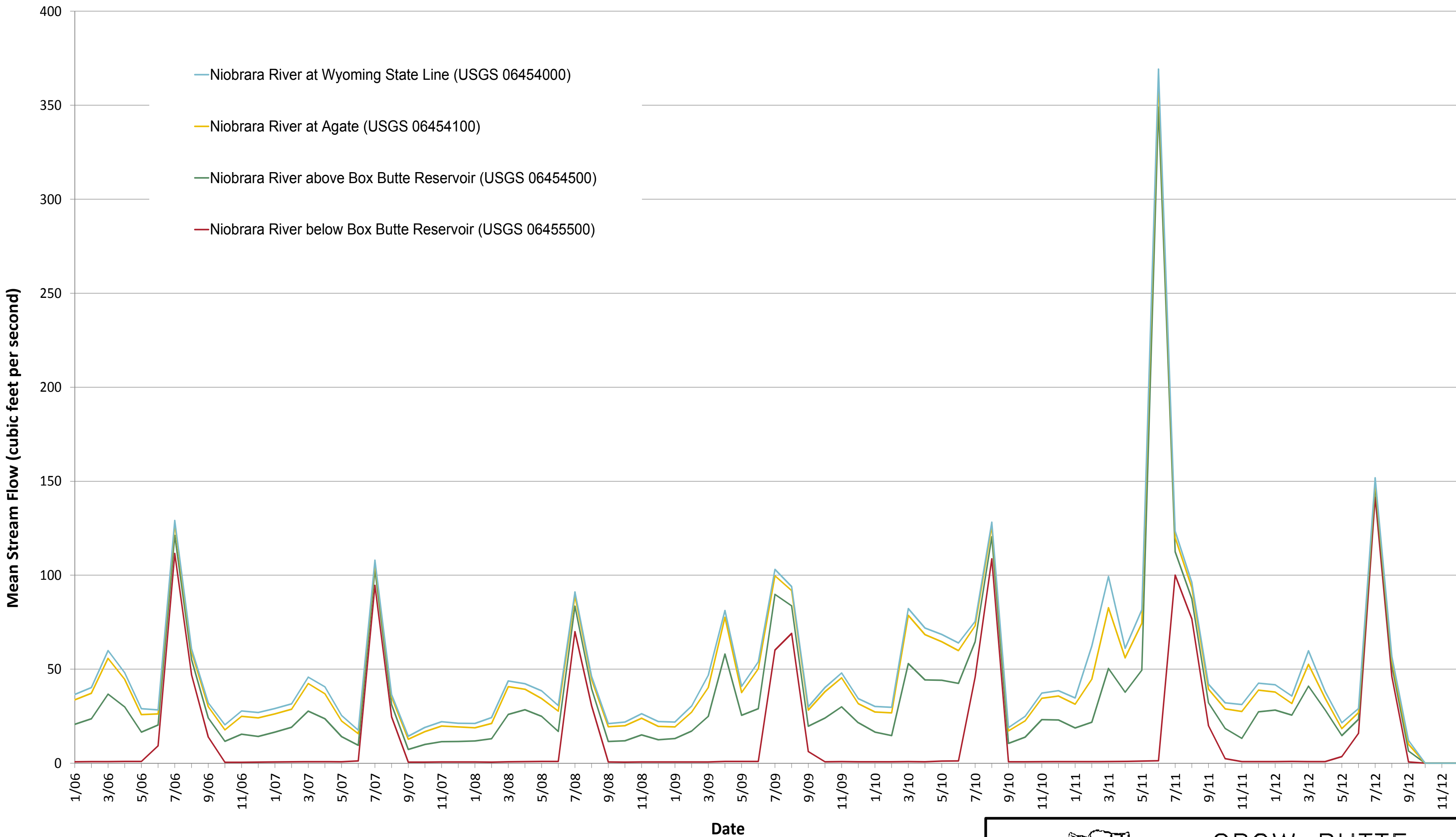
Figure 6.1-9 Mean Stream Flow (cfs) for Niobrara River Stream Gaging Stations in Upper Area in Niobrara River



Source: Williams.2013; Table F.1-3

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FIGURE 6.1-9
UPPER NIOBRARA RIVER AVERAGE FLOWS AT USGS/NDNR STREAM GAGING STATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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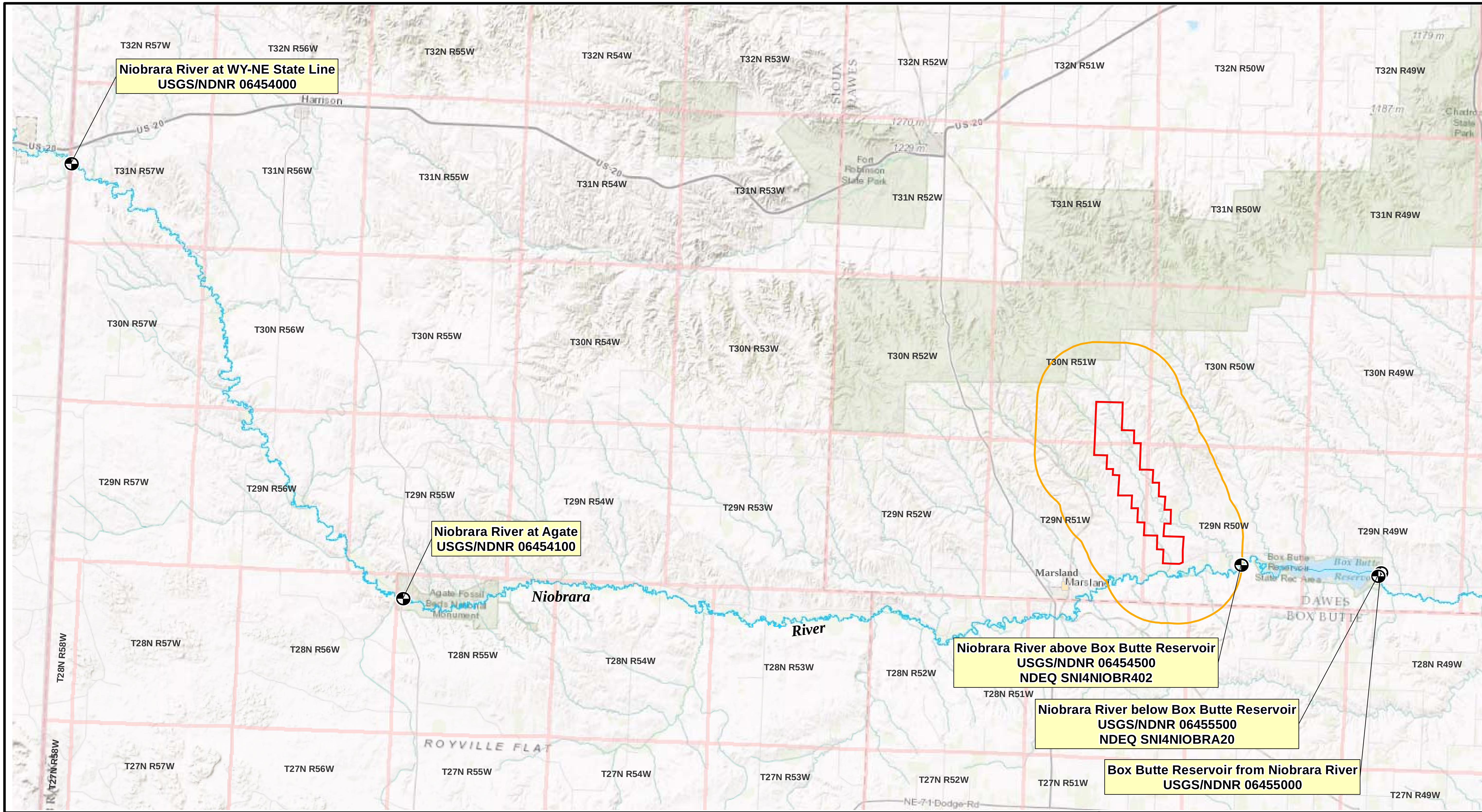
Figure 6.1-10 USGS/NDNR Stream Gaging Stations and NDEQ Sampling Locations for Niobrara River



LEGEND

- USGS/NDNR Stream Gaging Station and NDEQ Sampling Location
- Niobrara River
- Proposed Marsland Expansion Area
- Area of Review (AOR)

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH FIPS 2600
SOURCE: TOPOGRAPHIC MAP, SERVICED BY ESRI ARCGIS ONLINE

N

0 2 4
Miles

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-10
USGS/NDNR STREAM GAGING STATIONS AND NDEQ SAMPLING LOCATIONS FOR NIOBRARA RIVER

PROJECT: CO001636 | MAPPED BY: JC | CHECKED BY: JEC

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Path: C:\Users\jchen\Documents_PROJECTS\KCBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0005_NRC_ERIER Figure 6_1-10 USGS GagingStations and NDEQ Sampling Locations for Niobrara River.mxd | Last Saved By: jchen | Last Saved On: 1/8/2014

7 COST-BENEFIT ANALYSIS

7.1 General

The general need for production of uranium is assumed to be an integral part of 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 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 4.10-1 summarizes the tax revenues from the CPF.

Future tax revenues are dependent on uranium prices, which cannot be accurately forecast; however, these taxes also somewhat depend on the number of pounds of uranium produced by CBR. To the extent that uranium prices remain at current levels (spot market of approximately $50 per pound U_3O_8 in August 2011 [UxC 2011]), the production from MEA 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 MEA facility should be approximately 553,000 pounds per year. The incremental contribution to taxes would be on the order of $950,000 per year in combined taxes.

7.2.2 Temporary and Permanent Jobs

7.2.2.1 Current Staffing Levels

CBR currently employs approximately 68 employees and two contractors employing 14 people on a full-time basis. Short-term contractors and part-time employees are also employed for specific projects and/or during the summer months. This level of employment is significant to the local economies. Total employment in Dawes County in 2010 was 5,691 (BEA 2011). Based on these statistics, CBR currently provides approximately 1.5 percent of all employment in Dawes County. In 2009, the CBR total payroll was $4,155,000. Of the total Dawes County wage and salary payments of $106,652,000 in 2009, the CBR payroll represented about 4 percent.

Total CBR payroll for the past 5 years was:

2006	$2,543,000
2007	$3,822,000
2008	$3,941,000
2009	$4,155,000
2010	$4,200,000

The average annual wage for all workers in Dawes County was $27,347 in 2009. By comparison, the average wage for CBR was approximately $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.

7.2.2.2 Projected Short-Term and Long-Term Staffing Levels

CBR expects that construction of the MEA will provide approximately 10 to 15 temporary construction jobs for up to 1 year. 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 members (less than 5 percent) have been hired elsewhere and relocated to the area. Because of the small number of people who have needed to move into the area to support this project, the impact on the community in terms of expanded services has been minimal. CBR expects that the types of positions required at the current facility and those that will be created by any future expansion will be filled with individuals from the local workforce and that there will be no significant impact on services and resources such as housing, schools, hospitals, recreational facilities, or other public facilities. The annual unemployment rate in Dawes County in 2010 was 4.5 percent, equating to 216 individuals (BLS 2011). CBR expects that any new positions will be filled from this pool of available labor.

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

These additional positions should increase payroll by approximately $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 available in the local area.

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

2006	$4,396,000
2007	$5,167,000
2008	$7,685,000
2009	$7,838,700
2010	$4,330,900

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

This level of business is expected to continue dependent upon CBR project activities in any given year. As production at the CPF mine site ceases due to depleted ore reserves, expansion areas will be brought on stream. These expansion areas will be sequenced (brought on line) in a manner that will continue CPF production consistent with current production rates. CPF project activities should increase somewhat with the addition of expanded production from the proposed MEA and from restoration activities, although not in strict proportion to production. While there are some savings due to some fixed costs, there are additional expenses that are expected to be higher (wellfield development). 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 $3,650,000 to $4,350,000 per year.

7.2.4 Economic Impact Summary

As discussed in this section, CBR currently provides a significant economic impact to the local Dawes County economy. Approval of the proposed project would have a positive impact on the local economy as summarized in **Table 4.10-2**.

7.2.5 Estimated Value of Marsland Resource

CBR continues to develop the reserve estimates for the MEA. Based on the current recoverable resource estimate of 5,667,926 pounds of U_3O_8 and the current market price of uranium ($50 per pound in August 2011 [UxC 2011]), the total estimated value of the energy resources at MEA is approximately $283,396,300. This value will fluctuate as the market price and realized price vary.

7.2.6 Short-Term External Costs

7.2.6.1 Housing Impacts

The available housing resources should be adequate to support short-term needs during facility construction. In 2010, a total of 568 housing units were vacant in Dawes County out of a total housing base of 4,252 units (USCB 2011). Of the vacant units, 168 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.

Recent data for the City of Crawford indicate that, in 2010, there were a total of 567 houses in the City, with 470 occupied (334 by owners and 136 by renters; USCB 2011). This indicates that 97 housing units were available for purchase or rent. In 2008, 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 (Advameg 2010).

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 job site 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 two minor rural roads (Hollibaugh and River Roads) used primarily for access.

A BNSF rail line is located east of SH 2/71 and is approximately 1.1 miles (17.7 km) from the MEA 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 MEA. 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 MEA will be filled with local hires. As a result of employing the local workforce, the impact on local services should be minimal. In many cases, these services (e.g., schools) are underused 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 CBR activities in the past, 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 MEA project 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. As stated earlier, CBR expects that the new positions at the satellite facility will be filled from the local pool of available labor.

7.2.7.2 Noise and Congestion

CBR projects a minor increase in the long-term noise and traffic 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 wellfield. Some increase in heavy truck traffic will occur due to deliveries of process chemicals such as O_2 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.

The 2008 average daily traffic counts for a segment of SH 2/71 near Marsland at the southern end of the MEA was 675 total vehicles, including 90 heavy commercial vehicles. Traffic levels on SH 2/71 increase to 695 total vehicles, including 90 heavy commercial vehicles in the vicinity of East Belmont Road (NDOR 2010). Secondary and private roads connect with East Belmont

Road, River Road, Hollibaugh Road, and Squaw Mound Road to provide access to residences and agricultural lands within the MEA. The limited additional traffic related to the MEA operation will not significantly affect these routes.

7.2.7.3 Aesthetic Impacts

The primary visible surface structures proposed for the MEA include wellhead covers, wellhouses, electrical distribution lines, and DDW buildings, and one satellite processing building. The project will use existing and new roads to access each mine unit and wellhouse, DDW buildings, 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. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture that characterize the existing landscape. The project would primarily affect agricultural land.

In foreground-middleground views, the satellite processing building, wellhouses, DDW buildings, 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 processing building, wellhouses, wellhead covers, and DDW buildings would be painted to harmonize with the surrounding soil and vegetation cover. These facilities would be visible from Squaw Mound Road and the residence within the license boundary, 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 MEA can be characterized as an incremental increase in the impacts from current CBR operations. For the most part, the impact from operation of the current Crow Butte Uranium Project has been positive. 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, particularly the recent increases in local property taxes paid due to the increase in the price of uranium, have had a positive economic impact on local government-provided services.

Offsetting these positive impacts to the local population are increases in noise, traffic congestion, and aesthetic impacts for residents in and adjacent to the proposed satellite facility. Most residents located in the proposed license area are landowners who 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.

This section presents a written estimate of the costs for "environmental protection" deemed to be necessary during and after the cessation of operations. These cost estimates focus on costs associated with the restoration and reclamation (decommissioning) of the MEA in order to ensure that adequate funds are available for permanent closure of the project. The cost estimates address the above-referenced "measures" of concern. The estimated decommissioning costs will be included in the annual surety update required by SUA-1534 submitted to the NDEQ and the NRC for approval prior to construction activities.

The NRC requires a financial surety arrangement consistent with 10 CFR 40, Appendix A, Criterion 9 to cover costs of reclamation activities. Evidence of financial responsibility in the form of a letter of credit or other form satisfactory to the NDEQ in accordance with Title 122, Chapter 13, shall be provided to the NDEQ in an amount equal to or greater than the total costs indicated in the Surety Cost Estimate as required, along with an audit statement from an independent professional auditing firm. CBR will review the cost estimate annually and update in order to ensure adequacy of the dollar amount. The purpose is to ensure that there are sufficient funds available for decontamination, decommissioning, and reclamation of the facility in the event CBR is incapable of performing the tasks. NRC License SUA-1534 requires that CBR continuously maintain an approved surety instrument for Crow Butte Resources, Inc., in favor of the State of Nebraska. CBR is required to ensure that the financial assurance instrument, when authorized by the State of Nebraska, identifies the NRC-related portion of the instrument and covers the aboveground decommissioning and decontamination, the cost of off-site disposal of solid byproduct material, soil and water sample analyses, and groundwater restoration associated with the site. The basis for the cost estimate is the NRC-approved site closure plan or the NRC-approved revisions to the plan. Reclamation or decommissioning plan cost estimates and annual updates will follow the outline in Appendix C to RG-1569, entitled "Recommended Outline for Site-Specific In-Situ Leach Facility Reclamation and Stabilization Cost Estimates."

Groundwater and surface reclamation and restoration methods to be used for the MEA are discussed in Section 5. A decommissioning plan shall be based on factors such as the mine plan, baseline environmental information, and any other factors that will assure the long-term physical, geotechnical, and geochemical stability of the site. Restoration of a specific MU can start as soon as mining is completed, hence the importance of integrating the mine plan and the decommissioning plan. Restoration of a specific MU can occur while uranium recovery operations continue at other MUs. Once groundwater restoration has been completed in the final MU and approved by the NDEQ, decommissioning of the satellite processing plant, remaining CPF evaporation ponds, and other structures can be initiated.

The cost estimates presented in this section are based on the cost per year to restore one MU and reclaim one MU (surface and subsurface features). The CBR mine plan calls for sequential restoration and reclamation, and CBR will have approximately two to three MUs in restoration, mining, or reclamation at any one time. The surety cost estimates will be adjusted as necessary when additional MUs are to be brought on line and the proposed operations are better defined. A current and updated surety is required at least 90 days prior to commencement of construction of a new MU or significant expansion.

Cost information is presented in the following tables located in **Appendix P**:

Table P.1-1	Primary Assumptions Serving as the Basis for Surety Cost Estimates Associated with Restoration and Reclamation of One (1) Mine Unit
Table P.1-2	Marsland Total Restoration and Reclamation – 2013 Surety Estimate
Table P.1-3	Marsland Groundwater Restoration – 2013 Surety Estimate
Table P.1-4	Marsland Wellfield Reclamation – 2013 Surety Estimate
Table P.1-5	Marsland Well Abandonment Unit – 2013 Surety Estimate
Table P.1-6	Marsland Satellite Facility Equipment Decommissioning – 2013 Surety Estimate
Table P.1-7	Marsland Building Demolition Cost – 2013 Surety Estimate
Table P.1-8	Marsland Miscellaneous Site Reclamation – 2013 Surety Estimate
Table P.1-9	Marsland Deep Disposal Well Reclamation – 2013 Surety Estimate
Table P.1-10	Marsland Groundwater IX Treatment (GIX) Restoration 9Unit Cost]
Table P.1-11	Marsland Groundwater Reverse Osmosis (RO) Treatment [Unit Cost] – 2013 Surety Estimate
Table P.1-12	Marsland Groundwater Recirculation [Unit Cost] – 2013 Surety Estimate
Table P.1-13	Marsland Well Abandonment [Unit Cost] – 2013 Surety Estimate
Table P.1-14	Five Year Mechanical Integrity Tests (MIT) – 2013 Surety Estimate
Table P.1-15	Marsland Master Cost Basis – 2013 Surety Estimate

Table P.1-1 presents the primary assumptions that serve as the basis for the surety cost estimates associated with restoration and reclamation of one MU (as of June 11, 2013). **Table P.1-2** provides a summary of the total estimated costs for projected restoration and reclamation activities for MU 1 ($2,286,647), which includes a contract administration and contingency fees of 10 and 15 percent, respectively. The remaining tables further refine the cost estimates and the basis for the tasks and cost estimates. The DDWs will operate under a separate UIC permit, but the reclamation cost estimates for this well have been provided as part of the total surety estimate for the MEA.

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 at the CPF during the R&D project and the commercial restoration of MU 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 offsite. Radiological impacts to air and water are also minimal. Extensive ongoing environmental monitoring of air, water, and vegetation has shown no appreciable impact to the environment from the CPF.

The disturbance of the land for a satellite facility and related activities 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 MEA is favorable, and that amending SUA-1534 is the appropriate regulatory action.

8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

This ER has characterized the existing baseline environment of the MEA 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 8.1-1 summarizes the unavoidable environmental impacts of the proposed construction, operation, and decommissioning of the MEA. 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 MEA). No significant long-term impacts have been identified that would extend beyond the duration of the project. For each impact, mitigative measures are summarized.

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Table 8.1-1 Unavoidable Environmental Impacts

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 4,487 acre site; restricted access for the duration of the project.	Surface reclamation following operational activities to return surface to pre-operational use.
Lost cattle production ($/yr.)	$27,292	Compensation to landowners through surface leases and/or mineral royalties.
Lost crop production ($/yr)	$1,011	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 sandstone of the Chadron Formation 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.)	23.7	Dust control measures implemented where appropriate.
Radon emissions (Curies/yr.)	Additional maximum dose rate within 80 km = 1.6 person-rem/yr	None
Radiological Impacts		
Additional maximum predicted dose (mrem/yr.)	21.0 (nearby resident)	None
Highest dose rate at cities and towns within an 80 km radius of MEA was at Towns of Marsland and Hemingford, NE (m/rem/yr)	0.9	None

Table 8-1 Unavoidable Environmental Impacts

Impact	Estimated Impact	Mitigation Measures
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)	65	None
Solid waste produced (yd^3/yr.)	700	None
11(e)2 byproduct waste produced (yd^3/yr.)	60	None

9 REFERENCES

Section 1 Introduction of the Environmental Report

ARCADIS-US, Inc. (ARCADIS). 2012. Hydrologic and Erosion Study, Marsland Expansion Area. April 12.

ARCADIS. 2013. Hydrologic and Flood Study, Marsland Expansion Area. May.

Compressed Gas Association (CGA). 1993. Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems. Document G-4.4.1993. Arlington, VA.

CGA. 2000. CGA G-4.1, Cleaning Equipment for Oxygen Service.

Crow Butte Resources, Inc. (CBR). 2007. Application for Amendment of NRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report – Volume 1.

Federal Emergency Management Agency (FEMA). 2011. Map Service Center. [Web Page]. Located at: http://www.msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcome View? storeId=10001&catalogId=10001&langId=-1. Accessed on: October 7, 2011.

Ferret Exploration Company of Nebraska, Inc. (Ferret). 1987. Application and Supporting Environmental Report for NRC Commercial Source Material License. September, 1987.

Leftwich, Josh. 2011. Memorandum from Josh Lefwich, Director of Radiation Safety and Licensing, Cameco Resources, Inc. to Ronald Burrows, U.S. Nuclear Regulatory Commission Regarding CBR request to suspend NRC review of the TCEA application due to possible use if pipelines in lieu of full satellite facility. April 14. (ML111160020).

Leftwich, Josh. 2012. Letter from Josh Lefwich, Director of SHEQ, Cameco Resources, Inc. to Andrew Persinko, Deputy Director, Decommisisoning & Uranium Recovery License Directorate, Division of Waste Management and Environmental Management Program, U.S. Nuclear Regulatory Commission Regarding Notice of Intent to restart TCEA application process.. October 11. (ML12299A211).National Fire Protection Association (NFPA). 1996. NFPA-50, Standard for Bulk Oxygen Systems at Consumer Sites.

National Fire Protection Association (NFPA). 1996. NFPA 50: Standard for Bulk Oxygen Systems at Consumer Sites. 1996 Edition. 10 pp.

National Resource Conservation Service (NRCS). 2009. Geospatial Data Gateway. U.S. Department of Agriculture, [Web Page] Located at: http://datagateway.nrcs.usda.gov/ Version Date: Feb. 2009.Nebraska Board of Educational Land and Funds (NBELF). 2013 Public Land for Public Schools. [Web Page]. Located at: http://www.belf.nebraska.gov/. Accessed on: July 11, 2013.

Nebraska Department of Environmental Quality (NDEQ). 2011a. Class III Underground Injection Control (UIC) Permit for North Trend Expansion Area. Effective August 11, 2011.

NDEQ. 2011b. Aquifer Exemption Order Granting Approval of CBR Request for Exemption for Portion of Chadron Formation at North Trend Expansion Area. April 7.

Simley, J.D. and W.J. Carswell, Jr. 2009. The National Map – Hydrography: U.S. Geological Survey Fact Sheet 2009-3054. 4 pp.

U.S. Energy Information Administration (EIA). 2013a. Domestic Uranium Production Report – Annual. Data for 2012. [Web Page]. Located at: http://www.eia.gov/uranium/production/annual/. Accessed on: June 10, 2013.

EIA. 2013b. Nuclear and Uranium. Uranium Marketing Annual Report. Data for 2012. [Web Page]. Located at: http://www.eia.gov/uranium/marketing/. Accessed on: June 10, 2013.

U.S. Environmental Protection Agency (EPA). 2000. Stormwater Phase II Final Rule: Small Construction Site Program Overview. EPA 833-F_00-013. Washington, D.C.

EPA. 2002. Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008. February.

EPA. 2013. National Pollutant Discharge Elimination System (NPDES) Construction Site Stormwater Runoff Control. [Web Page]. Located at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=4. Accessed on: May 09, 2013.U.S. Nuclear Regulatory Commission. (NRC). 1987. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material (May 1987).

NRC. 2012. Safety Evaluation Report, License Renewal of the Crow Butte Resources ISR Facility, Dawes County, Nebraska, Materials License No. SUA-1534. Docket No. 40-8943. December. Wachal, D. and K.E. Banks. 2007. Integrating GIS and Erosion Modeling: A Tool for Watershed Management, ESRI 2007 International User Conference, Paper No. UC1038.

Vogl, B. 2010. Personal communication with Jason Adams (ARCADIS) via telephone regarding school capacities. February 26.

Wachal, David J and Kenneth E. Banks. 2007. Sediment Impacts from Natural Gas Exploration and Production Sites. 2007 ASABE Annual Meeting 072136. Published by the American Society of Agricultural and Biological Engineers, St. Joseph, Michigan.

Young, Thomas P. 2010. Letter from Thomas P. Young, Vice President, Operations, Cameco Resources, Cheyenne, WY to Larry Camper, Director, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. NRC, Rockville, MD Regarding Request for License Amendment, License SUA-1534. August 3.

Section 2 Alternatives

Crow Butte Resources, Inc. (CBR). 2007. Application for Amendment of NRC Source Materials License SUA-1534, North Trend Expansion Area, Technical Report – Volume 1.

U.S. Energy Information Administration (EIA). 2013a. Domestic Uranium Production Report – Annual. Data for 2010. [Web Page]. Located at: http://www.eia.gov/uranium/production/annual/. Accessed on: June 10, 2013.

EIA. 2013b. Nuclear and Uranium. Uranium Marketing Annual Report. Data for 2010. [Web Page]. Located at: http://www.eia.gov/uranium/marketing/. Accessed on: June 10, 2013.

U.S. Environmental Protection Agency (EPA). 2008. Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining. Volume 1: Mining and Reclamation Background. EPA 402-R-08-55. April.

U.S. Nuclear Regulatory Commission (NRC). 1982. Draft Environmental Statement Related to the Operation of the Teton Project, RG-0925, June 1982. Para. 2.3.5.

NRC. 2003. Standard Review Plan for In Situ Leach Uranium Extraction License Applications. Final Report, NUREG-1569. June 2008. Regulatory Guide 3.11. Design, Construction, and Inspection of Embankment Retention Systems at Uranium recovery Facilities (Revision 3, November 2008).

NRC. 2008. "Regulatory Guide 3.11 – Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities". Rev. 3. November.

Section 3 Description of the Affected Environment

3.1 Land Use
3.2 Transportation and Utilities

DeLorme Maps. 2005. Nebraska Atlas and Gazetteer; Third Edition. Yarmouth, Maine.

National Agricultural Statistics Service (NASS). 2009a. Census of Agriculture Volume 1 Chapter 2: Nebraska County Level Data. Issued February, 2009. [Web Page]. Located at: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/index.asp. Accessed on: July 2011.

NASS. 2009b. Quick Stats Nebraska County Data - Livestock. [Web Page]. Located at: http://www.nass.usda.gov/QuickStats. Accessed on: July 2011.

NASS. 2011. QuickStats Ad-hoc Query Tool. [Web Page]. Located at: http://quickstats.nass.usda.gov. Accessed on: June 2011.

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web Page]. Located at: http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: November 19, 2011.

Nebraska Oil and Gas Conservation Commission (NOGCC). 2011. Well data and publications. [Web Page]. Located at: http://www.nogcc.ne.gov/NOGCCPublications.aspx. Accessed on: October 7, 2011.

Petersan, Doris N. 2005. *Economic Importance of and Economic Impacts Associated with Livestock Production in Dawes County*. Economic Development Department, Nebraska Public Power District.

U.S. Census Bureau (USCB). 2011. Census 2000 Summary File 1 (SF 1) 100-Percent Data, Detailed Tables. [Web Page]. Located at: http://factfinder2.census.gov. Accessed on: September 2011.

U.S. Nuclear Regulatory Commission (NRC). 2007a. Renewal Application for 2007 License Renewal, USNRC Source Materials License SUA-1534, Crow Butte License Area November 27. ML073480266/ML073480267.

NRC. 2007b. Application for Amendment of USNRC Source Materials License SUA-1534, North Trend Expansion Area, Crawford, Nebraska, Volume I, Technical Report. May 30. ML071760344.

NRC. 2010. Application for Amendment of USNRC Source Materials License SUA-1534, Three Crow Expansion Area, Crawford, Nebraska, Volume I, Technical Report. August 03. ML1012230171.

NRC. 2011a. Nebraska. [Web Page]. Located at: http://www.nrc.gov/info-finder/region-state/nebraska.html. Accessed on: October 7, 2011.

NRC. 2011b. Locations of Fuel Cycle Facilities. [Web Page]. Located at: http://www.nrc.gov/info-finder/materials/fuel-cycle. Accessed on: October 7, 2011.

NRC. 2013. Major Uranium Recovery Licensing Applications. [Web Page]. Located at: http://www.nrc.gov/materials/uranium-recovery/license-apps/ur-projects-list-public.pdf. Accessed on: May 06, 2013.

3.3 Geology and Seismology

Bureau of Land Management (BLM). 2008. Pinedale Field Office Resource Management Plan Final Environmental Impact Statement.

BLM. 2009. Assessment and Mitigation of Potential Impacts to Paleontological Resources – Guidelines for Assessment and Mitigation of Potential Impacts to Paleontological Resources. Instructional Memorandum No. 2009-011 Attachment 1. 19 pages.

Bradley, E. and Rainwater, F. H. 1956. Geology and Groundwater Resources of the Upper Niobrara River Basin, Nebraska and Wyoming With a Section on Chemical Quality of the Groundwater. USGS Water Supply Paper 1368.

Brown, V.M. and Harrell, J.A. 1991.Megascopic Classification of Rocks. Journal of Geological Education. v. 39. p. 379-387

Burchett, R.R. 1990. Earthquakes in Nebraska. University of Nebraska-Lincoln, Educational Circular No. 4a, 20pp.

Cady, R. C. and Scherer, O. J. 1946. Geology and Ground-Water Resources of Box Butte County, Nebraska: U.S.G.S Water Supply Paper Number 969. 114 p.

Caribbean Disaster Emergency Response Agency (CDERA). 2009. CDERA Virtual Disaster Library – Earthquakes and Seismic Activity. [Web Page]. Located at: http://www.cdera.org/doccentre/fs_earthquakes.php. Accessed on: December 30, 2009.

Clark, J. 1975. Controls of sedimentation and provenance of sediments in the Oligocene of the central Rocky Mountains In: Curtis, B.F., ed., Cenozoic history of the southern Rocky Mountains. Geological Society of America Memoir 144, p. 95-117.

Clark, J., Beerbower, J.R., and Kietzke, K.K. 1967. Oligocene sedimentation, stratigraphy, paleoecology and paleoclimatology in the Big Badlands of South Dakota. Field Museum of Natural History, Fieldiana Geology Memoirs, v. 5, p. 158.

Collings, S.P. and Knode, R.H. 1984. Practical Hydromet '83; 7th Annual Symposium on Uranium and Precious Metals, American Institute of Metallurgical Engineers.

Cook, H. J. 1915. Notes on the Geology of Sioux County, Nebraska and Vicinity. Nebraska Geological Survey Bulletin, v. 7. part 11, 16 pp.

DeGraw, H.M. 1969. Subsurface Relations of the Cretaceous and Tertiary in Western Nebraska. University of Nebraska, MS Thesis, 137pp.

DeGraw, H.M. 1971. The pre-Oligocene surface in western Nebraska – Its relation to structure and subsequent topographies. In: Stout, T.M. Degraw, H.M., Tanner, L.G., Stanley, K.O., Wayne, W.J., and J.B. Swinehart (eds.), Guidebook to the Late Pliocene and Early Pleistocene of Nebraska. Nebraska Geological Survey. April 1971. p. 13-22.

Diffendal, R.F., Jr. 1982. Regional implications of the geology of the Ogallala Group (Upper Tertiary) of southwestern Morrill County, Nebraska. Geological Society of America Bulletin, v. 93, p. 964-976.

Diffendal, R.F., Jr. 1994. Geomorphic and structural features of the Alliance 1 degree X 2 degree Quadrangle, western Nebraska, discernible from synthetic-aperture radar imagery and digital shaded-relief maps. Rocky Mountain Geology; October 1994; v. 30; no. 2; p. 137-147.

Evans, J.E. and Terry, D.O., Jr. 1994. The significance of incision and fluvial sedimentation in the Basal White River Group (Eocene-Oligocene), badlands of South Dakota, U.S.A. Sedimentary Geology, v. 90, p. 137-152.

Florida Oceanographic Online (FOO). 2002. Earthquake Magnitude and Intensity Information. [Web Page]. Located at: http://www.floridaoceanographic.org/ reference/earthquake.htm. Accessed on: December 30, 2009.

Gjelsteen, T.W., and S.P. Collings, 1988, Relationship between ground water flow and uranium mineralization in the Chadron Formation, northwest Nebraska: Wyoming Geological Association Guidebook, Thirty-ninth Field Conference, p. 271-284.

Gutentag, E.D., Heimes, F.J., Krothe, N.C., Luckey, R.R., Weeks, J.B. 1984. Geohydrology of the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas and Wyoming. USGS Professional Paper 1400-B, p.63.

Hansley, P.L. and Dickenson, K.A. 1990. Uranium Mineralization Favorabilty in the Oligocene Chadron Formation, Southeaster Wyoming and Northwestern Nebraska. Short Paper of the USGS Uranium Workshop. p. 27-31.

Hansley, P.L., S.P. Collings, I.K. Brownfield, and G.L. Skipp. 1989. Mineralogy of Uranium Ore from the Crow Butte Uranium Deposit, Oligocene Chadron Formation, Northwestern Nebraska. USGS Open File Report 89-225.

Harksen, J.C. and Macdonald, J.R. 1969. Type sections for the Chadron and Brule Formations of the White River Oligocene in the Big Badlands of South Dakota. South Dakota Geological Survey Report of Investigations #99, p. 23.

Hoganson, J.W., Murphy, E.C., and Forsman, N.F. 1998. Lithostratigraphy, paleontology, and biochronology of the Chadron, Brule, and Arikaree Formations in North Dakota. In: Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 185-196.

Hunt, R.M., Jr. 1981. Geology and vertebrate paleontology of the Agate Fossil Beds National Monument and surrounding region, Sioux County, Nebraska (1972-1978). National Geographic Society Research Reports, v. 13, p. 263-285.

Hunt, R.M., Jr. 1990. Taphonomy and sedimentology of Arikaree (lower Miocene) fluvial, eolian, and lacustrine paleoenvironments, Nebraska and Wyoming: A paleobiota entombed in fine-grained volcaniclastic rocks. In: Lockley, M.G., and Rice, A., eds., Volcanism and fossil biotas: Geological Society of America Special Paper 244, p. 69-111.

LaGarry, H.E. 1998. Lithostratigraphic revision and redescription of the Brule Formation (White River Group) of northwestern Nebraska. In: Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 63-91.

LaGarry, H.E., LaGarry, L.A., and Terry, D.O. 1996. New vertebrate fauna from the Chamberlain Pass Fm (Eocene), Sioux City, Nebraska. Proceedings, 106th Annual Nebraska Academy of Sciences, Earth Science Section, p. 45.

Larson, E.E. and Evanoff, E. 1998. Tephrostratigraphy and source of the tuffs of the White River sequence. In: Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 1-14.

Lillegraven, Jason A. 1970. Stratigraphy, Structure, and Vertebrate Fossils of the Oligocene Brule Formation, Slim Buttes, Northwestern South Dakota. B005S12EAS. *Geol Soc Amer Bull*. January 1.

Lisenbee, A.L. 1988. Tectonic history of the Black Hills uplift. In: Wyoming Geological Association Guidebook, 39th Field Conference, pp. 45–52.

Lugn, A. L. 1939. Classification of the Tertiary System in Nebraska. Geological Society of America Bulletin, v. 50, p. 673-696.

McFadden, B.J. and Hunt, Jr., R. M. 1998. Magnetic Polarity Stratigraphy and Correlation of the Arikaree Group, Arikareean (Late Oligocene-Early Miocene) of Northwestern Nebraska. In: Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 15-37.

National Park Service (NPS). 2010. Mammal Fossils. [Web Page] Located at: http://www.nps.gov/agfo/naturescience/mammalfossils.htm. Accessed on: May 5, 2011.

Nebraska Department of Environmental Quality. (NDEQ). 2009. Letter dated August 19 from Michael J. Linder, Director, Department of Environmental Quality, Lincoln, Nebraska to Steve Collings, Crow Butte Resources, Inc., Lakewood, Colorado Regarding Mineral Exploration Permit Number NE0210824.

Nebraska Oil and Gas Conservation Commission. (NOGCC). 2011. Annual Activity Summaries 2004 – 2010. [Web Page]. Located at: www.nogcc.ne.gov/NOGCC Publications.aspx. Accessed on: May 17, 2011.

NOGCC. 2013a. Email from NOGCC (nogcc@nogcc.ne.gov) to Jack Cearley, Project Director, ARCADIS-US, Inc., Highlands Ranch, CO. Regarding online information request response from NOGCC as to any active producing oil and gas wells in Dawes County, NE. May 23.

NOGCC. 2013b. Well Data – Access 2003 Format (12/20/2012). [Web page]. Located at: http://www.nogcc.ne.gov/NOGCCPublications.aspx. Accessed on: May 23.

Nixon, D.A. 1995. The structure of the Pine Ridge of the tri-state region of Wyoming, Nebraska, and South Dakota and its relationship to the Black Hills Dome. Geological Society of America Abstracts with Programs, 29th annual meeting, p.77.

Petersen, M.D., Frankel, A.D., Harmsen, S.C., Mueller, C.S., Haller, K.M., Wheeler, R.L., Wesson, R.L., Zeng, Y., Boyd, O.S., Perkins, D.M., Luco, N., Field, E.H., Wills, C.J., and K.S. Rukstales. 2008. Documentation for the 2008 Update of the United States National Seismic Hazard Maps. United States Geological Survey, Reston, Virginia. Open-File Report 2008 – 1128.

Petrotek. 2004. Class I UIC Permit Re-Application, Class I Non-Hazardous Deepwell. Prepared for Crow Butte Resources, Inc. and submitted to the Nebraska Department of Environmental Quality, March 15, 2004.

Rothe, G.H. 1981. Earthquakes in Nebraska through 1979. Earthquake Notes, V.52, No. 2, pp.59-65.

Rothe, G.H., Lui, C.V., and Steeples, D.W. 1981. Recent Seismicity on the Chadron- Cambridge Arch, South-Central Nebraska. Earthquake Notes, V.52, No. 1, p.61.

Schultz, C. B. 1941. The Pipy Concretions of the Arikaree. Bulletin of the University of Nebraska State Museum, v. 8, p. 69-82.

Schultz, C.B. and Stout, T.M. 1955. Classification of Oligocene Sediments of Nebraska. Bulletin of the University of Nebraska State Museum, v. 4, p 17-52.

Singler, C.R. and Picard, M.D. 1980. Stratigraphic Review of Oligocene Beds in Northern Great Plains Earth Science Bul., WGA,. V.13, No.1, p.1-18.

Soil Conservation Service (SCS). 1977. Soil Survey of Dawes County Nebraska. United States Department of Agriculture SCS, in cooperation with University of Nebraska Conservation and Survey Division. February 1977.

Soil Survey Staff (SSS). 2011. Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. [Web Page] Located at: http://websoilsurvey.nrcs.usda.gov. Accessed on: April 26, 2011.

Stanley, K.O. and Bensen, L.V. 1979. Early diagenesis of High Plains Tertiary vitric and arkosic sandstone, Wyoming and Nebraska. In: Scholle, P.A., and Schluger, P.R., eds., Aspects of diagenesis: Society of Economic Geologists and Paleontologists Special Publication 26, p. 401-423.

State of Nebraska (Nebraska). 2010. Nebraska Energy Statistics – Energy Production in Btu. [Web Page] Located at: http://www.eia.doe.gov/emeu/states/sep_prod/P2/PDF/P2.pdf. Accessed on: May 17, 2011.

Stix, J. U.S. Department of Energy. 1982. Seasat-Satellitte Investigation of the Structure of Western Nebraska and Its Application to the Evaluation of Geothermal Resources. U.S. Department of Energy Publications. University of Nebraska – Lincoln. Referenced on Figure 3.3-11.

Stout, T.M., H.M. DeGraw, L.G. Tanner, K.O. Stanley, W.J. Wayne, and J.B. Swinehart. (Stout et al). 1971. Guidebook to the Late Pliocene and Early Pleistocene of Nebraska. Nebraska Geological Society. 113 pp.

Svoboda, R. F. 1950. A Detailed Sedimentation and Petrographic Analysis of the Monroe Cree Formation of the Pine Ridge Area of Northwest Nebraska. [unpublished M.S. thesis]: Lincoln Nebraska, University of Nebraska, p. 189.

Swinehart, J.B., Souders, V.L., DeGraw, H.M. and Diffendal, R.F. Jr. 1985. Cenozoic Paleography of Western Nebraska. In: Flores, R.M. and Kaplan, S.S., eds., Cenzoic Paleogeography of the West-Central United States: Rocky Mountain Section, SEPM, p.187-206.

Tedford, R. H., Swinehart, J. B., Hunt Jr. R. M., and Voorhies, M. R. 1985. Uppermost White River and Lowermost Arikaree Rocks and Fuanas, White River Valley, Northwestern Nebraska, and Their Correlation with South Dakota. In: Martin, J. E., ed., Follisiferous Cenozoic Deposits of Western South Dakota and Northwestern Nebraska: Dakoterra v. 2, pp. 335-352.

Tedford, R.H., Albright, L.B., III, Barnosky, A.D., Ferrusquia-Villafranca, I., Hunt, R. M. Jr., Storer, J.E., Swisher, C.C., Voorhies, M.R., Webb, S.D., and Whistler, D.P. 2004. Mammalian biochronology of the Arikareean through Hemphilian interval (Late Oligocene through Early Pliocene epochs). In: Woodburne, M.O. ed., Late Cretaceous and Cenozoic Mammals of North America: Columbia University Press. P. 169-231.

Terry, D. O., Jr. 1991. The study and implications of comparative pedogenesis of sediments from the base of the White River Group, South Dakota [M.S. thesis]: Bowling Green, Ohio, Bowling Green State University, p. 184.

Terry, D. O., Jr. 1998. Lithostratigraphic Revision and Correlation of the Lower Part of the White River Group: South Dakota to Nebraska. In: Terry, D. O., Jr., LaGarry, H. E. and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 15-37.

Terry, D.O., Jr. and J.E. Evans. 1994. Pedogenesis and paleoclimatic implications of the Chamberlain Pass Formation, Basal White River Group, Badlands of South Dakota. Paleogeography, Paleoclimatology, Paleoecology. v. 110, p. 197-215.

Terry, D. O., Jr., and LaGarry, H. E. 1998. The Big Cottonwood Creek Member: A New Member of the Chadron Formation in Northwestern Nebraska; in Terry, D. O., Jr., LaGarry, H. E., and Hunt, R. M., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Geological Society of America Special Paper #325, p. 117-141.

U.S. Geological Survey (USGS). 2009a. [Web Page]. Located at: http://earthquake.usgs.gov/earthquakes/states/nebraska/hazards.php. Accessed on: December 30, 2009.

USGS. 2009b. The Modified Mercalli Intensity Sale. [Web Page]. Located at: http://earthquake.usgs.gov/learn/topics/mercalli.php. Accessed on: December 30, 2009.

USGS. 2009c. Earthquakes. [Web Page]. Located at: http://earthquake.usgs.gov/earthquakes/. Accessed on: December 30, 2009. Referenced on Tables 3.3-4 and 3.3-5.

USGS. 2009d. Top Earthquake States. [Web Page]. Located at: http://earthquake.usgs.gov/earthquakes/states/top_states.php. Accessed on: December 29, 2009.

USGS. 2009e. Nebraska Seismicity Map – 1900 to Present. [Web Page]. Located at: http://earthquake.usgs.gov/earthquakes/states/nebraska/seismicity.php. Accessed on: December 29, 2009.

USGS. 2009f. Google Earth Files for Earthquake Catalogs. [Web Page]. Located at: http://neic.usgs.gov/neis/epic/kml/. Accessed on: December 30, 2009. Referenced on Tables 3.3-4 and 3.3-5.

USGS. 2009g. Hazard Mapping Images and Data. Earthquake Hazard Ranking in U.S. [Web Page]. Located at: http://earthquake.usgs.gov/hazards/products/. Accessed on: December 29, 2009.

USGS. 2010. Quaternary Fold and Fault Database for the United States. [Web Page]. Located at: http://earthquake.usgs.gov/hazards/qfaults/. Updated November 3, 2010. Accessed: April 1, 2013.

Vicars, R. G. and Breyer, J. A. 1981. Sedimentary Facies in Air-Fall Pryoclastic Debris, Arikaree Group (Miocene), Northwest Nebraska, U.S.A.: Journal of Sedimentary Petrology, v. 51. p. 0909-0921.

Vondra, C. F. 1958. Depositional history of the Chadron Formation in northwestern Nebraska: Proceedings, 68th Annual Meeting, Nebraska Academy of Sciences Abstracts with Programs, p. 16.

Wanless, H. R. 1923. The stratigraphy of the White River beds of South Dakota: Am. Philos. Soc. Proc., v. 62, p. 190-269.

Wellman, S. S. 1964. Stratigraphy of the Lower Miocene Gering Formation, Pine Ridge Area, Northwestern Nebraska: [unpublished M.S. thesis]: Lincoln, University of Nebraska, 35 p.

Wheeler, R. L., and Crone, A. J. 2001. Known and suggested quaternary faulting in the midcontinent United States: Engineering Geology, v. 62. p. 51-78.

Witzel, F. L. 1974. Guidebook and Road Logs for the Geology of Dawes and Northern Sioux Counties, Nebraska [M.S. thesis]: Chadron, Chadron State College, 97 p.

Wyoming Fuel Company (WFC). 1983. Crow Butte Project, Dawes County, Nebraska, Application and Supporting Environmental Report for State of Nebraska. Submitted to Nebraska Dept. of Environmental Control.

Section 3.4 Water Resources

3.4.1 Water Use

Engberg, R.A. and Spalding, R.F. 1978. Groundwater quality atlas of Nebraska: Lincoln, University of Nebraska—Lincoln, Conservation and Survey Division Resource Atlas No.3, 39 p.

Gosselin, D. C., Headrick, J., Chen, X-H., and Summerside, S. E. 1996. Regional Analysis of Rural Domestic Well-water Quality -- Hat Creek-White River Drainage Basin; from Domestic Water-well Quality in Rural Nebraska, Nebraska Department of Health.

Kelly, Mary. 2010. *Nebraska's Evolving Water Law: Overview of Challenges & Opportunities* Platte Institute for Economic Research. September.

Key to the City. 2011. Marsland, Nebraska. [Web Page]. Located at: http://www.usacitiesonline.com/. Accessed on: August 10, 2011.

Mayer, W. M., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W.Y., Dziegielewski, B., and Nelson, J.O. 1999. Sponsored by American Water Works Association Research Foundation. (AWWARF). Residential End Uses of Water. 310 p. Nebraska Department of Health and Human Services (NDHHS). 2010. Nebraska Administrative Code: Title 179. Public Water Systems, Chapter 7, 7-007 Design Standards, 7-007.03 Wells/Groundwater Source(s). April 4.

Nebraska Department of Health and Human Services (NDHHS). 2010. Nebraska Administrative Code: Title 179. Public Water Systems, Chapter 7, 7-007 Design Standards, 7-007.03 Wells/Groundwater Source(s). April 4.

Nebraska Department of Natural Resources. (NDNR). 2011. Summary Report Registered Groundwater Wells by County. [Web Page]. Located at: http://dnrdata.dnr.ne.gov/wellssql/Summary.asp?type=county. Accessed on: August 23, 2011.

NDNR. 2013a. State of Nebraska Department of Natural Resources Summary of Non-Abandoned Registered Wells on File After Second Quarter 2011. [Web Page]. Located at: http://dnr.ne.gov/GroundWater/ PDF_Files/Summary_non-AbandonedRegisteredWells_SecondQuarter 2011.pdf. Accessed on: April 9, 2013.

NDNR. 2013b. Registered Groundwater Wells Data Retrieval. [Web Page]. Located at: http://dnrdata.dnr.ne.gov/wellscs/Menu.aspx. Accessed on: April 9, 2013.

Nebraska Revised Statutes (NRS). 2008. Chapter 46: Irrigation and Regulation of Water. Section 46-602: Registration of water wells; forms; replacement; change in ownership; illegal water well; decommissioning required.

Teahon, L. 2013a. Personal communication [July 29 telephone conversation with Robin Foulk, District Conservationist, Natural Resources Conservation Service, Chadron Field Office, Chadron, NE, Regarding calculation of livestock water consumption for Dawes County when designing planned grazing system]. SHEQ Manager, Cameco Resources, Crow Butte Operations, Crawford, NE.

Teahon, Larry. 2013b. Personal communication. [September 6 e-mail to John Schmuck, Cameco Resources, Cheyenne, Wyoming. RE: TR RAI # 3 (Development of New Wells)]. SHEQ Manager, Crow Butte Resources, Inc., Crawford, Nebraska. 1 page.

United States Environmental Protection Agency. (EPA). 2013. Water Sense. [Web Page]. Located at:http://www.epa.gov/watersense/pubs/indoor.html. Access on: September 16, 2013.

United States Geological Survey (USGS). 2005. Estimated Use of Water in the United States County-Level Data for 2005. [Web Page]. Located at: http://water.usgs.gov/watuse/data/2005/index.html. Accessed on: April 10, 2013.

USGS. 2013. Water Use in the United States. [Web Page]. Located at: http://water.usgs.gov/watuse/. Access on: April 10, 2013.

University of Nebraska-Lincoln, Conservation and Survey Division. 1986. The Groundwater Atlas of Nebraska, Resource Atlas No. 4.

3.4.2 Surface Water
3.4.3 Groundwater

Alexander, J.S., Zelt, R.B., and Schaepe, N.J. 2010. Hydrogeomorphic Segments and Hydraulic Microhabitats of the Niobrara River, Nebraska – With Special Emphasis on the Niobrara National Scenic River, U.S. Geological Survey Scientific Investigations Report 2010-5141, 62 p.

Aqui-Ver, Inc. 2011. Marsland Regional Hydrologic Testing Report – Test #8, Crow Butte Project, Marsland Expansion Area.

Bentall, R. and Schaffer, F.B. 1979. Availability of Use of Water in Nebraska, 1975. Lincoln, University of Nebraska, Conservation Survey Division, Nebraska Water Survey Paper 48, 121 p. Referenced in Alexander et al 2010.

Carrier, W. 2003. Goodbye, Hazen; Hello, Kozeny-Carman. Journal of Geotechnical and Geoenvironmental Engineering, Vol. 129, No. 11: pp 1054-1056.

Cooper, H.H., and C.E. Jacob. 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans, Vol. 27, pp.526-534.

Hayden-Wing Associates, LLC (HWA). 2011 Ecological Resources Summary: Technical Report for Cameco Resources – 2011. Proposed Marsland Expansion Area Uranium Project in Dawes County, Nebraska. July.

Nebraska Department of Environmental Quality (NDEQ). 2005. Total Maximum Daily Loads for the Niobrora River Basin. Perimeter of Concern: E. coli Bacteria. December.

NDEQ. 2011a. 2010 Nebraska Water Monitoring Programs Report. January.

NDEQ 2011b. Ihre, D. Personal communication [September 15 email to J. Cearley, ARCADIS-US, Inc., Highlands Ranch, Colorado Regarding Request for Niobrara River Water Quality Data]. Planning Section, Water Division, NDEQ, Lincoln, NE. 1 page.

Neuzil, C.E. 1993. Low Fluid Pressure Within the Pierre Shale: A Transient Response to Erosion, Water Resource. Res., 29(7), 2007–2020.

Neuzil, C.E. and Bredehoeft, J.D. 1980. Measurement of In-Situ Hydraulic Conductivity in the Cretaceous Pierre Shale, 3rd Invitational Well-Testing Symposium, Well Testing in Low Permeability Environments, Proceedings March 26-28, 1908, Berkeley, California, p. 96-102.

Neuzil, C.E., Bredehoeft, J.D., and Wolff, R.G. 1982. Leakage and fracture permeability in the Cretaceous shales confining the Dakota aquifer in South Dakota, in Jorgensen, D.G., and Signor, D.C., eds., Geohydrology of the Dakota aquifer-Proceedings of the First C.V. Theis Conference on Geohydrology, October 5-6, 1982: National Water Well Association, p. 113-120.

Snowhite, L. 2011. Letter to Jenny Coughlin, Nebraska Department of Environmental Quality from Lee Snowhite, Senior Engineer, Cameco Resources Regarding Crow Butte Resources, Inc. Pumping Test Plan, Request for Changes. March 21.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

United States Bureau of Reclamation (USBR). 2008. Reclamation Managing Water in the West. Resource Management Plan, Box Butte Reservoir, Nebraska, Great Plains Region. November.

United States Geological Survey (USGS). 2011a. Water Resources of the United States. What are Hydrologic Units? October 28, 2011. [Web Page]. Located at: http://water.usgs.gov/GIS/huc.html. Accessed on: August 22, 2011.

USGS. 2011b. Water Resources of the United States. Boundary Descriptions and Names of Regions, Subregions, Accounting Units and Cataloging Units. October 28, 2011. [Web Page]. Located at: http://water.usgs.gov/GIS/huc_name.html#Region10. Accessed on: August 22, 2011.

Worley Parsons Resources and Energy (Worley Parsons). 2010. Regional Pumping Test Plan Crow Butte Marsland Expansion Area. September 27.

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

Section 3.5 Ecological Resources

Abegglen, J. 2011. Wildlife Biologist, U.S. Forest Service, Nebraska National Forest. Personal communication with Hayden-Wing Associates, June 7, 2011.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Chapman, S.S., Omernik, J.M., Freeouf, J.A., Huggins, D.G., McCauley, J.R., Freeman, C.C., Steinauer, G., Angelo, R.T., and Schlepp, R.L. 2001. Ecoregions of Nebraska and Kansas. [Web page]. Located at: ftp:/ftp.epa/gov/wed/ecoregions/ks/ksne_front.pdf. Accessed on: February 24, 2011.

Crow Butte Resources (CBR). 2007. Application for amendment of USNRC source materials license SUA-1534, North Trend Expansion Area, Technical Report – Volume I.

CBR. 2010. Application for amendment of USNRC source materials license SU-1534, Three Crow Expansion Area, Crawford, Nebraska. Technical Report – Volume I.

Ferraro, J. 2011. Extension Associate Professor and Herpetologist, School of Natural Resources, University of Nebraska-Lincoln. Personal communication with Hayden-Wing Associates, June 10, 2011.

Fitzgerald J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History, Denver, Colorado.

Fogell, D.D. 2010. A field guide to the amphibians and reptiles of Nebraska. University of Nebraska-Lincoln. Conservation and Survey Division, School of Natural Resources. May 2010.

Hayden-Wing Associates (HWA). 2011. Ecological Resources Summary: Technical Report for Cameco Resources – 2011. Marsland Expansion Area Uranium Project, Dawes County, Nebraska. Prepared for Cameco Resources by Hayden-Wing Associates, Laramie, Wyoming.

National Oceanic and Atmospheric Administration and University of Nebraska-Lincoln. 2011. High Plains Regional Climate Center Historical Climate Data Summaries. [Web Page]. Located at: http://www.hprcc.unl.edu/data/historical/. Accessed on November 9, 2011.

National Park Service (NPS). 2002. Agate Fossil Beds National Monument, Fish. [Web Page]. Located at: http://www.nps.gov/agfo/naturescience/fish.htm. Accessed on: July 21, 2011.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life. Version 7.1. NatureService, Arlington, Virginia. [Web Page]. Located at: http://www.natureserve.org. Accessed on: July 18, 2011.

Nebraska Game and Parks Commission (NGPC). 2008a. Annual Performance Report: 2008-09. U.S. Department of Interior Fish and Wildlife Service, Sportfish and Wildlife Restoration Program, Wildlife Surveys and Inventories, Project W-15-R, Segment 65. Nebraska Game and Parks Commission, Wildlife Division, Lincoln, Nebraska.

NGPC. 2008b. Estimated Current Ranges of Threatened and Endangered Species: List of Species by County. Nebraska Natural Heritage Program and Nebraska Game and Parks Commission, Lincoln, Nebraska. Referenced in Table 3.5-3.

NGPC. 2009. Range Maps for Nebraska's Threatened and Endangered Species. Nebraska Game and Parks Commission, Nebraska Natural Heritage Program, Lincoln, Nebraska.

NGPC. 2010. 2010 Big Game Guide. Nebraska Game and Parks Commission, Lincoln, Nebraska.

NGPC. 2011a. Wildlife Species Guide. Nebraska Game and Parks Commission, Lincoln, Nebraska. [Web Page]. Located at: http://outdoornebraska.ne.gov/wildlife/wildlife_species_guide/NEwildlife.asp. Accessed on: July 14, 2011.

NGPC. 2011b 2011 Big Game Guide. Nebraska Game and Parks Commission, Lincoln, Nebraska.

NGPC. 2011c. Big Game Hunting Guide, Buck Harvest Summary. Nebraska Game and Parks Commission, Lincoln, Nebraska. [Web Page]. Located at: http://outdoornebraska.ne.gov/hunting/guides/biggame/buckharvest.asp. Accessed on: July 14, 2011.

NGPC. 2011d. Whitetail and Mule Deer Hunting. Nebraska Game and Parks Commission, Lincoln, Nebraska. [Web Page]. Located at: http://outdoornebraska.ne.gov/hunting/guides/biggame/deer/BGdeer.asp. Accessed on: July 14, 2011.

NGPC. 2011e. Elk Hunting. Nebraska Game and Parks Commission, Lincoln, Nebraska. [Web Page]. Located at: http://outdoornebraska.ne.gov/hunting/guides/biggame/elk/BGelk.asp. Accessed on: July 14, 2011.

NGPC. 2011f. Bighorn Sheep Hunting. Nebraska Game and Parks Commission, Lincoln, Nebraska. [Web Page]. Located at: http://outdoornebraska.ne.gov/hunting/guides/biggame/bighorns/BGbighorns.asp. Accessed on: July 14, 2011.

Nebraska Ornithologists Union (NOU). 2011. Nebraska Ornithologists' Union. [Web Page]. Located at: http://www.noubirds.org. Accessed on: February 24, 2011.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. Species List, North American Breeding Bird Survey Route, Crawford. U.S. Geological Survey Patuxent Wildlife Research Center, Laurel, Maryland. [Web Page]. Located at: http://www.mbr-pwrc.usgs.gov/cgi-bin/rtena226.pl?54044. Accessed on: July 21, 2011.

Schauster E. R., E. M. Gese, and A. M. Kitchen. 2002. Population ecology of swift foxes (*Vulpes velox*) in southeastern Colorado. Canadian Journal of Zoology 80:307-319.

Stephens, R. M. and S. H. Anderson. 2005. Swift fox (Vulpes velox): A technical conservation assessment. USDA Forest Service, Rocky Mountain Region. [Web Page]. Located at: http://www.fs.fed.us/r2/projects/scp/assessments/swiftfox.pdf. Accessed on: July 18, 2011.

Troester, B. 2011. Landowner. Personal communication with Hayden-Wing Associates, June 2011.

U.S. Army Corps of Engineers (USACE). 2008. Interim regional supplement to the Corps of Engineers wetland delineation manual: Great Plains region. J. S. Wakeley, R. W. Lichvar, and C. V. Noble, eds. ERDC/EL TR-08-12. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

U.S. Fish and Wildlife Service (USFWS). 2011a. Birds Protected by the Migratory Bird Treaty Act. U.S. Fish and Wildlife Service, Migratory Bird Program. Updated April 11, 2011. [Web Page]. Located at: http://www.fws.gov/migratorybirds/ RegulationsPolicies/mbta/mbtintro.html. Accessed on: July 14, 2011.

USFWS. 2011b. Endangered, Threatened, Proposed, and Candidate Species in Nebraska Counties. U.S. Fish and Wildlife Service, Ecological Services, Nebraska Field Office, Grand Island, Nebraska.

USFWS. 2011c. Whooping Crane Tracking Project Database. Cooperative Whooping Crane Tracking Project, U.S. Fish and Wildlife Service, Nebraska Field Office, Grand Island, Nebraska.

USFWS. 2011d. Endangered and Threatened Wildlife and Plants; Reissuance of Final Rule to Identify the Northern Rocky Mountain Population of Gray Wolf as a Distinct Population Segment and to Revise the List of Endangered and Threatened Wildlife. Federal Register 76(87): 25590-25592.

USFWS. 2011e. National Wetlands Inventory. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. [Web Page]. Located at http://www.fws.gov/wetlands/. Accessed on: July 21, 2011.

Western Regional Climate Center (WRCC). 2011. Chadron 1 NW, Nebraska. [Web Page]. Located at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ne1575. Accessed on: July 13, 2011.

Wyoming Fuel Company (WFC). 1983. Application and Supporting Environmental Report for Research and Development Source Material License, February 11, 1983.

3.6 Climate and Meteorology

3.7 Noise

Argonne National Laboratory. (ANL). 1998. National Assessment Division. MILDOS-AREA User's Guide (Draft). September.

Cameco Resources. 2011. Marsland Expansion Area On-Site Meteorological Monitoring Data. 2011. August 24, 2010 through August 29, 2011.

Curtis, J. and K. Grimes. 2007. Wyoming Climate Atlas. [Web page] Located at: http://www.wrds.uwyo.edu/wrds/wsc/climateatlas/. Accessed on: May 2.

Jensen, M.E., R. D. Burman, and R. G. Allen 1990. Evapotranspiration and Irrigation water Requirements, ASCE manuals and Reports on Engineering Practice NO.70 American Society of Civil Engineers NY 1-332.

National Climatic Data Center (NCDC). 2011. Surface Data, Monthly Extremes. Located at: http://gis.ncdc.noaa.gov/website/ims-cdo/extmo/viewer.htm?Box=-110.307738654357:41.4493000825986:-102.349767058746:45.2536595444503. Accessed on July 5, 2011.

National Oceanic and Atmospheric Administration and University of Nebraska-Lincoln. 2010. High Plains Regional Climate Center (HPRCC). [Web Page]. Located at: http://www.hprcc.unl.edu/. Accessed on: March 19, 2010.

National Oceanic and Atmospheric Administration and Desert Research Institute. 2011. Western Regional Climate Center (WRCC). [Web Page]. Located at: http://www.wrcc.dri.edu/. Accessed on: July 5, 2011.

National Renewable Energy Laboratory (NREL). 1990. "Solar Radiation for Flat-Plate Collectors Facing South at a Fixed-Tilt," 30-year (1961-1990) averages for Scottsbluff, Nebraska. Located at: http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/sum2/24028.txt. Accessed on July 5, 2011

Nebraska Department of Environmental Quality (NDEQ). 2003. Environmental Fact Sheet: Establishing Air Quality Regulations in Nebraska. [Web Page]. Located at: http://www.deq.state.ne.us/. Accessed on: July 5, 2011.

NDEQ. 2011. NDEQ 2010 Ambient Air Monitoring Network Plan and 5 Year Assessment. [Web Page]. Located at: http://www.deq.state.ne.us/. Accessed on: November 9, 2011.

South Dakota Department of Environment & Natural Resources (SD DENR). 2011. South Dakota Ambient Air Monitoring Annual Network Plan 2009. [Web Page]. Located at: http://denr.sd.gov/des/aq/aqnews/South%20Dakota%20AP2009.pdf. Accessed on: November 9, 2011.

U.S. Environmental Protection Agency (EPA). 2010a. Airdata: Access to Air Pollution Data. Monitor Values Report - Criteria Air Pollutants – South Dakota. [Web Page]. Located at: http://epa.gov/air/data/monvals.html?st~SD~South%20Dakota. Accessed on: March 19, 2010.

EPA. 2010b. Airdata: Access to Air Pollution Data. Monitor Values Report - Criteria Air Pollutants – Nebraska. [Web Page]. Located at: http://epa.gov/air/data/monvals.html ?st~SD~South%20Dakota. Accessed on: March 19, 2010.

EPA. 2011. EPA Memorandum from Gina McCarthy, Assistant Administrator to Air Division Directors, Regions I-10 Regarding Implementation of the Ozone National Ambient Air Quality Standard. September 22. (Table 3.6-19 and 3.6-20)

EPA. 2012. Implementation of the 2008 National Air Quality Standards for Ozone: Nonattainment Area Classifications Approach. Attainment Deadlines and Revocation of the 1997 Ozone Standards for Transportation Conformity Purposes. Federal Register Volume 77, No. 30, pp. 8197-8209. February 14.

EPA. 2013. Air and Radiation. National Ambient Air Quality Standards (NAQQS). [Web Page]. Located at: http://www.epa.gov/air/criteria.html. Accessed on: May 06, 2013. (Table 3.6-20).

United States Geological Survey (USGS). 2009. Geomorphic Segmentation, Hydraulic Geometry, and Hydraulic Microhabitats of the Niobrara River, Nebraska – Methods and Initial Results.

Section 3.8 Historic and Cultural Resources

Graves, Natalie. 2011. Submittal letter to Terry Steinacher, Nebraska State Historical Society for Marsland Expansion Area Uranium Project, Cultural Resource Inventory. April 28.

Graves, Adam, Natalie Graves, Maureen Boyle, and Ashley Howder. 2011. Marsland Expansion Area Uranium Project Cultural Resource Inventory. ARCADIS U.S., Inc., Buffalo, Wyoming. Prepared for Cameco Resources, Crawford, Nebraska. 152 pages plus attachments. April.

Graves, Natalie and Graves, Adam. 2012. Marsland Expansion Area Uranium Project. Prepared for Cameco Resources, Crawford, Nebraska. Addition. 11 pages plus attachments. March.

Nebraska State Historical Society (NSHS). 2012. Letter from Terry Steinacher, H.P. Archaeologist (concurrence by L. Robert Puschendorf, Deputy NeSHPO) to Natalie Graves, Field Director, Project Archaeologist, Regarding Marsland Expansion Addition, Dawes County, NE H.P. #1105-021-01. March.

Santee Sioux Nation. 2013. Tribal Historic Preservation Office. Niobrara, Nebraska. Crow Butte Project, Dawes County Crawford, Nebraska.

U.S. Nuclear Regulatory Commission. (NRC). 2013. Letter from U.S. Nuclear Regulatory Commission to Tribal Historic Preservation Officer Regarding Update of Section 106 Consultation for the Proposed Crow Butte In-Situ Uranium recovery (ISR) License Renewal, North Trend, Marsland and Three Crow Projects. January 3.

Section 3.9 Visual/Scenic Resources

U.S. Department of .Interior. Bureau of Land Management (BLM). 1986a. Visual Resource Inventory. BLM Manual Handbook 8410-1.

BLM. 1986b. Visual Resource Contrast Rating. BLM Manual Handbook 8431-1.

Section 3.10 Population Distribution

Advameg, Inc. 2010. Crawford, Nebraska. [Web Page]. City-Data.com. Located at: http://www.city-data.com/city/Crawford-Nebraska.html. Accessed on: February 25, 2010.

Bureau of Economic Analysis (BEA). 2011. Personal Income and Per Capita Income by County for Nebraska 2005-2007. [Web Page]. Located at: http://www.bea.gov/regional/reis/. Accessed on: August 11, 2011.

Chadron State College. (CSC). 2010a. Student Enrollment Information. [Web Page]. Located at: http://www.csc.edu/ir/enrollment.csc. [225, 2006 and 2007 data]. Accessed on: February 25, 2010.

CSC. 2010b. Enrollment Quick Facts. [Web Page]. Located at: http://www.csc.edu/ir/quickfacts.csc. [2008 data]. Accessed on: February 25, 2010.

Haag, Justin. 2012. CSC Information Services. Rapid City Journal. January 10.

Nebraska's Coordinating Commission for Postsecondary Education (NCCPE). 2005. 2005 Nebraska Higher Education Progress Report for the LR75 Legislative Evaluation Task Force: Volume One. [Web Page] Located at: http://www.ccpe.state.ne.us/publicdoc/ccpe/reports/LR174/2005/default.asp. Accessed on: February 25, 2010.

Nebraska Department of Economic Development (NDED). 2010. Projected Nebraska Farm and Nonfarm Employment 1998 to 2045. [Web Page]. Located at: http://www.neded.org/files/research/stathand/csecc3.gif. Accessed on: January 15, 2010.

NDED. 2011. Tourism and recreation. [Web Page]. Located at: http://www.neded.org/search-ne-ded?q=recreational+area+attendance. Accessed on: November 21, 2011.

Nebraska Department of Education (NDE). 2011a. 2009-2010 State of the Schools Report. [Web Page]. Located at: http://reportcard.education.ne.gov. Accessed on: June 2011.

NDE. 2011b. Education Directory Search. [Web Page]. Located at: http://educdirsrc.education.ne.gov/default.aspx. Accessed on: November 21, 2011.

Nebraska Department of Labor (NDOL). 2010. Labor Force/Work Force Summaries. [Web Page]. Located at: http://www.dol.nebraska.gov/nwd/center.cfm?PRICAT=3&SUBCAT=4F. Accessed on: February 26, 2010.

Nebraska Department of Revenue Property Assessment Division (NE Revenue). 2010. Reference List of All Individual Taxing Subdivisions & Tax Rates for Tax Year 2010. Available at: http://www.revenue.ne.gov/PAD/research/valuation/tax_entity_all/taxentity_allcnty2010.pdf.

Nebraska Department Property Assessment and Taxation. (NDPA&T). 2010. Research Reports [Valuation, Taxes Levied, & Tax Rate Data]. [Web Page]. Located at: http://pat.nol.org/researchReports/map/index.html. Accessed on: February 25, 2010.

Nebraska Public Power District (NPPD). 2011. Community Facts – Crawford Nebraska. 48 pg.

The Chadron Record. (TCR). 2010.

U.S. Department of Commerce, Census Bureau (USCB). 1990a. 1990 Census of Population and Housing – Population and Housing Counts - Nebraska. CPH-2-29. [Web Page] Located at: http://www.census.gov/prod/cen1990/cph2/cph-2.html.

USCB. 1990b. 1990 Census of Housing – General Housing Characteristics - Nebraska. CH-1-29. [Web Page] Located at: http://www.census.gov/prod/cen1990/ch1/ch-1.html.

USCB. 2000a. Census 2000 Summary File 1 (SF 1) 100-Percent Data. All Blocks in a County – Dawes County, Nebraska. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet. Accessed on: February 25, 2010.

USCB. 2000b. Census 2000 Summary File 1 (SF 1) 100-Percent Data. All Blocks in a County – Sioux County, Nebraska. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet. Accessed on: February 25, 2010.

USCB. 2001. Census of Population and Housing – Profiles of General Demographic Characteristics – Nebraska. DP-1-29. Issued May 2001. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html.

USCB. 2003a. 2000 Census of Population and Housing - Population and Housing Unit Counts - Nebraska. PHC-3-29. Issued September 2003. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html.

USCB. 2003b. 2000 Census of Population and Housing - Population and Housing Unit Counts – South Dakota. PHC-3-43. Issued September 2003. [Web Page] Located at: http://www.census.gov/prod/cen2000/index.html.

USCB. 2003c. 2000 Census of Population and Housing – Summary Population and Housing Characteristics - Nebraska. PHC-1-29. Issued September 2003. [Web Page]. Located at: http://www.census.gov/prod/cen2000/index.html.

USCB. 2009a. 2008 Population Estimates – County Characteristics. [Web Page]. Located at: http://www.census.gov/popest/counties/asrh/CC-EST2008-agesex.html. Accessed on: February 27, 2010.

USCB. 2009b. Download Center - 2008 Population Estimates. [Web Page]. Located at: http://factfinder.census.gov/servlet/DCGeoSelectServlet?ds_name=PEP_2008_EST. Accessed on: December 20, 2009.

USCB. 2010a. Dawes County, Nebraska – Quick Facts. [Web Page]. Located at: http://quickfacts.census.gov/qfd/states/31/31045.html. Accessed on: February 27, 2010.

USCB. 2010b. Box Butte County, Nebraska – Quick Facts. [Web Page]. Located at: http://quickfacts.census.gov/qfd/states/31/31013.html. Accessed on: February 27, 2010.

USCB. 2011. 2010 SF1 100% Data. [Web Page]. Located at: http://factfinder2.census.gov Accessed on: September 2011

Universities.com. 2010. Chadron State College. [Web page]. Located at: http://www.universities.com/edu/Chadron_State_College.html.

University of Nebraska, Bureau of Business Research (UNL-BBR). 2009. Population Projections of Nebraska, 2000-2020. [Web Page]. Located at: http://www.bbr.unl.edu/PopProjections. Accessed: on December 20, 2009.

University of Nebraska Rural Initiative (UNRI). 2008. Nebraska Population Growth Continues to be Concentrated in Metropolitan Counties. 4 pg. [Web Page]. Located at: http://ruralinitiative.nebraska.edu/growth/index.html.

Vogl, B. 2010. Personal communication with Jason Adams [ARCADIS] via phone regarding school capacities. February 26, 2010.

Wyoming Department of Administration and Information, Economic Analysis Division. 2009. Wyoming Population Estimates and Forecasts from 2000 to 2030. [Web Page]. Located at: http://eadiv.state.wy.us/pop/wyc&sc30.htm. Accessed on: February 26, 2010.

Section 3.12 Waste Management

Aqui-Ver, Inc. 2011. Marsland Hydrologic Testing Report – Test #8. Marsland Expansion Area, Dawes County, NE, Final Report. July 8.

Aqui-Ver, Inc. 2013. Letter Report from Robert L. Lewis, P.G., Principal Hydrogeologist to Doug Pavlick and John Schmuck, Crow Butte Resources, Crawford, NE Regarding Hydraulic containment analysis for the Marsland Expansion Area. May 30.

Crow Butte Resources and Dension Mines (USA) Corporation (CBR and DUSA). 2010. Byproduct Disposal Agreement for Disposal of CBR Byproduct Waste at White Mesa Mill. June 1.

Environmental Simulations, Inc. (ESI). 1999. AquiferWin32/WinFlow/WinTran Version 3.Nebraska Department of Environmental Quality (NDEQ). 2010a. Title 119, Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System.

NDEQ. 2010b. Title 122, Rules and Regulations for Underground Injection and Mineral Production Wells.

NDEQ. 2010c Title 124, Rules and Regulations for the Design, Operation, and Maintenance of On-site Wastewater Treatment Systems.

NDEQ. 2010d. Title 128, Nebraska Hazardous Waste Regulations.

U.S. Environmental Protection Agency (EPA). 2002. Onsite Wastewater Treatment Systems Manual. EPA/625/R-00/008. February.

U.S. Nuclear Regulatory Commission (NRC). 2001. RG/CR-6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licensees. (September 2001).

NRC. 2002. Regulatory Guide 8.31, Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable (Revision 1, May 2002).

Schmuck, J. 2014. Email to Jack Cearley, Project Director, ARCADIS-US, Inc., Highlands Ranch, CO., Regarding Environmental Report Update. March 27. [Source for Table 1.3-7].

Section 4.0 Environmental Impacts

4.1 Land Impacts

Compressed Gas Association (CGA). 1996. Cleaning Equipment for Oxygen Service. 30 pp. September 22.

National Agricultural Statistics Service (NASS). 2009 Census of Agriculture Volume 1 Chapter 2: Nebraska County Level Data. Issued February, 2009. [Web Page]. Located at: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/index.asp. Accessed on: December 21, 2009.

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web page]. Located at: http://www.dor.state.ne.us/mnaps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: November 19, 2011.

4.2 Transportation Impacts

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web Page]. Located at: http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: June 05, 2013.

4.3 Geologic Impacts

ARCADIS-US, Inc. (ARCADIS). 2012. Hydrologic and Erosion Study, Marsland Expansion Area. April 12.

ARCADIS. 2013. Hydrologic and Flood Study, Marsland Expansion Area. May.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). 1977. Soil Survey of Dawes County Nebraska. USDA, NRCS, in cooperation with University of Nebraska Conservation and Survey Division. Issued February 1977.

4.4 Water Resource Impacts

NDEQ. 2005. Title 119 – Rules and Regulations Pertaining to the Issuance of Permits under the National Pollutant Discharge Elimination System, May 16, 2005.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

4.5 Ecological Resource Impacts

Hayden-Wing Associates, LLC (HWA). 2012. Ecological Resources Summary: Technical Report for Cameco Resources – 2011 Proposed Marsland Expansion Area Uranium Project Dawes County, Nebraska. February.

4.6 Air Quality Impacts

On Road Mobile Emission Factors from California ARB EMFAC2002 Scenario Year 2004 (Model Years A11965 to 2004). 2013. [Web Page]. Located at: http://www.google.com/advanced_search?hl=en&authuser=0, exact word search: CE-Emission-Factor-Calcs. Accessed: August 7, 2013.

California Environmental Protection Agency Air Resources Board. 2013. EMFAC, [Web Page]. California Environmental Protection Agency Air Resources Board, Located at: http://www.epa.arb.ca.gov/msei/msei.htm. Accessed: August 7, 2013.

Nebraska Department of Environmental Quality (NDEQ). 2011. Guidance Documents. Potential Emission Calculation Spreadsheets; Calculate Potential Haul Road Emissions. September 9. [Web Page]. Located at: http://www.deq.state.ne.us/. Accessed on: July 31, 2013.

U.S. Environmental Protection Agency (EPA). 1978. Supplement No. 8 for Compilation of Air Pollutant Emission Factors Third Edition (Including Supplements, 1-7). Research Triangle Park, North Carolina, May 1978.

EPA. 2006. Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors [Web Page]. U.S. Environmental Protection Agency. Section 13.2.2, Unpaved Roads, November, Located at: http://www.epa.gov/ttnchie1/ap42/. Accessed: August 7, 2013.

EPA. 2011. Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors [Web Page]. U.S. Environmental Protection Agency. Section 13.2.1, Paved Roads, January, Located at: http://www.epa.gov/ttnchie1/ap42/. Accessed: August 7, 2013.

U.S. Nuclear Regulatory Commission (NRC). 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. RG – 1910. Washington, D.C. May 2009.

4.7 Noise Impacts

U.S. Department of the Interior, Bureau of Land Management (BLM). 2005. Jonah Infill Drilling Project Air Quality Impact Analysis. Supplemental Draft Environmental Impact Statement. Pinedale and Rock Springs Field Offices. August 2005. DES-05-05.

U.S. Nuclear Regulatory Commission (NRC). 2009. Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities. RG – 1910. Washington, D.C. May 2009.

4.8 Historical and Cultural Resources Impacts

Graves, Adam, Natalie Graves, Maureen Boyle, and Ashley Howder. 2011. Marsland Expansion Area Uranium Project Cultural Resource Inventory. ARCADIS U.S., Inc., Buffalo, Wyoming. Prepared for Cameco Resources, Crawford, Nebraska. 152 pages plus attachments. April.

4.10 Social and Economic Impacts

Bureau of Economic Analysis (BEA). 2011. Personal Income and Per Capita Income by County for Nebraska 2005-2007. [Web Page]. Located at: http://www.bea.gov/regional/reis/. Accessed on: August 18, 2011.

U.S. Department of Labor, Bureau of Labor Statistics (BLS). 2011. Labor Force Data by County, Not Seasonally Adjusted, November 2008-December 2009. [Web Page]. Located at: http://www.bls.gov/lau/laucntycur14.txt. Accessed August 18, 2011.

Ux Consulting Company, The (UxC). 2011. Ux Weekly. [Web Page]. Located at: http://www.uxc.com/review/uxc Prices.aspx. Accessed on: October 19, 2011.

4.12 Public and Occupational Health Impacts

Brechignac, F. 2002. Protection of the environment: how to position radioprotection in an ecological risk assessment perspective. The Science of the Total Environment: 307 (2003), p. 34-35.

Center for Nuclear Waste Regulatory Analyses (CNWRA). 2001. RG/CR–6733, A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses.

City-Data.com. 2012. Dawes County, Nebraska (NE). [Web Page]. Located at: http://www.city-data.com/county/Dawes_County-NE.html. Accessed on: March 8, 2013.Compressed Gas Association, Inc. (CGA). 1996. CGA-G-4.1, Cleaning Equipment for Oxygen Service.

CBR. 2012. Letter from Larry Teahon, Manager, Safety, health, Environment and Quality, Crow Butte Operation to Document Control Desk, Deputy Director, Decommissioning and Uranium recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. Nuclear Regulatory Commission Regarding Evacuation Due to Threatening Wildfires. September 11.

Ferret Exploration Company of Nebraska, Inc. (Ferret). 1987. Application and Supporting Environmental Report for NRC Commercial Source Material License. September, 1987.

International Commission on Radiological Protection (ICRP). 1977. Recommendations of the International Commission on Radiation Protection. Publication 26. Pergamon Press, Oxford.

ICRP. 1991. Recommendations of the International Commission on Radiation Protection. Publication 60. Annals of the ICRP 21. Pergamon Press, Oxford.

ICRP. 2010. Annals of the ICRP, Environmental Protection: Transfer parameters for Reference Animals and Plants. ICRP ref 4871-0544-3078. June.

National Oceanic and Atmospheric Administration (NOAA). 2012, National Climatic Data Center Storm Events Database: Nebraska. 2012. [Web Page]. Located at: http://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=31%2CNEBRASKA. Accessed on: March 07, 2013.

Savignac, N. 2013. MILDOS-AREA Radiation Doses from Cameco Resources Marsland Expansion Area In-Situ Recovery Operation. September 24.

USA.com. 2013. Dawes County Natural Disasters and Weather Extremes – Tornado Index. [Web Page]. Located at: http://www.usa.com/dawes-county-ne-natural-disasters-extremes.htm#TornadoIndex. Accessed on: March 07, 2013.

U.S. Nuclear Regulatory Commission. (NRC). 1980. RG–0706, Final Generic Environmental Impact Statement on Uranium Milling—Project M–25. September 1980.

NRC. 1997. RG—1508, Final Environmental Impact Statement to Construct and Operate the Crown Point Uranium Solution Mining Project, Crown Point, New Mexico. 1997.

NRC. 2000. RG/CR—6672, Reexamination of Spent Fuel Shipment Risk Estimates. SAND2000—0234, 2000.

4.14 Cumulative Effects

Bureau of Economic Analysis (BEA). 2011. Personal Income and Per Capita Income by County for Nebraska 2005-2007. [Web Page]. Located at: http://www.bea.gov/regional/reis/. Accessed on: August 11, 2011.

Crow Butte Resources, Inc. (CBR). 2007. Application for 2007 License Renewal, Crow Butte License Area. October 2007.

CBR. 2010. Application for Amendment of USNRC Source Materials License SUA-1534 Three Crow Expansion Area, Crawford, NE, Environmental Report, Volume I. ML102220278.

CBR. 2012. Application for Amendment of NRC License Source Materials License SUA-1534 Marsland Expansion Area, Crawford, NE, Environmental Report, Volume I.. ML12160A513.

National Agricultural Statistics Service (NASS). 2009. Census of Agriculture Volume 1 Chapter 2: Nebraska County Level Data. Issued February, 2009. [Web Page]. Located at: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/index.asp. Accessed on: July 2011.

NASS. 2013 Census of Agriculture Volume 1 Chapter 2: Nebraska County Level Data. Issued February, 2009. [Web Page]. Located at: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Nebraska/index.asp. Accessed on: June 17.

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web Page]. Located at: http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: November 19, 2011.

Nebraska Energy Office. (NEO). 2013. 2012 Annual Report. [Web Page]. Located at: http://www.neo.ne.gov/annual_rept/NEOAnnualReport.pdf. Accessed on: June 5, 2013.

Nebraska Oil and Gas Conservation Commission. (NOGCC). 2013a. Well Data – Access 2003 Format (12/20/2012). [Web page]. Located at: http://www.nogcc.ne.gov/NOGCCPublications.aspx. Accessed on: May 23.

NOGCC. 2013b. Email from NOGCC (nogcc@nogcc.ne.gov) to Jack Cearley, Project Director, ARCADIS-US, Inc., Highlands Ranch, CO. Regarding online information request response from NOGCC as to any active producing oil and gas wells in Dawes County, NE. May 23.

NOGCC. 2013c. Annual Activity Summaries 2005 – 2012. [Website]. Located at: http://www.nogcc.ne.gov/. Accessed on: May 16, 2013.

NOGCC. 2013d, Monthly Activity Summaries. [Web page]. Located at: http://www.nogcc.ne.gov/NOGCCPublications.aspx. May 16.

Petrotek. 2002. Groundwater Pumping Test #4 Data Evaluation Report. Crow Butte Resources, Inc. October 2002.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

U.S. Nuclear Regulatory Commission. (NRC). 2009. Generic Environmental Effect Statement for In-Situ Leach Uranium Milling Facilities (NUREG-1910) Prepared by U.S. Nuclear Regulatory Commission, Office of Federal and State Materials and Environmental Management Programs and Wyoming Department of Environmental Quality Land Quality Division. Published May 2009. [Web Page] Located at: http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/. Accessed on: March 1, 2013.

Section 5.0 Mitigation Measures

American National Standards Institute (ANSI). 1999. ANSI/HPS N13.12, Surface and Volume Radioactivity Standards for Clearance.

Crow Butte Resources and Dennis Mines (USA) (DUSA) Corporation (CBR and DUSA). 2010. Byproduct Disposal Agreement for Disposal of CBR Byproduct Waste at White Mesa Mill. June 1.

Nebraska Department of Environmental Quality (NDEQ). 2006. Title 118 – Ground Water Quality Standards and Use Classification, March 27, 2006. Referenced on Table 5.4-1.

Powertech (USA) Inc. 2009. Dewey-Burdock Project Underground Injection Control Permit Application. Prepared for South Dakota Department of Environmental & Natural Resources. April.

U.S. Nuclear Regulatory Commission (NRC). 2000. Multi-Agency Radiation Survey and Site Investigation Manual, NUREG-1575, Rev. 1. August.NRC. 2003. Standard Review Plan for In Situ Leach Uranium Extraction License Applications. Final Report. NUREG-1569. June.

NRC. 2004. Multi-Agency Radiological Laboratory Analytical Protocols Manual. RG-1576. July 2004.

NRC. 2012. Letter from Keith I. McConnell, Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, US Nuclear Regulatory Commission to Thomas P. Young, Vice-President of Operations, Cameco Resources Regarding License Amendment No. 26 Regarding 2011 Surety Update, Crow Butte Resources Inc., Crawford, Nebraska, Source Materials License SUA-1534 (TAC No. J00634). March 6.

Section 6 Environmental Measurements and Monitoring Programs

Alexander, J.S., Zelt, R.B., and Schaepe, N.J. 2010. Hydrogeomorphic Segments and Hydraulic Microhabitats of the Niobrara River, Nebraska – With Special Emphasis on the Niobrara National Scenic River, U.S. Geological Survey Scientific Investigations Report 2010-5141, 62 p.

Aqui-Ver, Inc. 2011. Marsland Regional Hydrologic Testing Report – Test #8, Crow Butte Project, Marsland Expansion Area.

Crow Butte Resources, Inc. (CBR). 2010. Safety, Health, Environment and Quality Management System, Volume VI, Environmental Manual.

Energy Laboratories, Inc. (ELI). 2012. Letter from Steve Dobbs, Client Services Supervisor, ELI to Rhonda Grantham, Supervisor Radiation Safety & Regulatory Affairs/RSO, Crow Butte Resources, Inc. Regarding NRC Regulatory Guide 4.14 Lower Limits of Detection for the Marsland Baseline Samples. April 23.

Engberg, R.A. and Spalding, R.F. 1978. Groundwater quality atlas of Nebraska: Lincoln, University of Nebraska—Lincoln, Conservation and Survey Division Resource Atlas No.3, 39 p.

Elsenbud, M. 1987. Environmental radioactivity: from natural, industrial and military sources (3rd ed.). Academic Press Inc., Fl. (as cited by the Government of Ontario in Appendix IV. Fish Tissue Analysis and Work Plan [Web Page]. Located at: http://www.ene.gov.on.ca/envision/techdocs/4022App_IV.htm\. Accessed on: March 26, 2010.

Hayden, T. 2011. Supervisor, Nebraska Department of Natural Resources, Bridegeport, NE. Personal communication [August 23 telephone conversation with Jack Cearley, Project Director, ARCADIS-US, Inc., Highlands Ranch, Co., Regarding availability of water quality data on the Upper Niobrara River]. August 23.

Ihrie, D. 2011. Personal communication [September 15 email to J. Cearley, ARCADIS-US, Inc., Highlands Ranch, Colorado Regarding Request for Niobrara River Water Quality Data]. Planning Section, Water Division, NDEQ, Lincoln, NE. 2 pages. Referenced in Table F.1-13.

Ihrie, D. 2013a. Personal communication [July 24 email to J. Cearley, ARCADIS-US, Inc., Highlands Ranch, Colorado Regarding Request for Niobrara River Water Quality Data]. Planning Section, Water Division, NDEQ, Lincoln, NE. 9 page.

Ihrie, D. 2013b. Personal communication [July 24 email to J. Cearley, ARCADIS-US, Inc., Highlands Ranch, Colorado Regarding Request for Niobrara River Water Quality Data]. Planning Section, Water Division, NDEQ, Lincoln, NE. 6 pages.

Landauer, Inc. (Landauer). 2010. OSL Applications. [Web Page]. Located at: http://www.landauer.com/National_Security/Technology/OSL_Applications.aspx. Accessed on: July 10, 2010.

Lindeman, G.H. 2011. Personal communication [July 27 email to J. Cearley, ARCADIS U.S., Inc., Highland Ranch, Colorado Regarding Niobrara River Flow Measurements. Nebraska Department of Natural Resources, Lincoln, Nebraska. 1 p. Referenced on Table 6.1-14.

Nebraska Department of Environmental Quality (NDEQ). 2005. Total Maximum Daily Loads for the Niobrora River Basin. Perimeter of Concern: E. coli Bacteria. December.

NDEQ. 2010. Water Quality Integrated Report. April 01.

NDEQ. 2011a. 2010 Nebraska Water Monitoring Programs Report. January.

NDEQ 2011b. Ihre, D. Personal communication [September 15 email to J. Cearley, ARCADIS-US, Inc., Highlands Ranch, Colorado Regarding Request for Niobrara River Water Quality Data]. Planning Section, Water Division, NDEQ, Lincoln, NE. 1 page. Referenced on Table 6.1-14.

NDEQ 2012. 2012 Water Quality Integrated Report. Nebraska Department of Environmental Quality, Water Quality Division. April 1.

Nebraska Department of Natural Resources. (NDNR). 2011. Data Bank. Department of Natural Resources Stream Gaging [Web Page]. Located at: http://dnr.ne.gov/docs/hydrologic.html. Accessed on: July 14, 2011.

NDNR. 2013. DNR Annual Hydrographic Report and Station List. [Web Page]. Located at: http://dnr.ne.gov/Publications/HydroReportStation.html. Accessed on: April 28, 2013. NOTE: Site under construction, so more recent reports not available.

NDNR. 2013b. Registered Groundwater Wells Data Retrieval. [Web Page]. Located at: http://dnrdata.dnr.ne.gov/wellscs/Menu.aspx. Accessed on: September 6, 2013.

Powertech (USA) Inc. 2011. Dewy-Burdock Application for NRC Uranium Resource License, Fall River and Custer Counties, South Dakota, Technical Report RAI Responses Volume I of 4-29 – References, Background Characteristics. June 30. ML11208B714.

Savignac, N. 2013. MILDOS-AREA Radiation Doses from Cameco Resources Marsland Expansion Area In-Situ Recovery Operation. September 24.

Shaffer, F.B. 1975. History of irrigation and characteristics of streamflow in northern Nebraska: USGS Open-File Report 75-01, 114 p. Referenced in: Alexander et al 2010.

U.S. Bureau of Reclamation (USBR). 2008. Reclamation Managing Water in the West. Resource Management Plan, Box Butte Reservoir, Nebraska, Great Plains Region. November.

USBR. 2011a. Mirage Flats Project. [Web Page]. Located at: http://www.usbr.gov/projects/Project.jsp?proj_Name=Mirage%20Flats%20Project. Accessed on: August 8, 2011.

USBR. 2011b. Hydromet: ARC050 Database. Water Operations: Reservoirs, Dams & Hydropower. [Web Page]. Located at: http://www.usbr.gov/gp/lakes_reservoirs/ . Accessed on: August 8, 2011.

U.S. Nuclear Regulatory Commission (U.S. Nuclear Regulatory Commission (NRC). 1979. Description of the United States Uranium Resource Areas and Supplement to the Generic Environmental Impact Statement on Uranium Milling, RG-0597, June 1979.

Williams, J. 2013a. Personal communication [July 29 email to J. Cearley, ARCADIS U.S., Inc., Highland Ranch, Colorado Regarding Niobrara River Flow Measurements. Nebraska Department of Natural Resources, Lincoln, Nebraska. Referenced on Table 6.1-13.

Williams, J. 2013b. Personal communication [July 22 email to J. Cearley, ARCADIS U.S., Inc., Highland Ranch, Colorado Regarding Niobrara River Flow Measurements. Nebraska Department of Natural Resources, Lincoln, Nebraska. Referenced on Table 6.1-14.

Section 7 Cost Benefit Analysis

Advameg. 2010. Crawford, NE (Nebraska) Houses and Residents. [Web Page]. Located at: http://www.city-data.com/housing/houses-Crawford-Nebraska.html. Accessed on: August 18, 2011.

Bureau of Economic Analysis (BEA). 2011. Personal Income and Per Capita Income by County for Nebraska 2005-2007. [Web Page]. Located at: http://www.bea.gov/regional/reis/. Accessed on: August 18, 2011.

Nebraska Department of Roads (NDOR). 2010. Annual Average 24-Hour Traffic; Year Ending December 31, 2010. [Web Page]. Located at: http://www.dor.state.ne.us/maps/Statewide%20Traffic%20Flow%20Maps/2010-Statewide-Traffic-Flow-Map.pdf. Accessed on: November 19, 2011.

U.S. Census Bureau (USCB). 2011. 2010 SF1 100% Data. [Web Page]. Located at: http://factfinder2.census.gov. Accessed August 18, 2011.

U.S. Department of Labor, Bureau of Labor Statistics (BLS). 2011. Labor Force Data by County, Not Seasonally Adjusted, November 2008-December 2009. [Web Page]. Located at: http://www.bls.gov/lau/laucntycur14.txt. Accessed on: August 18, 2011.

Ux Consulting Company, The (UxC). 2011. Ux Weekly. [Web Page]. Located at: http://www.uxc.com/review/uxc_Prices.aspx. Accessed on: October 19, 2011.

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Appendix A

Water User Survey Information for Active and Abandoned Water Supply Wells within 2.25-Mile Area of Review

Appendix B

Calibration Records for
Marsland Expansion Area
Meteorological Station

Appendix C

Geophysical Boring Logs

Appendix D

Well Plugging and Abandonment Records

Appendix D-1

Oil and Gas Plugging Records

Appendix D-2

Water Well Abandonment Records

Appendix E

Water Well Registration and Completion Records

Appendix E-1

Water Well Registration Records

Appendix E-2

Water Well Completion Reports

Appendix F

Pumping Test #8 Report

Appendix G

Mineralogical and Particles Size Distribution Analyses

Appendix G-1

Mineralogical and Particles Size Distribution Analyses (2011)

Appendix G-2

Mineralogical and Particles Size Distribution Analyses (2013)

Appendix H

Flora and Fauna Lists

Appendix H-1

Plant Species List

Appendix H-2

Mammal Species List

Appendix H-3

Bird Species List

Appendix H-4

Amphibian and Reptile Species List

Appendix H-5

Fish Species List

Appendix H-6

Macroinvertebrate Species and
Relative Abundance

Appendix H-7

Range Maps for State and Federally Listed Threatened and Endangered Species for Dawes County, Nebraska

Appendix I

Standard Operating Procedures
for Air Particulate Samplers

Appendix J

Groundwater Analytical Lab Results

Appendix K

Hydrologic and Erosion Study Report for Marsland Expansion Area

Appendix L

Crow Butte Solubility Characteristics of Crow Butte Yellowcake

Appendix M

MILDOS Analysis for Marsland Expansion Area

Appendix N

Wellfield Decommissioning Plan
for Crow Butte Uranium Project

Appendix O

Swift Fox Survey Protocol

Appendix P

Cost Estimate for Decontamination, Decommissioning and Reclamation of Proposed Marsland Expansion Area (One Mine Unit)

Appendix Q

Energy Laboratories, Inc.
Explanation of Lower Limits of
Detection for Marsland Baseline
Samples

Appendix R

Siting of Meteorological Instruments

Appendix S

Justification for Use of 15 Years of Scottsbluff Meteorological Data

Appendix T

Marsland Water Balance
(Production, Restoration and
Stabilization Sampling)

Appendix U

Santee Sioux Nation Traditional Cultural Properties Survey Report for Crow Butte Operations

Appendix V

Nebraska Game and Parks Commission Consultation Letter for Marsland Expansion Area

Appendix W

Marsland Expansion Area
Drawdown-Distance Analysis
Assumptions

Appendix X

Three Crow Expansion Area
Cross Sections